WEEG NEWSLETTER April/May 2020

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: Hydraulic engineering is of course not only important for rivers, the coastline, hydropower and so on, but also for food production. In this issue, we look at the hydraulics of algal ponds – an area which, despite its potential economic importance, has been woefully neglected.

Hydraulic Engineering International: *Engineering of algal ponds*

What actually are algal ponds, some of our readers may ask? Well, they are shallow raceway-type basins with depths of 0.2 to 0.5 m, widths up to 12 m and lengths of 3-400 m as shown in Fig. 1. In these ponds, algae are grown for food, as basis for cosmetics, for fish food and a variety of other purposes. Similar systems can be used for wastewater treatment.

Fig. 1: Typical raceway type algae pond

The water containing the algae is usually kept in motion by paddlewheels, just about visible in the picture, at velocities of 0.2 to 0.3 m/s. The water has to be mixed to bring the lower strata up towards the surface to promote algal growth. In 'clean' (non-wastewater) systems CO2 and nutrients must be added and O2 removed. Power is required to drive the flow and to overcome the losses created e.g. by the 180 degree bend.

Strangely enough, although the power required for the paddlewheel is possibly the highest contributor to the system's energy demand, the hydraulics of the raceway - which determine the energy demand - have not really attracted much attention.

So, as part of the FP7 ALL-GAS project (www.all-gas.eu), we did some tests to look at the losses in algal raceways to determine loss coefficients and also as a basis for the development of a hydraulic model for the raceway. We used a 2 x 50 m long, 1 m wide experimental raceway in Almeria/Spain, Fig. 2.

Fig. 2: Experimental raceways in Almeria

Now, with flow velocities of 0.2 to 0.3 m/s, you can imagine that losses in the bends will be very small, in the mm-range. At the same time, the bends are 50 m apart and we also wanted to measure the surface gradient. This requires complex, sophisticated and extremely accurate measurement equipment. We did not have this on site so we went back to the water harp, which is neither complex and sophisticated nor expensive, but very accurate indeed.

What is a water harp, some readers will ask? We all know the principle of interconnected tubes: the water level at one end is exactly the same as at the other. So we bought 100 m of flexible plastic tubing with 5 mm diameter. One end of the tube went into the water where we wanted to measure the water level very precisely; the other end was connected to a 40 mm diameter plastic tube.

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Fig. 3: The water harp

All these tubes were put together in a wooden frame, et voila: here is your water harp in Fig.

3. You can see how the water level drops from the paddlewheel (left tube) to the end of the last bend. A ruler was placed in the centre of the frame, and a picture taken for each specific set-up. With the ruler, we could calibrate the scale and then determine the water level differences to 1/10 mm accuracy. The water harp allowed us to measure differential water levels extremely accurately over long distances without even having to think of a surveying instrument, ultrasonic probes, data acquisition computer and software - or money.

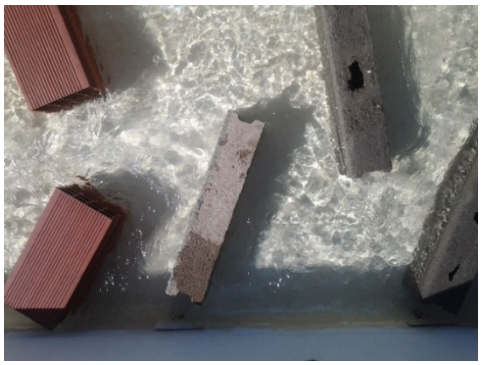

Fig. 4: Bricks used to create head drop

Using bricks as obstacles, we could also increase the effective length of the raceway by generating a head drop (Fig. 4). From the tests, we got values for the head loss coefficient in the bend. We also found the paddlewheel does not push the water around, but creates a head difference which then drives the flow. This in turn allowed us to develop theoretical models for the raceway showing that it constitutes a gravity flow driven by a surface gradient. Further analysis indicated the specific energy demand is very high for short raceways, and that there is actually a minimum point. There is also a maximum possible length for a given water depth, although we are not yet quite clear what happens if the raceway exceeds this.

New grant awarded

As it happens, we are part of a consortium to develop a large algal production facility in Morocco and were just awarded ~£500k (out of a total project budget of several millions) to develop the theoretical models of algae ponds further. The consortium is headed by Susewi Ltd., a company which specialises in algae production for fish food.

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Cyclone Amphan hits our study area

Dr Derek Clarke with an international team of experts has been looking at environmental risks and how these affect the UN Sustainable Development Goals. We have been working in the Ganges delta region of West Bengal (India) and Bangladesh. Issues being evaluated include the effect of sea level rise, climate change, and increased population pressures.

We hope to provide guidance on how to manage these problems and maintain the biodiversity in the Sundarbans Mangrove Forest World Heritage Centre.

One of the strongest cyclones in recent history struck the region between Calcutta and Bangladesh which is the main focus of the research project. Our colleagues in Calcutta have been severely affected with loss of electricity, water, phone and internet connections. Reports say that many rural areas are under 1-2 m of sea water, which has badly damaged farms and crops in the region. Our best wishes to those affected - another sad reminder of the urgency of these issues.

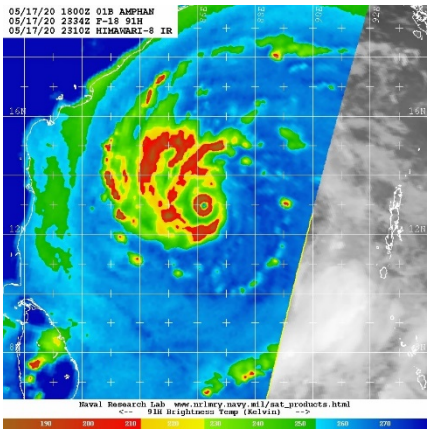

Fig. 5: Cyclone Amphan in Bay of Bengal (source: https://www.nrlmry.navy.mil)

Jobs in water engineering:

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

Advert: A senior post with a leading company

Principal Engineer- Water Sector

https://careers.snclavalin.com/job/principal-civil-engineer-water-sector-in-london-jid-12197

Civil and Environmental Engineering at Southampton University:

WEEG: Civil and Environmental Engineering modules offer the chance to deepen your knowledge in water-related areas, and prepare you for environmental engineering projects.

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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/

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