WEEG NEWSLETTER October 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: in the very first edition of our WEEG newsletter, we looked at the Kariba Dam and the erosion of the plunge pool. At the moment, there is a huge project underway to reshape and thereby stabilise the pool – the Kariba dam rehabilitation project. (For any cineasts, the word 'rehabilitation' has of course taken on a rather different meaning ever since the film 'Idiocracy' was released, but let's forget that for the time being...)

Hydraulic Engineering International: *the Kariba Dam rehabilitation project*

The Kariba dam is located on the River Zambezi, at the border between Zambia and Zimbabwe. It has a height of 128 metres and a length of 579 metres. The resulting Lake Kariba extends for 280 kilometres, with a volume of 85 cubic kilometres of water. The power station has a capacity of 1.626 GW.

Fig. 1: The Kariba Dam

The dam was operational in 1977. In 2013, the electricity generation capacity was increased by 300 MW.

The Kariba Dam's is built on basalt rock. Its plunge pool is a rock pool with an original depth of 10 m. By 2018 it has reached a depth of 90 m, with the erosion still ongoing, and that's the main problem. There were several attempts at repairs, but the erosion continued, endangering the stability of the dam itself. Fig. 2 shows the plunge pool erosion. The Kariba Dam Rehabilitation Project KDRP was initiated in 2014 to stop depth erosion. The project has a pricetag of US$294M, and involves the reshaping of the plunge pool, the strengthening of the rock base with a concrete layer and rehabilitation of the spillway.

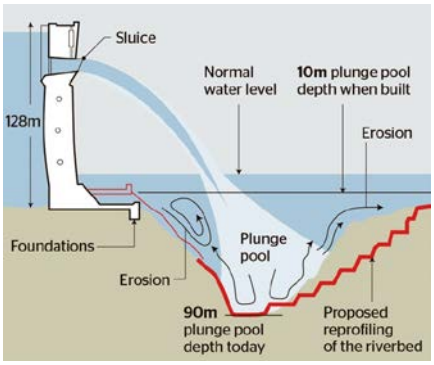

Fig. 2: Plunge pool erosion

In order to reshape the plunge pool, a massive cofferdam was built downstream. The pool itself was then pumped out in 8 steps to avoid endangering the dam. Then in 2018 the reshaping started. Fig. 3 shows the cofferdam from the plunge pool side

Fig. 3: The cofferdam and plunge pool

The rock face closest to the dam will have a concrete layer to reduce erosion, the river side is stepped to widen the basin.

Fig. 4: Reshaping the plunge pool

Fig. 4 gives a good impression of the magnitude of the reshaping works. The works are expected to be completed in 2025.

So, why should the KDRP stabilise the pool bed and achieve something that was not achieved (or foreseen, for that matter) before? Well, the deign relies on some rather sophisticated analysis of the effect of high speed jets on pool beds. Still, there are questions about why the jet of the falling water does not diffuse in the large depth of the pool. Has it something to do with large vortices forming on both sides of the jet (Fig. 5)?

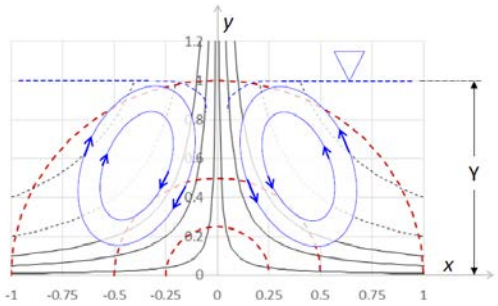

Fig. 5: Vortices allow for deep jet penetration

That could also explain how eroded material is transported from -90 m at the bottom of the scour hole to -10m, which is the river bed.

New measurement technology available: *Particle Image Velocimetry – PIV*

PIV is a non-intrusive measurement technique to map flow fields using optical methods.
In a previous Newsletter (see February 2019 at http://hydro.soton.ac.uk/resources/newsletters/) we talked about what Particle Image Velocimetry (PIV) is and how we set up an economic system for our labs. A recent IP was so successful in using this technique that we recently commissioned a much more powerful PIV system for research-oriented projects.

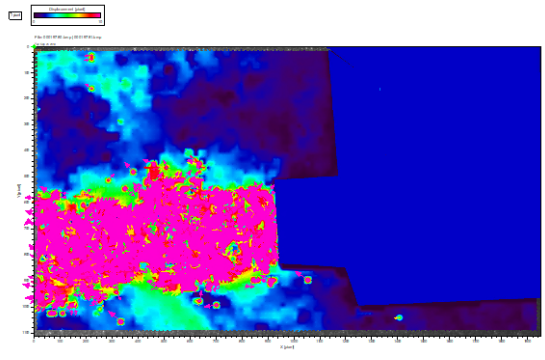

Fig. 6. PIV application. The two top images are used to produce the contour map shown below, helping visualise the water jet.

The detail of the velocity fields that can be obtained with it is pretty impressive, as you can see in Fig. 6. If you want to learn more about this technique or equipment, please contact Dr Gustavo de Almeida (G.deAlmeida@soton.ac.uk) or Dr Sergio Maldonado (S.Maldonado@soton.ac.uk).

IP project: Bioplastic production from wastewater

Sewage represents an important carbon resource that can be used to produce useful materials such as bioplastics, e.g. polyhydroxyalkanoates (PHA), as illustrated in Figure 7. The enrichment of PHA-producing bacteria and optimisation of conditions for PHA production are very important to achieve the highest possible productivity. This IP project aims to investigate the effects of pH, dissolved oxygen levels and VFA concentrations on PHA accumulation in bacteria in order to maximize PHA production from wastewater.

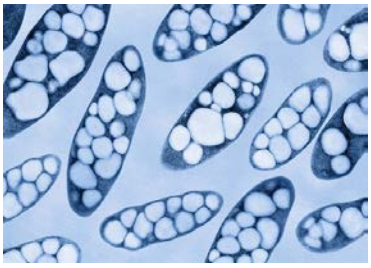

Fig. 7: PHA granules stored in bacteria seen under scanning electron microscope

Jobs in water engineering:

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

Advert: Lots of interesting jobs going with well-known company Jacobs - see e.g.

Senior Water Resource Engineer

https://jacobs.taleo.net/careersection/ex/jobdetail.ftl?job=BI0006B1&tz=GMT%2B00%3A00&tzname=

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. 178, Room 5008

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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