WEEG NEWSLETTER January 2018

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: The energy in ocean waves has the potential to supply 15% of the world's energy demand. After the oil crisis in the late 1970s, scientists started to look seriously at this power source and a lot of research has since gone into wave energy. But wave energy has a pre-history too: in the late 19th and early 20th Century, there was a real wave power craze in California where hundreds of projects were developed. Sadly, this is practically unknown although it produced a so-far-unbeaten record holder. So, here's the story.

Hydraulic Engineering International: *The Californian Wave Power Craze*

In the late 19th Century, the population and the economy of California were growing rapidly. This led to a substantial increase in the demand for energy. The long coastline, with waves pounding it near continuously, appeared to inventors and many others to be a potential source of energy. In consequence, a large number of wave energy converters, or 'Wave Motors' as they were called, were proposed, and many of them actually built. Strangely, there appeared to be no scientific input at all: the *Los Angeles Herald* reported in 1909 that there were "*175 different schemes for utilizing wave power, each representing as many different notions, not scientific knowledge, about wave action*." A large variety of operating principles was employed. There were heave (e.g. Holland's Wave Motor of 1896) and surge converters (Reynold's Ideal Wave Motor of 1907), flap-type devices with vertical or horizontal axis of rotation, Fig.1, as well as oscillating water columns or combinations of these principles.

Fig. 1: Edward's Wave Motor (1909)

Power take-off principles ranged from the compression of air, to a combination of ratchets and flywheels to the pumping of water into reservoirs to drive a water turbine. The first motor mentioned in the newspapers was Stern's motor near Cliff House, San Francisco built in 1886. The inventor claimed a power of 10,000 horsepower, although that was already doubted at the time. Not much is known about its working principle. It was destroyed when a ship loaded with 40 tons of dynamite grounded nearby, and exploded. A large number of further projects emerged, some real, some imaginary, nearly all of them failures. In its 1920 edition, the Encyclopedia Americana concluded: "*The history of all other devices that have been tried is more or less similar, and educated engineers have come to regard the wave motors as akin to the perpetual motion delusion*".

This, however, leaves out the story of Armstrong's Wave Motor of 1898. It consisted of two vertical shafts of 2.4 and 1.5 m diameter driven into a rock cliff near Santa Cruz. These were connected with a horizontal shaft located below low water level.

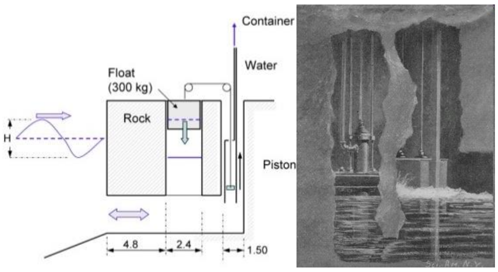

Fig. 2: Armstrong's Wave Motor (a) Principle, (b) Sketch (from *Scientific American*)

Inside the larger vertical shaft, a float of 600 pounds mass was located, Fig. 2. This float was connected through a pulley system to a submerged piston pump in the smaller shaft. With the wave crest, the float was carried upwards and the pump drew water. During the wave trough, the water level dropped, and the float pulled the piston of the pump upwards, pumping water into a container 20 m above cliff level. The water was used to sprinkle the coast road, to reduce dust. Armstrong's Wave Motor was in operation from 1898 until 1911: to our knowledge this is still the longest continuous operational time of any wave energy converter built so far.

The wave power craze finally ended in 1947 with "Professor" Reece's wave motor As usual, the motor was not a success. In all, at least 26 prototypes were built, most of which however either did not function, and/or were soon destroyed by waves.

Upcoming MSc projects: an*aerobic granular sludge with different calcium concentrations*

Aerobic granular sludge is a novel technology for biological wastewater treatment. Due to its excellent settling ability and compact structure, it is considered as ***the*** most promising technology to replace conventional methods. In the UK, three commercial sewage plants with aerobic granular sludge are under construction.

Water hardness, and especially calcium ion concentrations, varies considerably from Scotland to England. Generally, the water is softer in the north and harder in the south. The effects of calcium on aerobic granulation and on pollutant removal are still unknown. This project will investigate the formation of aerobic granules at different calcium concentrations, and the effects of substrate type and calcium concentration on granule characteristics. The results will provide guidance for this operation for different water hardness.

Supervisor: Dr Y Liu, email: Y.Liu@soton.ac.uk

Fig. 3: spherical aerobic granular sludge

New research project: *The effect of debris accumulation at bridge piers*

The main cause of failure of bridges across rivers is scouring or the undermining of bridge piers. Here, the acceleration of the flow caused by the piers – which reduce the cross sectional area of the river – is a pivotal point. During flood events, rivers also transport floating debris which accumulates at bridge piers, further increasing the flow velocity, the forces acting on the bridge and the danger of failure. The project partners, Network Rail and the Environment Agency, are directly affected by the issues above: Network Rail owns more than 8,000 bridges near or close to waterways, while the Environment Agency owns approximately 2,000 bridges over water courses. Recent research conducted at the University of Southampton has delivered a step-change in our understanding of how debris jams at bridge piers grow. These new results and predictive capabilities now pave the way for significant improvements in the way that the project partners assess risk, and therefore to a more effective use of resources to mitigate the risk of failure of critical infrastructures.

Fig. 4: Scour hole at bridge pier

Jobs in water engineering:

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

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 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/

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