WEEG NEWSLETTER April/May 2021

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 we think about waves, images of breakers on a beach, rolling wave-trains, surf waves and so on may come into our mind. There is however one particular type of wave which does not occur often, but has some surprising aspects – meet the *SOLITARY WAVE*....

Hydraulic Engineering International: *Solitary waves*

In 1833, when observing the motion of a canal boat, the Scottish Engineer John Scott Russell noticed that when the boat suddenly stopped – it hit a bump on the canal bed – a rounded, smooth and well-defined heap of water formed at the boat, travelling with great velocity forward without change of form or speed. This was the discovery of the wave of translation, or better, the ***solitary wave***.

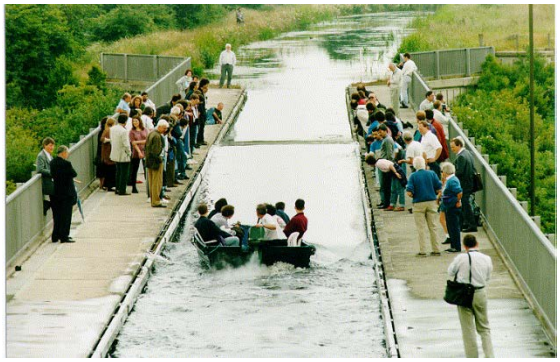

Fig. 1: Re-creation of Scott's solitary wave

We all know ordinary common-or-garden type waves as we can see them on beaches. Rolling wave crests and troughs, continuing endlessly. These waves are characterised by the fact that they transport energy, but not mass.

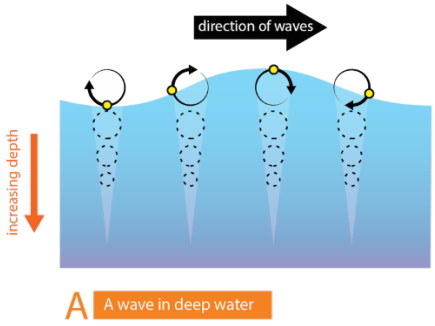

Fig. 2: Particle motion in propagating waves

The particles in fact have an orbital motion, which you can see when you focus on small floating items or foam specs on the surface: they move fore – and backwards, and on average remain where they are. Nearly, but that's another story.

Anyway, there is also this other type of wave which has a wave crest only, a wave length which is infinite, and which actually transports water: the solitary wave.

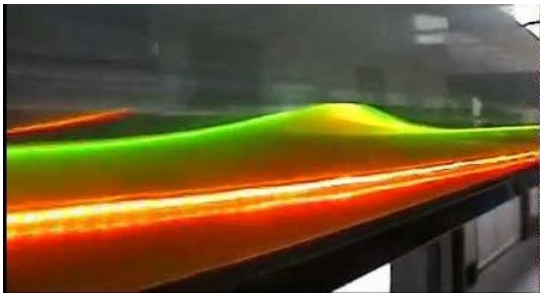

Fig. 3: Solitary wave in a laboratory

The solitary wave fascinates mathematicians and physicists, but it also has some engineering applications. We all remember the pictures of tsunamis in Japan hitting and flooding the coastline - clearly the wave here transports mass, and solitary wave theory Is often used to simulate tsunami waves.

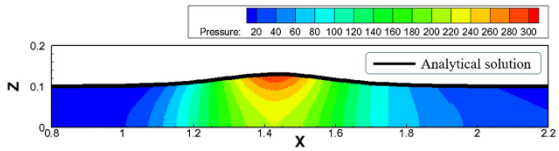

Fig. 4: Particle velocities in a solitary wave

In tsunami modelling, the vertical displacement of the seabed generates a series of waves which eventually – when approaching the shoreline – develop into something quite close to solitary waves.

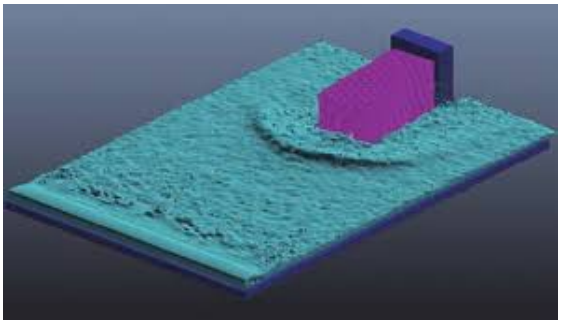

Fig. 5: Computer simulation of a tsunami wave

Solitary waves did, however, have another quite surprising application, linked to the facts that the wave transports mass, that it moves quite

fast and that it does not diminish in speed. You may have guessed it: *the express canal service*. ***Let's go back in time - the 1830s***; the place - a canal in Scotland. Canal boats then were towed by horses and were very, very slow.

Fig. 5: Horse-drawn canal boat

A man called William Houston operated a canal boat service from Paisley to Glasgow in those days. One day, "*his horse took fright whilst towing an empty boat, and bolted. He decided to hang on, expecting the resistance of the boat to quickly tire the horse. Imagine his alarm when the boat rose up onto its bow wave and shot off along the canal at high speed.*". Now, what had happened here? Well, the sudden acceleration of the boat had created a solitary wave, on which the boat was riding at high speed. Since the water particles at the wave crest move with the wave, there was no velocity difference between boat and wave, and the flow resistance was minimal. Mr Houston, being Scottish, immediately saw the business potential and established an express canal boat service between Paisley and Glasgow which travelled at 10 – 12 mph, much faster than the 4 mph of the horse-towed boats.

The idea was soon taken up by other canal operators, one claiming that a 22-tonne boat could be drawn at 12 mph by one horse only. I estimate the power requirement as 0.3 to 0.4 kW, the same as a small e-bike. Eventually however express boats disappeared, since the railways took over.

What could this mean? Well, today we all are looking to save energy. Could this type of energy-saving water transport be revived? Also of course we must admire Mr Houston's business sense, he saw an opportunity and jumped on it.

3rd year Individual Projects (IPs): *Sudden deceleration of an open channel flow*

The sudden deceleration of fast-flowing water in a canal occurs e.g. at the inflow of hydropower stations, or – strangely enough – when a tsunami bore hits a vertical wall. One of our IP students, Dawid Cisewscki, investigated the problem theoretically and conducted tests with a sudden deceleration. Interestingly, the reflected bore had a height well above the total energy line – this indicates that the fast flow continuously pumps water into the bore until it is high enough.

Fig. 6: Sudden deceleration experiment, Fr = 1.8

We also found that the theory in the textbooks underpredicts the experimental results (see Fig. 7). Needless to say, we managed to update the theory...

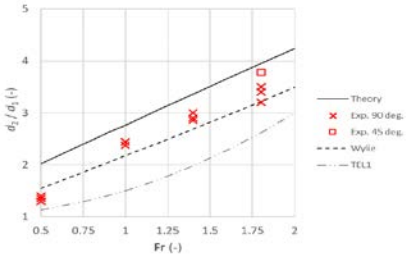

Fig. 7: Experimental results

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Jobs in water engineering:

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

Advert: A slightly different type of job this time, but we have a strong interest in finding the ideal candidate:

Professor of Environmental Engineering

https://jobs.soton.ac.uk/Vacancy.aspx?ref=1381721DA

Civil and Environmental Engineering at Southampton University:

WEEG: our modules offer the chance to deepen your knowledge in water-related areas, and give better preparation for environmental engineering projects.

Contact: Dr Sonia Heaven, s.heaven@soton.ac.uk, Bldg 178, Room 5021

Further information:

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

www.facebook.com/Hydraulicslaboratory/

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