Built environment

CSIR coastal engineering expert wins JD Roberts Award

The development of innovative methods for effective monitoring of harbour and coastal structures is one of the factors that came into play when Dave Phelp of the CSIR was selected as the 2009 recipient of the prestigious JD Roberts Award in July.

The CSIR's Dave Phelp, winner of the 2009 JD Roberts award (centre), with (from left) Carien Botha, Murray & Robert Executive for Innovation; Ann Jones, daughter of the late Dr Douglas Roberts; Brian Bruce, Murray & Roberts Group Chief Executive; and Hans Ittmann, Executive Director, CSIR Built Environment

Dave Phelp with a model ship in the CSIR's physical modelling laboratory in Stellenbosch

Phelp's outstanding leadership in technology research and development is clear, as reflected in the successful realignment of the CSIR's physical modelling laboratory in Stellenbosch to become a world-class facility. This research facility plays a major role in enhancing port and coastal engineering capabilities and expertise in South Africa.

The annual JD Roberts Award was instituted by Murray & Roberts in the late 1970s in remembrance of one of the group's founding fathers, Dr JD 'Douglas' Roberts. Roberts was a doyen of the construction industry in South Africa, well known for his entrepreneurial flair and passion for seeking and trying new techniques and ways of doing things. The award recognises and promotes competitive and environmentally-sustainable solutions to human dilemmas and encourages scientific research into technology that will enhance the quality of life of all South Africans.

Pursuing safety

Coastal engineering methods play a major role in ensuring the safety and integrity of coastal facilities. Breakwaters and coastal structures are designed for dynamic stability and are progressively damaged during extreme storms, especially as a result of global warming and sea-level rise. The monitoring of their armouring is important to determine their present condition, performance against design criteria and the optimum maintenance requirements. Most of the damage occurs near the water line, in a very dynamic environment, where access and visibility are complicated and even dangerous.

Phelp has developed a novel aerial survey and analysis method that provides the required accuracy and reproducibility for monitoring the armouring of breakwaters and coastal structures. His method allows accurate comparisons to determine the amount of damage in a precise while corresponding closely with the way damage is recorded in physical models.

Several methods were used in the past, such as conventional surveys or a crane-and-ball profiling method. These methods have severe limitations, are costly and lack sufficient accuracy.

Flying into action

With GPS positioning, a helicopter can hover at predetermined positions above the breakwater. Digital photographs are taken from the above-water armouring along the structure at low tide. Using fixed marks on the breakwater or structure, the photographs can be adjusted in scale and angle by image processing software, to match exactly the previous set of photographs. With a flicker technique, the differences between the old and new images can be quantified in the form of damage or displacements.

This method was originally perfected in small-scale modelling of breakwaters in the CSIR's hydraulics laboratory in Stellenbosch. A series of fixed cameras is used rather than model helicopters to allow accurate assessment of damage of the structures as a function of the wave conditions. Digital image technology has been extended to accurately monitor the movement of moored ships and even the measurement of very small waves in the physical model.

Phelp has trained a number of researchers to undertake the new aerial surveys and perform the image processing and analysis for both model and prototype structures. All breakwaters and most coastal structures in South Africa are now being monitored by Phelp and his team, especially after severe storm events, such as those along the KwaZulu-Natal coast in 2007, and the Eastern Cape in 2008.

Under the scrutiny of international experts, this technology was recently used successfully for the model testing of a major new port, Khalifa, in Abu Dhabi.

The model monitoring system has been adopted by a number of world-class laboratories, including the Hydraulics Laboratory of the National Research Coun in Ottawa.

The application of the digital photography method to monitor moored ships has led to the development of the keogram method for very accurately monitoring the motions of model ships in the laboratory. Furthermore, the HarbourWatch system has been put in place, where images are taken of the harbour by a rotating camera at a port (currently the Port of Cape Town). These images are sent to Stellenbosch through radio telemetry and are stored and analysed. In this way, incidents or accidents in the port can be captured and analysed. The system is being extended to monitor the motions of ships moored in the port.

Advancing civil engineering

The hive of R&D activity in the model hall has attracted a number of civil engineers from Stellenbosch University to use the opportunity to choose port and coastal topics for their engineering projects and thesis work. The CSIR has an on-going agreement with the University to promote this field of civil engineering, which has a growing number of students, studying for both BSc and MSc degrees.

Phelp is a member of the Coastlab Network, an international network for small and medium coastal engineering laboratories, where model monitoring methods are shared. Phelp has been invited to collaborate with the coastal engineering section of the American Society of Civil Engineering, and to compile a
breakwater monitoring.

- Hilda van Rooyen