NEW DESIGN MEANS MORE SAFETY AND ACCURACY

USGS Tethered ACP Platforms

The US Geological Survey has developed an innovative tethered platform that supports an Acoustic Current Profiler (ACP) in making stream-flow measurements (use of the term ACP in this article refers to a class of instruments and not a specific brand name or model). The tethered platform reduces the hazards involved in conventional methods of stream-flow measurement. The use of the platform reduces or eliminates time spent by personnel in streams and boats or on bridges and cable-way and stream-flow measurement accuracy is increased.

One vital mission of the US Geological Survey (USGS) is to provide flow data for streams across the United States. The USGS began using ACPs to make streamflow measurements in 1985 and by the late 1990s, USGS use of ACPs for stream-flow measurement became commonplace.

Acoustic Current Profilers

Mounted on boats, ACPs can be used to measure water velocity, depth, boat speed and boat direction, capabilities that allow them to be used to measure stream-flow. An ACP measures stream-flow as the boat traverses a channel and the data is collected on a laptop computer as the measurement is being made. Usually, four to eight stream traverses (transects) are made, each producing a stream-flow value. Stream-flow measurement usually consists of the average of the four to eight transect stream-flow values.

Benefits of ACPs

The use of ACPs has reduced the hazards involved in using conventional methods to make stream-flow measurements. Conventional methods involve personnel measuring water speeds with mechanical, propeller-type current meters and measuring depths with wading rods or sounding weights suspended from a cable at twenty to thirty locations across a stream channel. Measurements made by conventional methods generally take longer than those made by ACP methods, thus increasing personnel exposure to potential hazards, and may not be as accurate as ACP measurements.

Tethered Platform

In 1998, the USGS Indiana office developed a prototype tethered ACP platform. The basic premise of the tethered-platform method consists of a lightweight, floating platform for an ACP; the platform can be pulled manually across a stream by a tether to make a stream-flow measurement. The prototype platform was designed as a safety consideration to reduce the time personnel spent on bridges or cableway; the platform also allowed access to sites with limited manned-boat access.

Prototype

The prototype tethered platform was a catamaran with floats constructed of polystyrene foam. The design emphasis was on speed and ease of use. Data telemetry was accomplished using two 900-megahertz (MHz) radio modems, one on the tethered platform connected to the ACP and the other on the shore connected to a laptop computer that ran the software and collected data from the ACP. A 12-volt gel-cell battery provided power for the ACP and radio modem. To make a stream-flow measurement the platform was carried to a bridge or cableway and lowered over the guard-rail into the stream. When the operator of the computer was ready, a signal was given to the platform operator to guide the platform across the stream by the tether, thus beginning a transect.

Refining the Platform

The prototype tethered ACP platform was used successfully to make stream-flow measurements and proved particularly useful for making measurements during floods. The USGS Indiana office built several similar tethered platforms for other USGS offices. The USGS Kentucky office had also developed a remote-controlled boat for conducting bridge-scour investigations. The tethered and remote-controlled platforms generated interest throughout the USGS because of the potential they offered in reducing personnel exposure to hazards. Recognising this potential, the USGS initiated a project to refine the tethered and remote-controlled ACP platforms.

The primary objective of this project was to develop and test designs for tethered and remote-controlled boats for increasing safety during stream-flow measurement. The project included the following major tasks: develop specifications based on a survey of user needs; investigate various models of radio modems for wireless data telemetry; investigate commercial availability of boat hulls; test and evaluate prototype hulls; and make designs available to other USGS offices.

Specification Development

A survey of user needs was sent to all USGS district offices and to other federal agencies known to use ACPs, asking users to specify desired features for the tethered platform, such as maximum length and weight. Based on the responses received, specifications were developed for a tethered platform. These were: maximum weight with payload, 18 kilograms; maximum length, 2.5 metres; maximum beam, 0.9 metres; maximum water velocity of streams where the platform would be used, 3.7 metres per second; minimum acceptable

time between battery replacement or recharge, 2 hours.
In order safely and efficiently to acquire ACP data from a tethered platform data needed to be transmitted wirelessly from the ACP to a laptop computer. A 900-MHz radio modem could be used for this purpose. Desired specifications for the radio modems were: ability to communicate reliably with the ACP, using the ACP data-acquisition software provided by the manufacturer; rugged, water-proof housing; 12-volt DC power; and, 115,200-baud data-communication capability with the ACP to maximise data throughput. A number of radio modems were tested; one model possessed all of the desired features.

Hull Evaluation
A search for possible off-the-shelf products did not yield any hulls that met the project specifications. Private vendors were commissioned to construct prototype hulls specifically designed for making ACP stream-flow measurements. The resulting hulls included two catamaran, two mono-hull, and three trimaran designs. Hulls were tested in a tow-tank at the USGS Hydraulics Laboratory at Stennis Space Center; hulls were tested in the field during ACP stream-flow measurements under various flow conditions.
For the tow-tank tests, each platform tested was fitted with an ACP and towed the length of the tank at varying speeds. Drag was measured for each platform with a strain-gauge meter that measured the force on the towrope. The drag each platform produced while being towed was recorded. The platforms were towed through the tank at speeds varying from 0.3 to 3.7 metres per second to simulate the desired flow rates in which the platform might be used. During some of the tow-tank tests, radio modems were used to acquire ACP data that included pitch and roll.
Field tests of the platforms included testing below the surface of a US Army Corps of Engineers (USACE) reservoir. The USACE increased the release of water from the reservoir during the testing to create high-flow conditions with velocities up to 2.2 metres per second. During these tests, each platform was fitted with an ACP and radio modem.

Test Results
The results of the testing indicated that, while any of the designs could be used under certain conditions, the best all-around performance under a wide range of conditions was achieved with the trimaran design with the ACP mounted in the centre hull. The cylindrical shape of the ACP produced a high amount of drag in the water; mounting the ACP in the streamlined hull reduced the drag considerably. The trimaran had lower drag while still retaining the stability of the catamaran design. The advantage of the trimaran is realised by combining the drag efficiency gained by placing the ACP in a centre hull with two outer hulls that give added stability. Placing the ACP in a hull also has the observed advantage of reducing the flow disturbance around the head of the ACP.

Widespread Use
Tethered platforms have become widely used in the USGS in making stream-flow measurements with ACPs, resulting in increased personnel safety and increased accuracy compared to conventional methods. Tethered platforms are particularly useful during floods, when hazards associated with operating manned boats can be great. More details concerning the USGS project to refine the tethered ACP platform can be found on the USGS Office of Surface Water Hydroacoustic Support World Wide Web site: http://hydroacoustics.usgs.gov.

Commercially Available Platforms
Tethered ACP platforms are now available from several vendors. They include a trimaran platform based on the designs that were tow-tank and field tested by the USGS. As of December 2002, about 130 trimaran platforms have been delivered to customers in North America, South America, Europe and Asia.