

Coastal Engineering Technical Note

THE COASTAL RESEARCH AMPHIBIOUS BUGGY (CRAB)

PURPOSE: To describe a recent innovation for improved surveying and data collection in the surf zone.

BACKGROUND: Scientists and engineers working in the surf zone are all too familiar with the difficulties of operating in such an active area. During high waves, the mere act of collecting data, regardless of its accuracy, can be a feat in itself. Consequently, our knowledge of the hydraulic and sediment motion in the zone of wave breaking is based primarily on theories and laboratory experiments with little field verification. Breaking waves also preclude accurate surveying of this zone using a conventional boat-mounted fathometer.

The Coastal Research Amphibious Buggy or CRAB (Figure 1) was designed and built by the Wilmington District Corps of Engineers for a cost of \$75,000 (1980 dollars); it is owned and operated by the US Army Coastal Engineering Research Center (CERC) to support coastal research studies at its Field Research Facility in Duck, North Carolina.

Though designed primarily for accurate surveying of the beach and nearshore zones out to a water depth of 30 feet (10 m), the CRAB can also be outfitted to perform various other tasks in the surf zone, such as taking sand samples, obtaining current and wave data, or serving as a stable platform for bottom coring and diving operations. Since it is able to operate in significant waves up to 6 feet

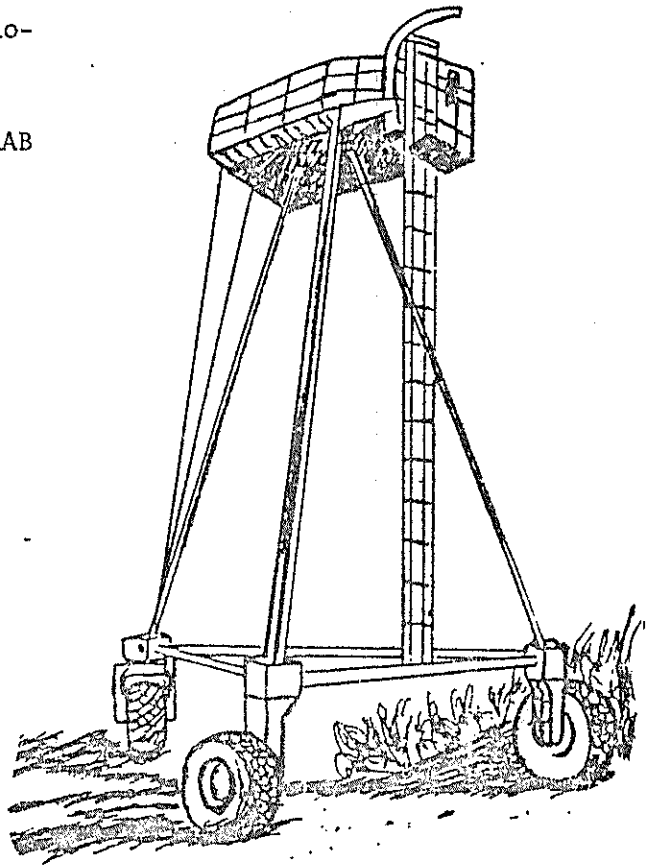


Figure 1. The CRAB

(2 m) in height, data can be collected immediately following coastal storms.

The CRAB is modeled after a vehicle originally built by Marine Travelift and Engineering for use in monitoring a beach nourishment project at Rockaway, New York. An earlier version 25 feet (7.6 m) high was built by the Wilmington District in 1978 to monitor beach nearshore sediment movement at New River, North Carolina. However, to allow for a wider variety of operations in deeper water, the CRAB height was extended to 35 feet (10.6 m), the deck was expanded, and a davit and power winch were added. The modified CRAB was delivered to the Field Research Facility in October, 1980.

SPECIFICATIONS AND CAPABILITIES: The CRAB consists of a tripod of 8-inch (20.3 cm) schedule-80 aluminum pipe tied together at the base by horizontal members 7 feet (2.1 m) above the ground. Power is supplied by a 53 hp Volkswagen engine* on the deck which drives a variable stroke hydraulic pump. This main pump in turn pumps hydraulic fluid at 800 psi (5.52×10^6 pa) or higher to hydraulic motors at each of the wheels. The variable stroke feature of the pump allows an infinitely variable gear ratio in either forward or reverse drive at constant engine speed. The system also supplies power steering to the steerable front wheel. For strength and corrosion resistance, all hydraulic lines are stainless steel except for short flexible sections at the front wheel. Total vehicle weight with ballasted tires is about 18,000 pounds (80 kN); about 15,000 pounds (67 kN) without ballast. The distance between the rear wheels is 27 feet (8.23 m). Though it appears top heavy, the liquid-filled (ballast) tires and wide wheelbase makes it very stable. It has passed a 20-degree tilt test and should be able to withstand even steeper angles. The large tires have only negligible effect on a hard rippled sand bottom. However, scour around the tires has been noticed in areas of active wave breaking or strong currents, and the CRAB cannot be used on soft silty or loose bottoms. Top speed of the CRAB is 2 mph (3.2 kph) on land and somewhat less in water depending on wave conditions. Because of its size and slow speed, it cannot be driven on the highway. It is most easily moved by Chinook helicopter, but without ballast it is near the helicopter's maximum payload weight. It can also be barged to a study area and off-loaded by crane. One major drawback of the vehicle is its lack of portability. Future CRABS could be designed to "break down" more easily into a mobile package which can then be transported by truck to a new location and reassembled.

SURVEYING: As important as the CRAB itself is the system used for surveying and positioning. The earlier CRAB used a Motorola Mini-Ranger* to determine the horizontal coordinates, and an automatic level and large stadia board were used to determine elevation.

*Mention of trade name does not constitute an official endorsement or approval of the use of such commercial products.

With the increased range and depth capabilities of the modified CRAB, such a system was no longer adequate. Therefore, a Zeiss Elta-2* surveying system with data recording capability was obtained (Figure 2). This instrument is at the state-of-the-art (1981) in electronic survey systems, and incorporates in one compact unit an electronic distance meter and theodolite, microprocessor, rechargeable power supply, and interchangeable solid-state memory. The cost for the instrument and associated computer interface equipment was about \$50,000.

When optically aimed at a reflecting prism assembly located on the CRAB, the instrument calculates, records and displays the X, Y and Z coordinates of the ground under the CRAB. The accuracy and operating range of the instrument depends on conditions and number of prisms used, but when used with a triple prism assembly on the CRAB, survey measurements can easily be made to ± 0.1 foot (0.03 m) or better at a range of 1 mile (1.6 km). Only about 10 seconds are required to aim, shoot, and record a data point. A typical survey of 50 points, over a 3,500-ft (1 100 m) long profile, takes about 45 minutes. Because the actual coordinates of each point can be displayed, the CRAB can be kept on line to within ± 2 feet (± 1 m) or better. It is also possible to direct the CRAB to a pre-determined location. This is most useful when repetitive surveys of complex bathymetry are planned. There is, of course, no requirement to survey profile lines since area surveying in 3 dimensions is possible. Land areas too steep to traverse with the CRAB are surveyed using a prism mounted on a range pole. Once a survey is completed, the solid-state memory is removed from the instrument and data are transmitted from a Zeiss-supplies interface through a computer terminal to a main-frame computer or directly to a desk top or mini-computer. Because the system is totally automatic, instrument reading errors and data entry errors are eliminated. A unique feature of the Zeiss system is its ability to accept and record additional pieces of information (up to 14 digits) on every point. This has been useful for manually entering the angular tilt of the CRAB (up to 14 degrees have been measured) which occurs on steep sections of the beach. This tilt is automatically compensated for when the data are processed.

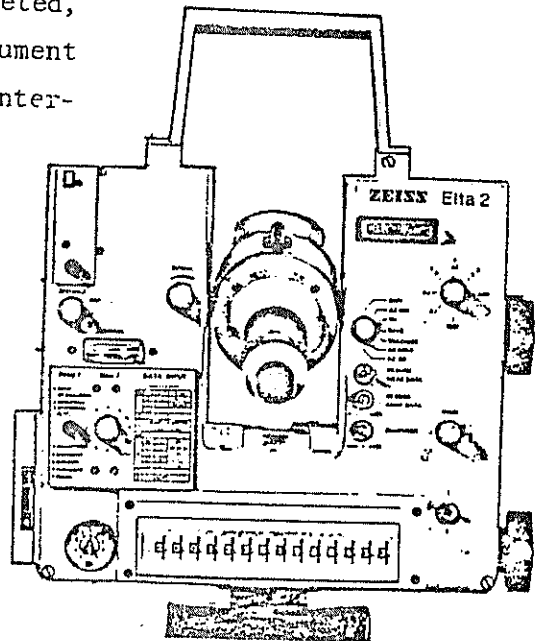


Figure 2. ZEISS ELTA-2 Surveying Instrument*

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The system has performed admirably providing highly accurate repetitive surveys at relatively low cost. For example, contractual cost for a conventional quarterly bathymetric survey of 26 profile lines at CERC's Field Research Facility for one year exceeds the total initial cost of the CRAB/Zeiss system. Costs for doing this work now are about \$1,000 per survey (plus an equipment amortization of about \$4,000) compared to about \$35,000 before. Most of this dramatic savings comes from the reduction in personnel. The CRAB survey can be accomplished by only 2 people (operators for the CRAB and the Zeiss) while 8 people were required for the conventional survey which consisted of using a sea sled nearshore and a fathometer offshore. Other intangible benefits of the system are reduced office time, faster data analysis, and higher accuracy. Idle time is also reduced since the CRAB can operate in more adverse wave conditions than conventional surveying equipment.

The high accuracy of the system can be seen in Figure 3 which shows repetitive surveys of a single profile line from June to September 1981. While there is movement of the nearshore bar during the period, of greater interest is the stability (accurate to ± 0.1 feet or 0.03 m, or better) of the offshore zone (deeper than 20 feet or 6 m). This accuracy would be difficult, if not impossible to obtain using any conventional survey technique.

SUMMARY: The CRAB-Zeiss system is an innovative multi-purpose tool for working in the nearshore zone. Its many advantages and varied uses make it a superb tool for the coastal engineer and promises to produce many interesting and unique data sets. It can also serve as a cost effective bathymetric survey system on coastal projects such as a beach nourishment or jetty construction.

ADDITIONAL INFORMATION: Contact the CERC Field Research Facility in Duck, North Carolina (919) 261-3511 and from the Washington, DC metro area 370-6423 or 370-6576.

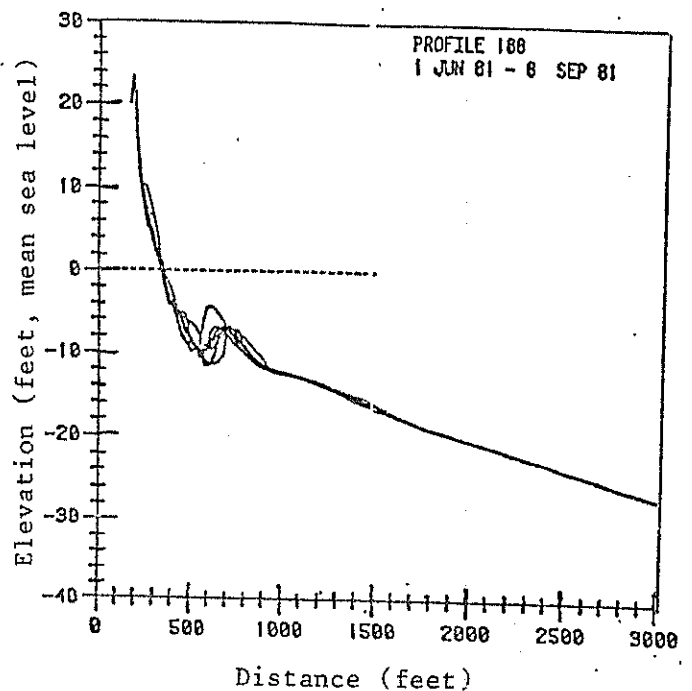


Figure 3. Sample Repetitive Surveys Using the CRAB/ZEISS System