US Army Corps of Engineers®
Engineer Research and Development Center

CRREL Ice Engineering Test Basin

Purpose

The Ice Engineering Test Basin of the Cold Regions Research and Engineering Laboratory is a large refrigerated room where multiple ice sheets can be grown and tested each week. It was designed primarily for larger-scale modeling of ice forces on structures such as drill platforms and bridge piers, and for tests using model icebreakers and where the model penetrates up through the ice using vertical lift systems. The Test Basin has been used

- To measure the vertical, horizontal, and impact forces of ice
- To study debris loading on structures
- To test vertical ice penetration
- To evaluate hull performance in ice
- As an ice-covered obstacle course for evaluating all-terrain vehicles.

The Test Basin is located in CRREL's Ice Engineering Facility, a unique hydraulic research and testing complex; there is no equivalent facility in the world. At the IEF, the impacts of ice on civil works flood control and navigation structures and waterways are studied in three separate areas: the test basin, the flume, and the research area. Refrigeration systems and computerized data acquisition systems provide state-of-the-art operation and capability, and separate temperature controls allow independent operation of each area.

Specifications

- The tank is 120 ft long × 30 ft wide × 8 ft deep (37 × 9 × 2.4 m)
- The main carriage has rack and pinion drive; carriage speed ranges from 1 in. to 7 ft/s at 1,000-lb load on the XYZ axis, and the high-force module underneath the carriage has screw drive with 10,000-lb XYZ load capacity.
- A second, tire-mounted carriage can characterize the ice sheet with plate deflection and cantilever beam tests and prepare the water surface for seeding the ice cover
- Both carriages are connected to utilities, the computer network, and fixed instrumentation
- Data acquisition and instrumentation systems can take 250 samples per second.
- Monorail system with 2.5-ton crane
- Tests use fresh water, salt water, or 1% urea-doped solution for scaling engineering properties of ice
- Ice sheets are grown with a practical range of ice thickness from 2–15 cm and ice strength of 20–120 kPa. The ice growth rate is 3 mm/hr.

Benefits

The Test Basin allows researchers to study the mechanical behavior of ice and ice–structure interactions and to measure ice forces. A towing carriage pulls structure models through the ice sheet. Bubblers on the bottom of the basin are used to ensure that the water is isothermal for maintaining uniformity of ice characteristics between ice sheets. The ice can be frozen to the walls to simulate a continuous cover, or wall heaters can create a free-floating cover.

A set-up pool at one end can be shut off from the rest of the basin and either drained or kept at a different temperature. At the opposite end, the wall is sloped and backed up to a large melt tank; when an experiment is finished, the broken ice can be pushed over the wall into this tank where it is then melted while a new ice sheet is growing, thus allowing experiments to continue on a daily schedule.

Fixed and mobile underwater cameras and lights allow for observation and documentation of the ice/structure interaction from beneath the ice cover. The room temperature can be controlled down to –20°F (–29°C) with very even temperature distribution, which results in uniform ice thickness. Other studies conducted in the Test Basin deal with ice problems in and around navigation locks, vertical uplift forces, and special ice features such as pressure ridges and brash ice fields for ship tests.

Success Stories

A physical model study for the Corps of Engineers was used to develop design criteria for rip-rap erosion protections for shorelines and riverbanks. Test variables included the size distribution of the stone used as model rip-rap, ice thickness, the slope of the beach, and the orientation of the beach with respect to impacting ice. The model beaches were mounted on a wheeled platform resting on the bottom of the tank that was pushed into the ice by the main carriage. Results of this study have been incorporated into the Shore Protection Design Manual for use by all Corps Districts.

One of the shoreline erosion protection tests on a 3V:1H slope with a 90° angle of attack.

Ice model tests were conducted for the National Science Foundation in the IEF Test Basin to help predict and improve the performance of vessels in ice-infested waters.

A model of the NSF research icebreaker RV Nathaniel B. Palmer *undergoing testing.*

Point of Contact

Contact Leonard Zabilansky at (603) 646-4319 or by email at Leonard.J.Zabilansky @erdc.usace.army.mil.