own antifreeze admixture from chemicals likely to be found in a cold-region theater of operation. The search for candidate chemicals is not limited to those that are benign to the long-term performance of concrete. Chemicals that allow concrete to remain structurally viable for as little as 6 months also will be considered. The product of this effort will be a "How To Do" pamphlet, which will detail mixing procedures, mixture proportions, chemical dosages, concrete strength estimates, and handling advisories. It will be followed by an update to Army manuals.

Figure 2 presents one of CRREL's findings. It shows that this particular admixture promotes a strength gain at 14 F that compares to that of normal concrete cured at 40 F. What's more, preliminary findings (not shown) suggest that concrete made with this admixture may be unaffected by temperatures as low as minus 4 F. Although it gains little usable strength at this low temperature, concrete seems to recover its full compressive strength when thawed.

The main drawback to this chemical is that it contains an alkali that may adversely affect the long-term durability of concrete. It causes certain siliceous aggregates to swell and crack the concrete. However, even in very high dosages, which CRREL does not recommend, the first cracking probably would not occur for 5 to 10 years. Concrete so affected probably would last many more years before its strength was greatly compromised. Since the only concern is for long-term applications, the chemical in Figure 2 was recommended as an antifreeze admixture for expedient cold-weather concreting in Bosnia (see user's guide, page 26).

Conclusions

Normal concrete cannot be exposed to freezing weather without some form of thermal protection, which places serious constraints on the use of concrete in cold-region theaters of operation. An alternative approach to cold-weather concreting is under development. When completed, it will allow military engineers to place fresh concrete for short-term applications at below-freezing temperatures without the need for heat. Following this 2-year study, longer-term topics aimed at providing military engineers with enhanced winter construction capabilities will be addressed.

For more information about cold-weather concrete operations or to see other cold-weather construction practices developed, contact Mr. Korhonen at the U. S. Army Cold Regions Research and Engineering Laboratory, 72 Lyme Road, Hanover, New Hampshire 03755; telephone, (603) 646-4438; fax, 603) 646-4640; e-mail, korhonen@crrel.usace.army.mil.

Mr. Korhonen is a research civil engineer at CRREL, dealing with maintenance and rehabilitation issues of military facilities in cold regions. He holds a master's degree in arctic engineering from the University of Alaska and is a doctoral candidate at Purdue University.

Army Division Advanced Warfighting Experiment

By Vern Lowrey

Six senior military evaluators from the U.S. Army Engineer School's Maneuver Support Battle Lab participated in the Army Division Advanced Warfighting Experiment (DAWE) at Fort Hood, Texas, 5-13 November 1997. The DAWE was a key event in Force XXI warfighting experimentation. Results of the DAWE directly impact the heavy division design decision, which is expected in February 1998.

The 4th Infantry Division conducted the exercise using the conservative heavy division design force structure. This design has three combat engineer battalions located in the division troops but no engineer brigade headquarters or commander. A 24-person engineer planning and operations staff is located at the division level.

In addition to the new force structure, several new engineer systems were included in the experiment. The three systems tested in each maneuver brigade and division tactical operations center were the Engineer-Obstacle Planner System/Tactical Engineer Command and Control System (E-OPS/TECCS), Digital Topographic Support System-Mobile (DTSS-M), and the Raptor Intelligent Combat Outpost. New systems simulated were the Grizzly, the Wolverine, the Heavy Dry Support Bridge, the Airborne Standoff Minefield Detection System (ASTAMIDS), the Deuce, and the multirole bridge company. These systems directly support the Force XXI objectives of gaining information dominance and conducting dominant maneuver.

The following key issues are being evaluated as a result of the DAWE:

- Operational and tactical impacts on the removal of the engineer brigade headquarters for the experiment.
- Operational and tactical implications of an engineer force structure that includes a mix of Active, Reserve, and National Guard forces.
- Impact of the combat service support redesign on engineer operations and logistical support to divisional and echelon-above-division (EAD) engineers.
- Impact of changing engineer capabilities for line-of-communication and main-supply-route missions throughout the division battlespace.
- Impact of digital terrain data management on the maneuver commander's visualization of the battlespace.
- Impact of EAD engineers integrating into a digitized environment with possible incompatible communication systems.

The DAWE has given us a view of the future of our Army. We have a long way to go, but there are new and exciting implications for mobility and survivability systems as well as for other operating systems.

Vern Lowrey is technical director, Maneuver Support Battle Lab, Fort Leonard Wood.