

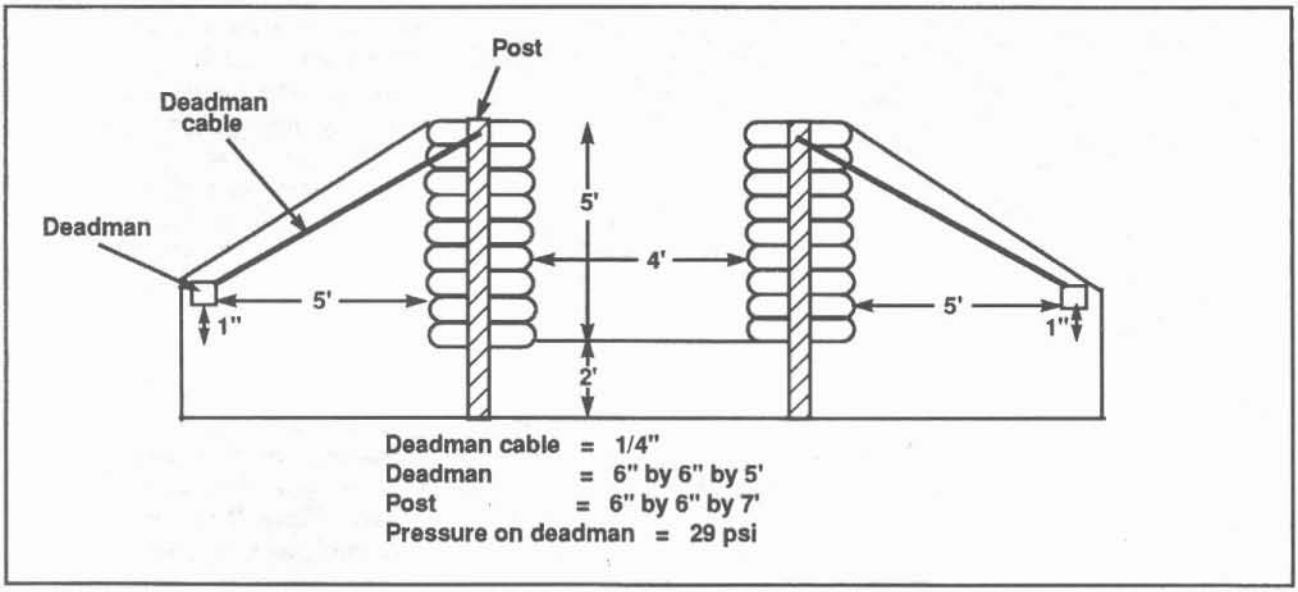
Building a Bunker/Trench Live-Fire Complex in Korea

By Captain Raymond E. Hart

Within the 2d Infantry Division in Korea is a unique organization—the 2d Brigade Combat Team—consisting of the 1/9 Infantry Battalion (Mechanized) and the 1/506th and 1/503rd Infantry Battalions (Air Assault, Light). The mission of the two light battalions requires extensive dismounted operations that include clearing prepared enemy defensive positions, such as extensive trench lines and bunkers. In the past, situational training exercises of this type required recurrent construction of small trenches, which the infantry cleared with grenade simulators, blank ammunition, and percussion grenades. The small trenches caused several training problems that impacted on the unit's wartime readiness:

- Hastily dug trenches and bunkers were not suited to heavy use during multiple iterations by a battalion-sized element.
- Temporary trenches required large amounts of manpower for construction and time for repairs, adversely affecting the training cycle.
- Practice trenches did not meet safety requirements necessary to conduct realistic live-fire exercises.

Since the 2d Infantry Division needed a permanent facility to train bunker and trench-clearing operations, the 2d Brigade Combat Team was challenged to produce a conceptual design and overwatch the construction. The team commander wanted a tactical scenario that provided an enemy defensive position with trench lines and bunkers suitable for use by squad-sized through company-sized units. The complex would provide an opportunity to exercise small-unit command and control and direct-fire coordination and offer a safe environment for throwing live grenades. The facility would be located in Cherokee Valley, part of the Eighth U.S. Army (EUSA) multipurpose range complex, approximately 17 kilometers west of Chongok. In February 1995, EUSA provided funds and resources for the construction.



Cross section of a representative trench

Mission Objectives

The complex was constructed by B Company, 2d Engineer Battalion, 2d Infantry Division, assisted by the 82d Combat Support Equipment (CSE) Company, elements of the 2d Korean Service Corps Company, and platoons from the 1/506th and 1/503rd Infantry Battalions. The original specifications required two trench lines with a single interconnecting trench. The trench system included six bunkers and numerous target wells. To turn the concept into a reality, they—

- Developed a safe design for a live-fire complex with interconnecting trenches.
- Used discarded vehicle tires as the primary construction material.
- Organized the soldiers to efficiently accomplish the mission.

Because of the complexity of the project and the number of agencies and personnel involved, the mission objectives were divided into two phases. Phase I consisted of gathering information and conducting an initial reconnaissance. The information required included the conceptual design, the bill of materials, and the safety requirements outlined by the division safety office and range control. Phase II consisted of a detailed reconnaissance with all the key players to finalize the site layout, tactical scenario, structural design, and safety requirements.

Design and Planning

The design linked the requirements of the tactical scenario, training objectives, and safety requirements to the realities and constraints of the available terrain and material. The two main trench lines were on level ground, running along the hillside. The interconnecting trenches ran up and down the hill between the upper and lower trenches, an approximate elevation difference of 16 feet. The bunkers were 5 feet by 4 feet, small enough to contain the blast of a fragmentation grenade. A small opening in each bunker allowed grenades to be thrown inside. Built with durable, blast-resistant tires filled with soil, the bunkers will withstand numerous blasts.

The trenches have 5-foot-high tire walls supported by 6-inch by 6-inch posts and deadmen (see photo and figure). Used tires provide a readily available and free building material that will hold up under live fire. Conventional construction materials—lumber, plywood, nails, and bolts—were unacceptable for several reasons. An extremely expensive building material in Korea, lumber splinters easily when hit by live grenades and small-arms ammunition and requires extensive and costly repairs. In addition, the nails and bolts holding lumber in place create a safety hazard from ricocheting munitions.

Tire preparation was a critical task and a choke point. Work crews separated the tires by diameter and packed the tire walls with soil before putting them in place. Every third



View of upper trench with walls at one-half their finished height. Notice that every third stack of tires is supported by a post.

stack of tires was supported by a 6-inch by 6-inch by 6-foot 6-inch post. They were driven 2 feet into the ground and secured with a 1/4-inch cable attached to a 6-inch by 6-inch by 5-foot deadman buried adjacent to the trench. Intermediate stacks had U-shaped pickets to provide rigidity and support to the wall. Using 16-gauge wire, a separate crew laced every tire to those above and below it and to the tire on each side.

Since Korea receives heavy monsoon rains in the summer, adequate drainage was a major consideration in the facility design and construction. To aid with runoff, they built trenches on a 2-percent slope leading to french drains that transported water under the trench walls to a nearby stream. Each trench was lined with gravel to facilitate runoff and add solid footing. An intercepting ditch on the upper slope of the trench lines minimized runoff from the valley walls.

The unit developed an initial activities list and an estimate sheet for each activity. Since standard work rates for this type of construction were not available, initial work rates were based on estimates and verified during construction. B Company discovered that troop efficiency fluctuated constantly because of weather, work-crew experience, terrain, and the length of work periods. The critical path method (CPM) required daily updating as time estimates were verified and variables changed.

Design adjustments were made based on guidance from the 2d Brigade Combat Team, the division G3 and safety offices, and the materials available. The changes maximized safety and training benefits and resulted in a design that exceeded the original request. The final design included a 328-foot (100-meter) upper trench, a 246-foot (75-meter) lower trench, seven bunkers, and more than 328 feet (100 meters) of interconnecting trenches. The completed trench complex can provide scenarios for live-fire exercises for squad- through battalion-sized units.

Challenges

Several challenges unique to the project required innovative solutions. First, B Company had to complete a section of the trench and several bunkers by mid-April so the 1/503rd Infantry and the 2d Infantry Division safety office could proof the design. Proofing went well because the sunken bunker floor greatly reduced the grenade blast angle, allowing very little shrapnel to exit the bunker.

The next challenge was to interconnect the trenches. With the 16-foot elevation change, interconnecting the trenches required stairs. Because of the size, shape, and slope of the site, traffic required careful monitoring. The 82d Combat Support Equipment Company constructed several terraces between the upper and lower trenches to facilitate backfill operations and spoil removal. Equipment was kept away from the newly constructed trenches to avoid digging up the deadmen or collapsing the trench walls. The slope and limited work space required skilled supervisors and operators, who had to be cognizant of their location and objectives at all times.

Using tires as the primary construction material presented the greatest challenge. Since

no single tire size was available in sufficient quantity to complete the entire project, tires were sorted by size and serviceability. Tire availability constantly affected the work rate and occasionally caused minor design modifications. When the local supply fell short of the requirements, the Korean Army allowed access to its stockpiles.

The construction site was characterized by rocky and often frozen soil. Since the small emplacement excavator (SEE) could dig in these harsh conditions with relative ease, it was used to dig the bunkers and backfill the trenches. It could maneuver into tight areas and dig with near-perfect precision. The SEE could backfill in the trench line with such speed that one hour of work with the SEE equalled one platoon hour of manual backfilling.

The SEE's pneumatic tools and front bucket were also valuable tools. The pneumatic clay spade dug postholes in rocky soil where it was almost impossible to dig by hand. Even though the front bucket is not capable of digging, it scooped up gravel, sand, and dirt from loose piles and transported them around the project site, eliminating numerous man-hours. On the job site, the bucket transported other construction materials, such as tires, wire, and lumber.

Lessons Learned

B Company learned several lessons from this project that may apply in similar situations:

Time Estimate. The limited time allocated for the project from conception to completion was a hard obstacle to overcome. Planning time was insufficient to ensure that the proper resources were available and the designs approved. The CPM must be a flexible working document that is updated daily to reflect work-rate changes. B Company was overly optimistic about the work rates and troop efficiency and should have devoted more time to ensuring accurate work-rate estimates. Activity estimate sheets and the CPM must be adjusted quickly so resource constraints can be identified immediately.

Materials. Materials must be on-site quickly to avoid a resource constraint. Having the material early allows the flexibility to begin an activity sooner than planned.

Crew Hours. Work-crew rest must be incorporated into the plan. Initially, B Company worked long hours to meet the completion date. Combined with night guard duty, this greatly reduced troop efficiency. Once identified as a problem, adjustments were made and overall efficiency rose considerably.

Customer Involvement. All key personnel—the constructing units, the user, the bill payers, the safety office, the unit responsible for ownership and maintenance, and higher headquarters involved in the approval decision—must participate in both the reconnaissance and the site layout. The customer must be involved in the project from design to completion, since an involved customer is a satisfied customer.

Design. The bunkers and trenches were designed to withstand heavy use and require minimum maintenance. Although using tires as the major construction material presented problems, they were the best choice considering the safety and maintenance requirements.

Conclusion

From November 1994 to April 1995, the EUSA bunker/trench complex went from concept to reality. From carving the site from a rugged, rocky valley to collecting the tires, no task proved insurmountable for the soldiers. The bill of materials included more than 16,000 tires, 4,500 feet of cable, 250 posts, and more than 3,000 sandbags. The project consumed 35,000 man-hours and 14,000 vehicle miles. In two months, a valley was turned into an extensive live-fire range that will help train the soldiers of the 2d Infantry Division. It was the sweat and muscle of a combined arms team—U.S. Army engineers and infantry and the Korean Service Corps—that successfully created the largest live-fire bunker and trench complex in the Army.

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