

# Military Engineering

Zella Carroll



First Edition, 2012

ISBN 978-81-323-3084-4

© All rights reserved.

*Published by:*

**Research World**

4735/22 Prakashdeep Bldg,

Ansari Road, Darya Ganj,

Delhi - 110002

Email: [info@wtbooks.com](mailto:info@wtbooks.com)

# Table of Contents

Chapter 1 - Combat Engineering

Chapter 2 - Military Engineering Vehicle

Chapter 3 - Sapper

Chapter 4 - Combat Engineering Corps

Chapter 5 - Mining (Military)

Chapter 6 - Royal Engineers

Chapter 7 - Military Engineer

Chapter 8 - Pioneer (Military)

Chapter 9 - Fortification

## Chapter 1

# Combat Engineering



U.S. Army Combat Engineers place satchel charges and detonating cord, preparatory to demolishing a railway bridge during the Korean War, 30 July 1950



Mobile field-deployable bridge (EFA) of the engineers of the French Army

**Combat engineering** is a combat arms role that falls within the scope of military engineering. It involves using the knowledge, tools and techniques of engineering by troops in peace and war, but specifically in combat. A combat engineer, in many armies also called **pioneer** or sapper, is a military specialist in using the tools and techniques of engineering under combat conditions, who may perform any of a variety of tasks.

Such tasks typically include constructing/breaching trenches, tank traps and other fortifications, bunker construction, bridge and road construction or destruction, laying or clearing landmines and general engineering tasks under fire. More generally speaking, the combat engineer's tasks involve facilitating movement and support of friendly forces while impeding that of the enemy.

Usually, a combat engineer is also trained as an infantry rifleman, and combat engineer elements often have a secondary role fighting as formed infantry. Beyond self-defense, combat engineers, infantry and assault troopers from Armored Corps units are generally the only troops that engage in the assault while dismounted. This role is limited by a lack of organic fire support (such as that obtained by Infantry units from their mortars), however combat engineers typically do have extensive anti-armored capability in their infantry fighting role.

## ***Terminology***

A general combat engineer is often called a *Pioneer* or *Sapper* (the word itself is derived from the French and British armies, and refers to the origin of combat engineering). In some armies the term *Pioneer* or *Sapper* is a term that indicates a specific military rank and level of training. While the officers of a combat engineering unit will generally be professionally-certified civil or mechanical engineers, the non-commissioned members are generally not.

Relevant terminology includes:

- **Sapper** is a term that is used for soldiers in the United States, British, Canadian, New Zealand and Australian armies that have specialized combat engineer training.
- In the Israeli Defence Forces, Sapper 07 ( סלפ 07 ) is a rank denoting a combat engineer who has graduated basic general engineering training.
- In the Finnish army, *pioneer* is the private equivalent rank in the army for a soldier who has completed the basic combat engineering training. Naval engineers retain the rank *matruusi* but bear the *pioneer* insignia on their sleeves.
- In the British, Canadian and Australian armies, an **assault pioneer** is an infantry soldier with some limited combat engineer training in clearing obstacles during assaults and light engineering duties. Until recently assault pioneers were responsible for the operation of flamethrowers.
- The term **field engineer** is generally used to refer to specialists with training as mechanics or technicians.
- The term **military engineer** encompasses both combat engineers and construction engineers. In some armies the two are allocated to different Corps, such as the former Soviet Army. Geomatics, or surveying and cartography is another area that sometimes is integrated into military engineering, and in other cases is a separate responsibility, as was formerly the case in the Australian Army.

The design and development of military equipment is generally not the province of the military engineer, although they can be involved in such design engineering when the technology in question has a military engineering application.

## **History**

"Combat Engineering" is a relatively modern term, but the concept can trace itself back to early integration of military engineering capability directly into fighting formations.

By the 18th century, regiments of foot (infantry) in the British, French, Prussian and other armies included pioneer detachments. In peacetime these specialists constituted the regimental tradesmen, constructing and repairing buildings, transport wagons, etc. On active service they moved at the head of marching columns with axes, shovels and pickaxes clearing obstacles or building bridges to open the way for the bulk of the regiment to move through difficult terrain. The modern Royal Welch Fusiliers and French Foreign Legion still maintain pioneer sections who march at the front of ceremonial parades, carrying chromium plated tools intended for show only. Other historic distinctions include long work aprons and the right to wear beards.

At the end of World War I, the standoff in the Western Front caused the Imperial German Army to gather experienced and particularly skilled soldiers to form "Assault Teams" which would break through the Allied trenches. With enhanced training and special weapons (such as flamethrowers), these squads obtained some success, but too late to change the outcome of the war. In early WWII, however, the Wehrmacht "Pioniere" battalions proved their efficiency in both attack and defense, somewhat inspiring other

armies to develop their own combat engineers battalions. Notably, the attack on Fort Eben-Emael in Belgium was conducted by Luftwaffe glider-deployed combat engineers.

The need to defeat the German defensive positions of the "Atlantic wall" as part of the amphibious landings in Normandy in 1944 led to the development of specialist combat engineer vehicles. These, collectively known as Hobart's Funnies, included a specific vehicle to carry combat engineers, the Churchill AVRE. These and other dedicated assault vehicles were organised into the specialised 79th Armoured Division and deployed during Operation Overlord - 'D-Day'.

During the 20th century, combat engineers gained vast knowledge and experience in explosives. They are tasked with planting bombs, landmines and dynamite.

Modern combat engineering still retains the Roman role of building field fortifications, road paving and the breaching of terrain obstacles. A notable combat engineer task was, for example, the breaching of the Suez Canal during the Yom Kippur War.

### ***Role, practices and techniques***

The combat engineering role includes practices and techniques of camouflage, reconnaissance, communication methods and enhancement of survival by other troops. Combat engineering also includes construction of roads, bridges, field fortifications and obstacles. In their role, combat engineers use a wide variety of engineer hand and power tools. They are also responsible for construction rigging, use of explosives and causing demolitions, camouflage, field fortifications, obstacle clearance and construction, assault of fortifications, bridge erection, use of assault boats in water obstacle crossings, expedient road and helipad construction, general construction, engineer route and road reconnaissance, and erecting communication installations. All these role activities and technologies are divided into several areas of combat engineering:

- Mobility
  - Clearing terrain obstacles
  - Overcoming trenches and ditches
  - Opening routes for armored fighting vehicles
  - Constructing roads and bridges
- Counter mobility
  - Planting landmines
  - Digging trenches and ditches
  - Demolishing roads and bridges
- Explosive material handling
  - Clearing landmine fields
- Assault
  - Opening routes during assault
  - Demolishing enemy structures (using bulldozers or explosive charges).
- Defense
  - Building fortifications
  - Building outposts
  - Building fences
- Defense against NBC weapon threats

- Planting landmines
- 
- Accurate demolitions

## ***Equipment and vehicles***

Combat engineering employs a wide range of transportation vehicles and equipment, and uses weapons unique to the engineers, including those used in land mine warfare.

### Equipment



IED detonator in Iraq

Basic combat engineering tools include safe use of: Driving and Chopping tools (hammers, mauls, sledges, screwdriver and bit, chopping tools); Cutting and Smoothing tools (saws, chisels, planes, files and rasps, brush-cutting tools, miscellaneous cutting tools); Drilling, Boring and Countersinking tools; Measuring, Levelling and Layout tools (rules, tapes, marking tools, levels and plumb bobs, squares); Gripping, Prying and Twisting tools (pliers, wrenches, bars); Holding, Raising and Grinding tools (vises, clamps, jacks, grinders and oilstones); Timber Handling and Climbing tools; Digging

tools (shovels, posthole diggers, picks and mattocks); Portable Power tools and Trailer-mounted tools (electric tool trailer and generator, portable power tools); Miscellaneous tools.

## Vehicles



Armoured front loader



German Army combat engineer vehicle *Dachs*



This EBG combat engineering vehicle is used by the engineers of the French Army for a variety of missions

## Obstacle breaching

For obstacle breaching, including minefields, the combat engineers use a variety of vehicles, explosive devices and plastic explosives including:

- Mine breaching devices
  - Dozer blade
  - Mine rollers
  - Bangalore Torpedo
  - Antipersonnel Obstacle Breaching System
  - Mine-clearing line charge (MICLIC)
- EOD robots
- Explosives, mines and bombs
- Field-deployable bridges
  - (ex: French EFA), Bailey bridge

## ***Specific corps***

The combat engineer role is a key one in all armed forces of the World, and invariably found either closely integrated into the force structure, or even into the combat units of the national troops.

## **Denmark**

The Danish military engineering corps is almost entirely organized into one regiment, simply named "Ingeniørregimentet" ("The Engineering Regiment"). The core of the Danish combat engineers are the so-called armored engineers. These units usually work in separated squads, each under the command of an infantry company, and equipped with an M113. Their roles are combat demolition, minefield clearing, basic minelaying and EOR. They are also extensively trained as infantry, to support the ordinary troops in combat. Besides these units, the regiment has the different workfields of combat engineers (construction, EOD, CBRN) spread out over different companies.

## Israel



IDF Caterpillar D9 with the Combat Engineering Corps flag.  
Armored bulldozers are standard combat engineering tools, as they can perform construction, destruction and EOD missions under heavy fire.

In the Israeli Defence Forces the combat engineers are organized under the Combat Engineering Corps (Hebrew: חיל ההנדסה הקרבית). In addition to IEC sappers, each infantry brigade has an engineer company trained with basic engineering and EOD skills. IEC sappers are often attached to other units (such as armored divisions or infantry) in order to help them breach obstacles and handle explosive threats. The IEC operates advance engineering tools such as the IDF Caterpillar D9 armored bulldozer, IDF Puma armored CEV, Armoured vehicle-launched bridges, armored engineering vehicles, EOD robots and electromagnetic mine-detectors. Their main role is enabling Israeli forces to advance (breach the enemy's obstacles), stop the enemy's movement, handle explosives and perform construction and destruction missions under fire. The Israeli engineering corps is also responsible for counter-NBC warfare (i.e. defending troops against unconventional weapon and clean infected areas). The IEC has a special unit, called **Yahalom** (in Hebrew it means "Diamond" but also abbreviation of "Engineering Unit for Special Operations") which handles EOD, commando, engineering recon, advance robotics, tunnel warfare, maritime breaching, counter-NBC and other classified tasks.

The Israeli combat engineer Corps motto is "Rishonim Tamid" Hebrew: ראשונים תמיד, meaning "Always first".

## Soviet Union/Russia

Soviet engineers were typically armed with the RPO-A Shmel (Bumblebee) rocket launcher to destroy fortifications.

## United States

The motto of the US Army Corps of Engineers is "ESSAYONS," from French "Let us try." In the United States Army, the four tasks of combat engineer units are mobility, countermobility, survivability, and general engineering.

- **Mobility:** improving your own force's ability to move around the battlefield. Combat engineers typically support this role through reduction of enemy obstacles which include point and row minefields, anti-tank ditches, wire obstacles, concrete and metal anti-vehicle barriers and wall and door breaching in urban terrain. Mechanized combat engineer units also have armored vehicles capable of laying short bridges for limited gap-crossing.
- **Countermobility:** building obstacles to prevent the enemy from moving around the battlefield. Destroying bridges, blocking roads, creating airstrips, digging trenches, etc. Can also include planting landmines and anti-handling devices when authorized and directed to do so. Explosive Ordnance Disposal units in the U.S. Army employ ordnance personnel.
- **Survivability:** building structures which enable one's own soldiers to survive on the battlefield. Examples include trenches, bunkers, shelters, and armored vehicle fighting positions.
- **General Engineering:** general engineering sustains military forces in the theater through the performance of facility construction and repair, and through acquisition, maintenance, and disposal of real property.

## Historical

FM 5-5	11 October 1943	Engineer Field Manual, Engineer Troops
FM 5-5 C-1	31 March 1944	CHANGES No. 1} FM 5-5, 11 October 1943 is changed as follows:
FM 5-5 C-2	10 May 1944	CHANGES No. 2} FM 5-5, 11 October 1943 is changed as follows:
FM 5-5 C-3	5 July 1944	CHANGES No. 3} FM 5-5, 11 October 1943 is changed as follows:
FM 5-5 C-4	11 October 1944	CHANGES No. 4} FM 5-5, 11 October 1943 is changed as follows:

FM 5-5 C-5	28 December 1944	CHANGES No. 5} FM 5-5, 11 October 1943 is changed as follows:
FM 5-5,C1..C5	<ul style="list-style-type: none"> <li>I. Engineer Units with <i>Army Air Forces</i></li> <li>II. Engineer Units with <i>Army Service Forces</i> <ul style="list-style-type: none"> <li>i. port repair ship</li> <li>ii. port construction and repair group</li> <li>iii. special brigade</li> </ul> </li> <li>III. Engineer Units, SERVICE, with <i>Army Ground Forces</i></li> <li>IV. Engineer units, COMBAT, with <i>Army Ground Forces</i> <ul style="list-style-type: none"> <li>i. airborne battalion</li> <li>ii. combat battalion</li> <li>iii. light ponton company</li> <li>iv. heavy ponton battalion</li> <li>v. treadway bridge company</li> </ul> </li> </ul>	

## Chapter 2

# Military Engineering Vehicle



The **EBG** combat engineering vehicle, based on the AMX 30 tank, is used by the engineers of the French Army for a variety of missions.



BAT-M engineering vehicle of Russia and the former Soviet Union

**Military engineering vehicles** are vehicles built for military engineering work on the battlefield or for the transportation of combat engineers. These vehicles can range from civilian equipment to purpose built military vehicles.

## ***Types of military engineering vehicles***

### **Civilian and militarized heavy equipment**



USMC Caterpillar D9 armored bulldozer. The civilian tractor is fitted with an armor kit, produced by Israel Military Industries.

Military engineering can employ a wide variety of heavy equipment in the same or similar ways to how this equipment is used outside the military. Bulldozers, cranes, graders, excavators, dump trucks, loaders, and backhoes all see extensive use by military engineers.

Military engineers may also use civilian heavy equipment which was modified for military applications. Typically, this involves adding armour for protection from battlefield hazards such as artillery, unexploded ordnance, mines, and small arms fire. Often this protection is provided by armour plates and steel jackets. Some examples of armoured civilian heavy equipment are the IDF Caterpillar D9, American D7 TPK, Canadian D6 armoured bulldozer, cranes, graders, excavators, and M35 2-1/2 ton cargo truck.

Militarized heavy equipment may also take on the form of traditional civilian equipment designed and built to unique military specifications. These vehicles typically sacrifice some depth of capability from civilian models in order to gain greater speed and independence from prime movers. Examples of this type of vehicle include high speed backhoes such as the Australian Army's High Mobility Engineering Vehicle (HMEV) from Thales or the Canadian Army's Multi-Purpose Engineer Vehicle (MPEV) from Arva.

## Armoured engineering vehicle



*PiPz Dachs* AEV of the German Army (2008)



Polish Army MID Bizon-S

Typically based on the platform of a main battle tank, these vehicles go by different names depending upon the country of use or manufacture. In the US the term "combat engineer vehicle (CEV)" is used, in the UK the term "Armoured Vehicle Royal Engineers (AVRE)" is used, while in Canada and other commonwealth nations the term "armoured engineer vehicle (AEV)" is used. There is no set template for what such a vehicle will look like, yet likely features include a large dozer blade or mine ploughs, a large calibre demolition cannon, augers, winches, excavator arms and cranes or lifting booms.

These vehicles are designed to directly conduct obstacle breaching operations and to conduct other earth-moving and engineering work on the battlefield.

Good examples of this type of vehicle include the UK Trojan AVRE, the Russian IMR, and the US M728 Combat Engineer Vehicle.

It should be noted that while the term "armoured engineer vehicle" is used specifically to describe these multi-purpose tank based engineering vehicles, that term is also used more generically in British and Commonwealth militaries to describe all heavy tank based engineering vehicles used in the support of mechanized forces. Thus, "armoured engineer vehicle" used generically would refer to AEV, AVLB, Assault Breachers, and so on.

### **Armoured earth mover**

Lighter and less multi-functional than the AEVs described above, these vehicles are designed to conduct earth-moving work on the battlefield. These vehicles have greater high speed mobility than traditional heavy equipment and are protected against the effects

of blast and fragmentation. Good examples are the American M9 ACE and the UK FV180 Combat Engineer Tractor.

## Breaching vehicle

These vehicles are equipped with mechanical or other means for the breaching of man made obstacles. Common types of breaching vehicles include mechanical flails, mine plough vehicles, and mine roller vehicles. In some cases, these vehicles will also mount Mine-clearing line charges. Breaching vehicles may be either converted armoured fighting vehicles or purpose built vehicles. In larger militaries, converted AFV are likely to be used as *assault breachers* while the breached obstacle is still covered by enemy observation and fire, and then purpose built breaching vehicles will create additional lanes for following forces.

Good examples of breaching vehicles include the USMC M1 Assault Breacher Vehicle, the UK Aardvark JSFU, and the Singaporean Trailblazer

## Bridging vehicles



U.S Army M104 Wolverine Heavy Assault Bridge

Several types of military bridging vehicles have existed through the years. The most notable are the various armoured vehicle-launched bridge (AVLB). An AVLB is

typically a modified tank hull converted to carry a bridge into battle in order to support crossing ditches, small waterways, or other gap obstacles.

Another type of bridging vehicle is the truck launched bridge. Possibly the most notorious such vehicle was the former Soviet TMM bridging truck that could carry and launch a 10 meter bridge that could be daisy-chained with other TMM bridges to cross larger obstacles. More recent developments have seen the conversion of AVLB and truck launched bridge with launching systems that can be mounted on either tank or truck for bridges that are capable of supporting heavy main battle tanks.

Earlier examples of bridging vehicles include a type in which a converted tank hull is the bridge. On these vehicles, the hull deck comprises the main portion of the tread way while ramps extend from the front and rear of the vehicle to allow other climb over the vehicle and cross obstacles. A notable example of this type of armoured bridging vehicle was the Churchill Ark used by the Allies in the Second World War.

### **Combat engineer section carriers**

Another type of CEVs are armoured fighting vehicles which are used to transport sappers (combat engineers) and can be fitted with a bulldozer's blade and other mine-breaching devices. They are often used as APCs because of their carrying ability and heavy protection. They are usually armed with machine guns and grenade launchers and usually tracked to provide enough tractive force to push blades and rakes. Some examples are the U.S. M113 APC, IDF Puma, Nagmachon, Husky, and U.S. M1132 ESV (a Stryker variant).

### **Military ferries and amphibious crossing vehicles**



This field-deployable apparatus, known as EFA, used by the engineers of the French Army, may either be used as a bridge (deployed in a series), or as a ferry

One of the major tasks of military engineering is crossing major rivers. Several military engineering vehicles have been developed in various nations to achieve this task. One of the more common types is the amphibious ferry such as the M3 Amphibious Rig. These

vehicles are self-propelled on land, they can transform into raft type ferries when in the water, and often multiple vehicles can connect to form larger rafts or floating bridges. Other types of military ferries, such as the Soviet *Plavayushij Transportyor - Srednyj*, are able to load while still on land and transport other vehicles cross country and over water.

In addition to amphibious crossing vehicles, military engineers may also employ several types of boats. Military assault boats are small boats propelled by oars or an outboard motor and used to ferry dismounted infantry across water.

### ***Tank based combat engineering vehicles***



Churchill "Bobbin", a rolled road surface that could be laid for following vehicles to cross loose sand

Most CEVs are armoured fighting vehicles that may be based on a tank chassis and have special attachments in order to breach obstacles. Such attachments may include dozer

blades, mine rollers, cranes etc. An example of an engineering vehicle of this kind is a bridgelaying tank, which replaces the turret with a segmented hydraulic bridge.

The Hobart's Funnies of the Second World War were a wide variety of armoured vehicles for combat engineering tasks. They were allocated to the initial beachhead assaults by the British and Commonwealth forces in the D-Day landings

### **Churchill tank**

The British Churchill tank because of its good cross-country performance and capacious interior with side hatches became the most adapted with modifications, the base unit being the AVRE carrying a large demolition gun.

### **M4 Sherman**



M4 with 105 mm howitzer and a dozer blade.

- **Dozer:** The bulldozer blade was a valuable battlefield tool on the WWII M4 Sherman tank. A 1943 field modification added the hydraulic dozer blade from a Caterpillar D8 to a Sherman. The later M1 dozer blade was standardized to fit any Sherman with VVSS suspension and the M1A1 would fit the wider HVSS. Some M4s made for the Engineer Corps had the blades fitted permanently and the turrets removed. In the early stages of the 1944 Battle of Normandy before the

Culin Cutter, breaking through the Bocage hedgerows relied heavily on Sherman dozers.

- **M4 Doozit:** Engineer Corps' Sherman dozer with demolition charge on wooden platform and T40 *Whizbang* rocket launcher.
- **Bridgelayer:** The US field-converted a few M4 in Italy with A-frame-supported bridge and heavy rear counter-weight to make the Mobile Assault Bridge. British developments for Shermans included the fascine (used by 79th Armoured Division), Crib, Twaby Ark, Octopus, Plymouth (Bailey Bridge), and AVRE (SBG bridge).
- **Mine-Clearing:** British conversions included the Sherman Crab. The US developed an extensive array of experimental types:
  - **T15/E1/E2:** Series of mine resistant Shermans based on the T14 kit. Cancelled at war's end.
  - **Mine Exploder T1E1 Roller (*Earthworm*):** Three sets of 6 discs made from armor plate.
  - **Mine Exploder T1E2 Roller:** Two forward units with 7 discs only. Experimental.
  - **Mine Exploder T1E3/M1 Roller (*Aunt Jemima*):** Two forward units with five 10' discs. Most widely used T1 variant, adopted as the M1. (picture)
  - **Mine Exploder T1E4 Roller:** 16 discs.
  - **Mine Exploder T1E5 Roller:** T1E3/M1 w/ smaller wheels. Experimental.
  - **Mine Exploder T1E6 Roller:** T1E3/M1 w/ serrated edged discs. Experimental
  - **Mine Exploder T2 Flail:** British Crab I mine flail.
  - **Mine Exploder T3 Flail:** Based on British Scorpion flail. Development stopped in 1943.
    - **Mine Exploder T3E1 Flail:** T3 w/ longer arms and sand filled rotor. Cancelled.
    - **Mine Exploder T3E2 Flail:** E1 variant, rotor replaced with steel drum of larger diameter. Development terminated at war's end.
  - **Mine Exploder T4:** British Crab II mine flail.
  - **Mine Exploder T7:** Frame with small rollers with two discs each. Abandoned.
  - **Mine Exploder T8 (*Johnny Walker*):** Steel plungers on a pivot frame designed to pound on the ground. Vehicle steering was adversely affected.
  - **Mine Exploder T9:** 6' Roller. Difficult to maneuver.
    - **Mine Exploder T9E1:** Lightened version, but proved unsatisfactory because it failed to explode all mines.
  - **Mine Exploder T10:** Remote control unit designed to be controlled by the following tank. Cancelled.
  - **Mine Exploder T11:** Six forward firing mortars to set off mines. Experimental.

- **Mine Exploder T12:** 23 forward firing mortars. Apparently effective, but cancelled.
- **Mine Exploder T14:** Direct modification to a Sherman tank, upgraded belly armor and reinforced tracks. Cancelled.
- **Mine Excavator T4:** Plough device. Developed during 1942, but abandoned.
- **Mine Excavator T5/E1/E2:** T4 variant w/ v-shaped plough. E1/E2 was a further improvement.
- **Mine Excavator T5E3:** T5E1/E2 rigged to the hydraulic lift mechanism from the M1 dozer kit to control depth.
- **Mine Excavator T6:** Based on the v-shape/T5, unable to control depth.
- **Mine Excavator T2/E1/E2:** Based on the T4/T5's, but rigged to the hydraulic lift mechanism from the M1 dozer kit to control depth.

## M60



A remotely controlled Panther armored mine clearing vehicle leads a column down a road in Bosnia and Herzegovina, May 16, 1996.

- **M60A1 AVLB** - Armored Vehicle Launched Bridge, 60-foot (18 m) scissors bridge on M60A1 chassis.

- **M60 AVLM** - Armored Vehicle Launched MICLIC (Mine-Clearing Line Charge), modified M60 AVLB with up to 2 MICLIC mounted over the rear of the vehicle.
- **M60 Panther** - M60 modified into a remotely controlled mine clearing tank. The turret is removed with the turret ring sealed, and the front of the vehicle is fitted with mine rollers.
- **M728 CEV** - M60A1-based Combat Engineer Vehicle fitted with a folding A-frame crane and winch attached to the front of the turret, and an M135 165mm demolition gun. Commonly fitted with the D7 bulldozer blade, or a mine-clearing equipment.
  - **M728A1** - Upgraded version of the M728 CEV.

## M1



Grizzly Combat Mobility Vehicle (CMV)

- M1 Grizzly Combat Mobility Vehicle (CMV)
- M1 Panther II Remote Controlled Mine Clearing Vehicle
- M104 Wolverine Heavy Assault Bridge
- M1 Assault Breacher Vehicle (USMC)

## Leopard 1

- Biber (Beaver) armoured vehicle launched bridge
- Pionierpanzer 1
- Pionierpanzer 2 Dachs (Badger) armoured engineer vehicle

## Leopard 2

- Panzerschnellbrücke 2 (Bridge layer)
- Pionierpanzer 3 Kodiak

## T-55/54



MTU-12 bridgelayer



MTU-20 bridgelayer



IMR combat engineering vehicle

- **T-54 Dozer** - T-54 fitted with bulldozer blades for clearing soil, obstacles and snow.
- **ALT-55** - Bulldozer version of the T-55 with large flat-plate superstructure, angular concave dozer blade on front and prominent hydraulic rams for dozer blade.
- **T-55** hull fitted with an excavator body and armoured cab.
- **T-55 MARRS** - Fitted with a Vickers armoured recovery vehicle kit. It has a large flat-plate turret with slightly chamfered sides, vertical rear and very chamfered front and a large A-frame crane on the front of the turret. The crane has cylindrical winch rope feet between legs of crane. A dozer blade is fitted to the hull front.
- **MT-55** or **MTU-55** (*Tankoviy Mostoukladchik*) - Soviet designator for Czechoslovakian MT-55A bridge-layer tank with scissors bridge.
- **MTU-12** (*Tankoviy Mostoukladchik*)- Bridge-layer tank with 12 m single span bridge that can carry 50 tonnes. The system entered service in 1955; today only a very small number remains in service. Combat weight: 34 tonnes.
- **MTU-20 (Ob'yekt 602)** (*Tankoviy Mostoukladchik*) - The MTU-20 consists of a twin-treadway superstructure mounted on a modified T-54 tank chassis. Each treadway is made up of a box-type aluminum girder with a folding ramp attached to both ends to save space in the travel position. Because of that the vehicle with the bridge on board is only 11.6 m long, but the overall span length is 20 m. This is an increase of about 62% over that of the older MTU-1. The bridge is launched by the cantilever method. First the ramps are lowered and fully extended before the treadways are forward with the full load of the bridge resting on the forward support plate during launch. The span is moved out over the launching girder until the far end reaches the far bank. Next the near end is lowered onto the near bank. This method of launching gives the bridgelayer a low silhouette which makes it less vulnerable to detection and destruction.
  - **MTU-20** based on the T-55 chassis.
- **BTS-1** (*Bronetankoviy Tyagach Sredniy* - Medium Armoured Tractor) - This is basically a turretless T-54A with a stowage basket.
  - **BTS-1M** - improved or remanufactured BTS-1.
- **BTS-2 (Ob'yekt 9)** (*Bronetankoviy Tyagach Sredniy* - Medium Armoured Tractor) - BTS-1 upgraded with a hoist and a small folding crane with a capacity of 3,000 kg. It was developed on the T-54 hull in 1951; series production started in 1955. The prototype Ob.9 had a commander's cupola with DShK 1938/46 machine gun, but the production model has a square commander's hatch, opening to the right. Combat weight: 32 tons. Only a very small number remains in service.
- **BTS-3** (*Bronetankoviy Tyagach Sredniy* - Medium Armoured Tractor) - JVBT-55A in service with the Soviet Army.
- **BTS-4** (*Bronetankoviy Tyagach Sredniy* - Medium Armoured Tractor) - Similar to BTS-2 but with snorkel. In the West generally known as **T-54T**. There are many different models, based on the T-44, T-54, T-55 and T-62.
- **BTS-4B** - Dozer blade equipped armoured recovery vehicle converted from the early -odd-shaped turret versions of the T-54.

- **BTS-4BM** - Experimental version of the BTS-4B with the capacity to winch over the front of the vehicle.
- **IMR (Ob'yekt 616) (*Inzhenernaya Mashina Razgrazhdeniya*)** - Combat engineer vehicle. It's a T-55 that had its turret replaced with a hydraulically-operated 2t crane. The crane can also be fitted with a small bucket or a pair of pincer type grabs for removing trees and other obstacles. A hydraulically-operated dozer blade mounts to the front of the hull; it can be used in a straight or V-configuration only. The IMR was developed in 1969 and entered service five years later.
- **SPK-12G (*Samokhodniy Pod'yomniy Kran*)** - Heavy crane mounted on T-55 chassis. Only two were built.
- **BMR-2 (*Boyevaya Mashina Razminirovaniya*)** - Mine clearing tank based on T-55 chassis. This vehicle has no turret but a fixed superstructure, armed with an NSVT machine gun. It is fitted with a KMT-7 mine clearing set and entered service around 1987 during the war in Afghanistan.
  - Improved version of BMR-2 that has been seen fitted with a wide variety of mine roller designs.

## T-64

- **BAT-2** – Fast combat engineering vehicle with the engine, lower hull and "small roadwheels" suspension of the T-64. The 40-ton tractor sports a very large, all axis adjustable V-shaped hydraulic dozer blade at the front, a single soil ripper spike at the rear and a 2-ton crane on the top. The crew compartment holds 8 persons (driver, commander, radio operators plus a five-man sapper squad for dismounted tasks). The highly capable BAT-2 was designed to replace the old T-54/AT-T based BAT-M, but Warsaw Pact allies received only small numbers due to its high price and the old and new vehicles served alongside during the late Cold War.

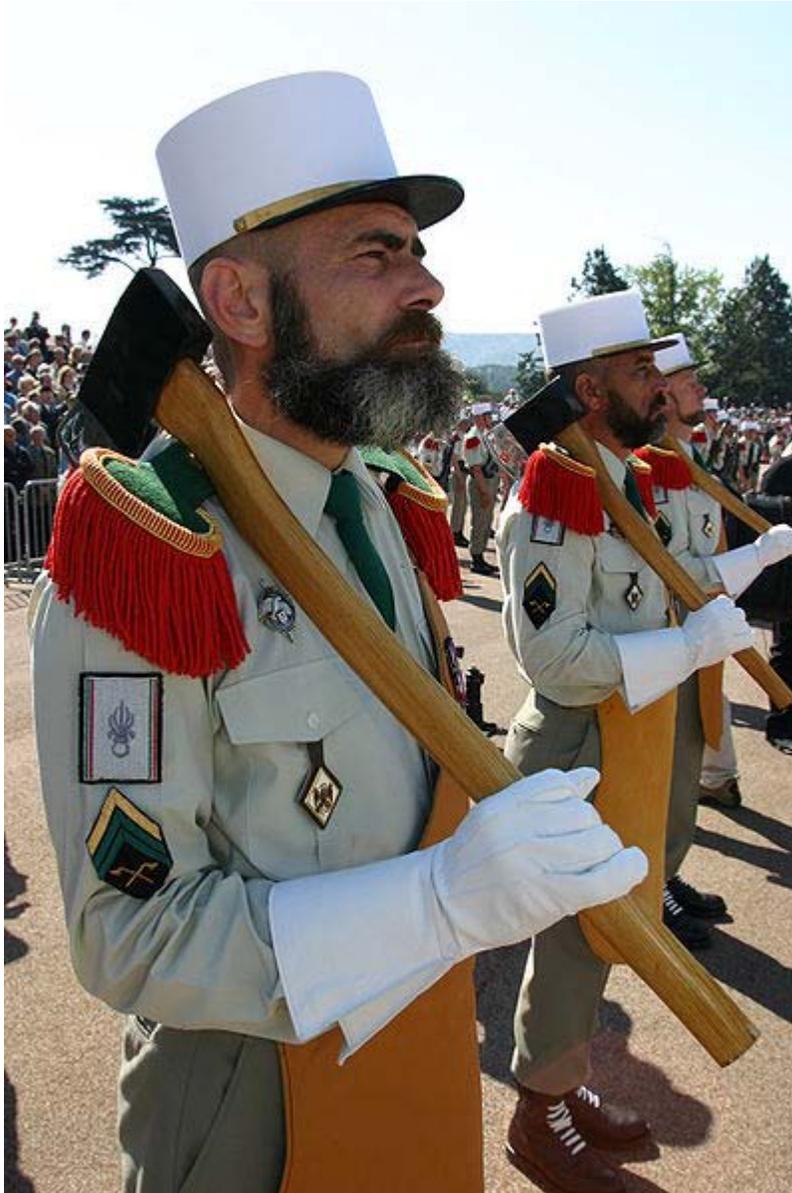
## T-72

- **IMR-2 (*Inzhenernaya Mashina Razgrashdeniya*)** - Combat engineering vehicle (CEV). It has a telescoping crane arm which can lift between 5 and 11 metric tons and utilizes a pincers for uprooting trees. Pivoted at the front of the vehicle is a dozer blade that can be used in a V-configuration or as a straight dozer blade. When not required it is raised clear of the ground. On the vehicle's rear, a mine-clearing system is mounted.
  - **IMR-2M1** - Simplified model without the mine-clearing system. Entered service in 1987.
  - **IMR-2M2** - Improved version that is better suited for operations in dangerous situations, for example in contaminated areas. It entered service in 1990 and has a modified crane arm with bucket instead off the pincers.
  - **IMR-2MA** - Latest version with bigger operator's cabin armed with a 12.7 mm machine gun NSV.
    - **Klin-1** - Remote controlled IMR-2.

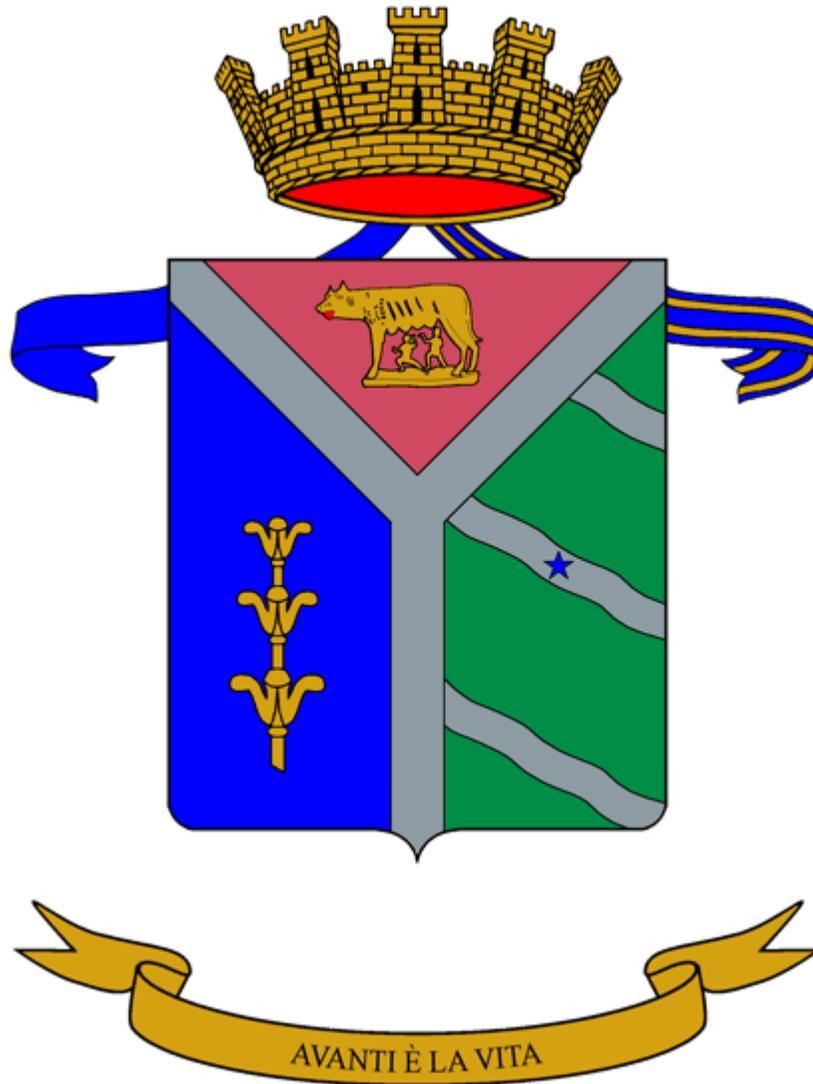
- **MTU-72 (Ob'yekt 632)** (*Tankovyj Mostoukladchik*) - bridge layer based on T-72 chassis. The overall layout and operating method of the system are similar to those of the MTU-20 and MTU bridgelayers. The bridge, when laid, has an overall length of 20 meters. The bridge has a maximum capacity of 50,000 kg, is 3.3 meters wide, and can span a gap of 18 m. By itself, the bridge weighs 6400 kg. The time required to lay the bridge is 3 minutes, and 8 minutes for retrieval.
- **BLP 72** (*Brückenlegepanzer*) - The East-German army had plans to develop a new bridgelayer tank that should have been ready for series production from 1987 but after several difficulties the project was canceled.

## Chapter 3

# Sapper



The pionier sappers ("*sapeurs*") of the French Foreign Legion traditionally sport large beards, wear leather aprons and gloves and carry axes.



8° Reggimento Genio Guastatori Paracadutisti "Folgore"

A **sapper** or **combat engineer** is a combatant soldier who performs a wide variety of combat engineering duties, typically including, but not limited to, bridge-building, laying or clearing minefields, demolitions, field defences, general construction and building, as well as road and airfield construction and repair. He is also trained to serve as an infantryman when needed in both defensive and offensive operations and is fully involved in modern counter-insurgency operations. A sapper's tasks have, throughout history, including modern day counter-insurgency operations, been devoted to the mission-critical tasks involving facilitating movement and logistics of allied forces and impeding that of enemies. This active combatant career field is normally limited to males in most countries due to legislation.

The term "sapper" is used in British Army, Polish Army or Commonwealth nations' military services. In the United States Army and United States Air Force, the term *sapper*

*leader* has been instituted to indicate combat engineers who meet additional professional qualifications that demonstrate a certain level of proficiency and accomplishment as a small unit leader of combat engineers. An ordinary engineer who has completed his training is called a pioneer. The German Army uses the term *Pionier*, while *sapeur* is used in the French Army, and *guastatore* (more precisely defined as an **assault engineer**) in the Italian Army.

## ***Historical origin***

### **Sapper**



Soldiers of No 2 Field Company, Bombay Sappers and Miners on duty in China in 1900. The mule carries the tools required for field engineering tasks.

A sapper, in the sense first used by the Assyrian Army in the early 7th Century BC, was one who excavated trenches under defensive fire to advance a besieging army's position in relation to the works of an attacked fortification, which was referred to as sapping the enemy fortifications.

Saps were excavated by brigades of trained sappers or instructed troops. When an army was defending a fortress with cannon, they had an obvious height and therefore range advantage over the attacker's own guns. The attacking army's artillery had to be brought forward, under fire, so as to facilitate effective counter-battery fire.

This was achieved by digging what the French termed a '**Sappe**'. Using techniques developed and perfected by Vauban, the *sapeurs* (sappers) began the trench at such an angle so as to avoid enemy fire 'enfilading' (passing directly along) the sappe. As they pressed forward, a position was prepared from which cannon could suppress the defenders on the bastions. The sappers would then change the course of their trench, zig-zagging their way toward the fortress wall.

Each leg brought the attacker's artillery closer and closer until (hopefully) the besieged cannon would be sufficiently suppressed for the attackers to breach the walls with their artillery. Broadly speaking, sappers were originally experts at demolishing or otherwise overcoming or bypassing fortification systems.

## Miner



The fort of Ghazni which fell as a result of mining by a mixed contingent of the Bombay and Bengal Sappers during the First Afghan War on 23rd July 1839.

An additional term applied to sappers of the British Indian Army was 'miner'. The native engineer corps were referred to as 'sappers and miners', as for example, the Royal Bombay Sappers and Miners. The term arose from a task done by sappers to further the battle after saps were dug. The saps permitted cannon to be brought into firing range of the besieged fort and its cannon, but often the cannon themselves were unable to breach the fort walls. The engineers would dig a tunnel from the forward-most sap up to and under the fort wall, then place a charge of gunpowder and ignite it, causing a tremendous explosion which would destroy the wall and permit attacking infantry to close with the enemy. This was dangerous work, often lethal to the sappers, and was vehemently

resisted by the besieged enemy. Since the two tasks went hand in hand and were done by the same troops, native Indian engineer corps came to be called 'sappers and miners'.

## ***Specific usage***

### **Commonwealth of Nations**

Sapper (abbreviated Spr) is the Royal Engineers' equivalent of Private. This is also the case within the Indian Army Corps of Engineers, Canadian Military Engineers, Royal Australian Engineers, South African Army Engineer Formation and Royal New Zealand Engineers. The term Sapper was introduced in 1856 when the Corps of Royal Sappers and Miners was amalgamated with the officer Corps of Royal Engineers to form the Corps of Royal Engineers.

### **Indian Army**

The term 'Sappers', in addition to the connotation of rank of engineer private, is used collectively to informally refer to the Engineer Corps as a whole and also forms part of the informal names of the three combat engineer groups, viz. Madras Sappers, Bengal Sappers and the Bombay Sappers. Each of these groups consist of about twenty battalion-sized engineer regiments and additional company-sized minor engineer units. The three Sapper groups are descended from the Sapper and Miner groups of the East India Company and later the British Indian Army of the British Raj.

### **Israel Defence Forces**

In the Israel Defence Forces a sapper (in Hebrew: סלפ, palas) is the military profession of a combat soldier who went through basic combat engineering training. Most of the sappers are soldiers of the Combat Engineering Corps, but there are also infantry sappers, who are part of the infantry brigades and are organized in Engineering companies called ן"החלפ (Palchahan). These companies are integral part of the infantry brigades. Combat engineering corps sappers are arranged in battalions.

Each sapper goes through high level infantry training, which qualifies him as Rifleman 07 (יאבור). Combat engineering sappers are qualified as Sapper 06 (סלפ 06). They are skilled in infantry combat, basic sabotage, landmine planting and demining, use of explosives, breaching and opening routes, trench warfare, and operating the IDF Puma combat engineering vehicle (CEV). Combat engineering commanders are qualified as Sapper 08 while combat engineering officers are qualified as Sapper 11. Both go through additional advance training to gain the skills needed for high level sapper profession.

## France



Sapeurs-pompiers de Paris (Paris Fire Brigade)

In France, the civil firefighters and the military firefighters of the Paris Fire Brigade and other town or country brigades are called "sappers-firemen" (*sapeurs-pompiers*, SP): the first fire company created by Napoléon I was a military sappers company. Apart from this, the sappers are the combat engineers.

The sappers were very common in the French army and in other European armies during the Napoleonic era but progressively disappeared in the 19th century, except in the French Foreign Legion, which retains a sapper unit.

In the French Army, since the 18th century, every grenadier battalion had a small unit of sappers. They had the mission to advance, under the enemy's fire, in order to destroy with their axes the obstacles drawn by the enemy and to clear the way for the rest of the infantry. The danger of such missions and their short life expectancies, allowed them certain privileges, such as the authorization to wear beards. In addition to their beards and axes, they traditionally wear leather aprons and gloves.

The current pioneer unit of the Legion reintroduced the symbols of the Napoleonic sappers: the beard, the axe, the leather apron, the crossed-axes insignia and the leather

gloves. If the parades of the Legion are opened by this unit, it is to commemorate the traditional role of the sappers "opening the way" for the troops.

## United States Army



US Combat Engineer setting a charge in World War II

In the U.S. Army, sappers are combat engineers who support the front-line infantry, and they have fought in every war in American history. For example, after the Battle of Yorktown, General Washington cited Louis Lebègue Duportail, the U.S. Army's first Chief of Engineers, for conduct which afforded "brilliant proofs of his military genius."

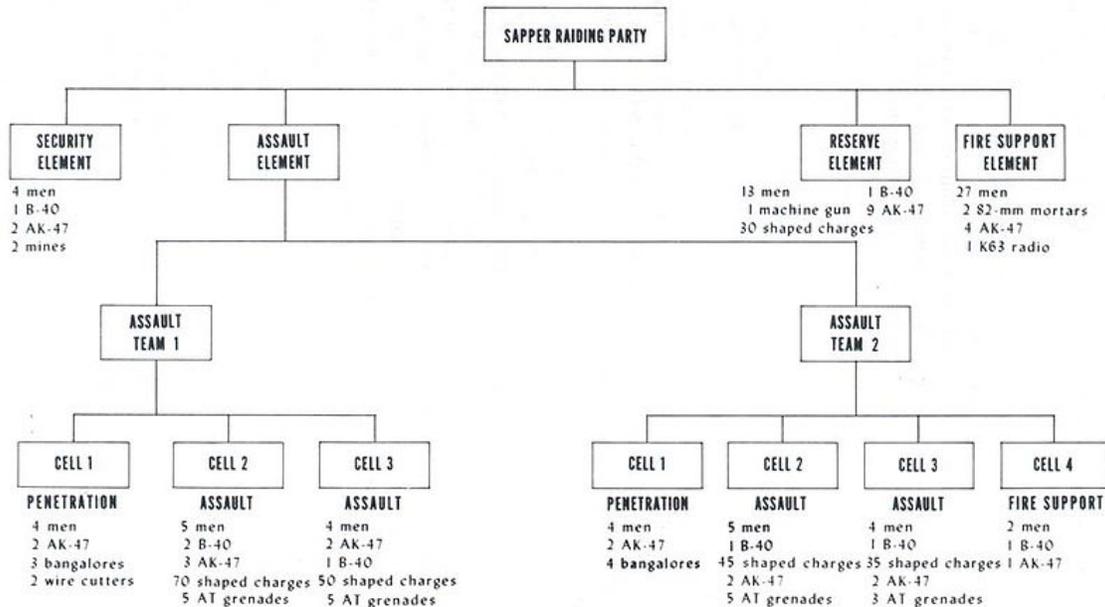
Designation as a sapper nowadays is earned as an additional proficiency. The U.S. Army authorizes four skill tabs for permanent wear above the unit patch on the left shoulder (Army Regulation 670-1 Chapter 29-13, Sub-Paragraph f). Along with the Sapper Tab, the Special Forces Tab and the Ranger Tab identify soldiers who have passed a demanding course of military instruction and demonstrated their competence in particular specialities and skills. The Sapper Tab ranks below the Special Forces Tab and the Ranger Tab, so the three tabs are worn in that order of precedence from highest to lowest.

To wear the Sapper Tab, a soldier must complete the *Sapper Leader Course* (SLC) which is operated by the U.S. Army Engineer School at Fort Leonard Wood, Missouri. The Sapper Leader Course is a 28-day course designed to train joint-service leaders in small unit tactics, leadership skills, and tactics required to perform as part of a combined arms team. The course is open to enlisted soldiers in the grades of E-4 (P) (in the Army,

specialist on the list for promotion to sergeant, E-5) and above, cadets, and officers O-3 (Army, captain) and below. Students can come from any combat or combat support branch of the service, but priority is given to engineering, cavalry, and infantry soldiers.

## PAVN and Viet Cong

CHART 1—CHARACTERISTIC SAPPER ORGANIZATION



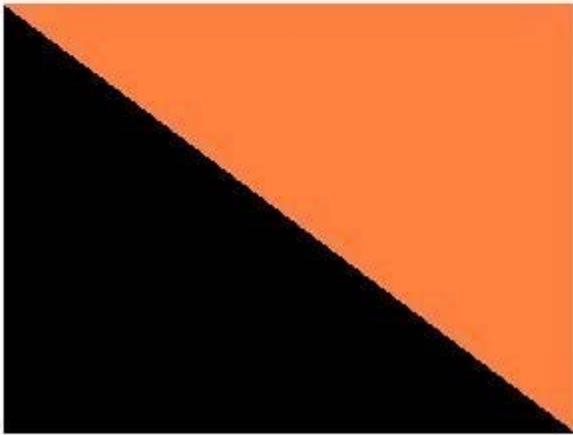
### Sapper formation- PAVN/Viet Cong

PAVN (People's Army of Vietnam) and Viet Cong sappers, as they were called by US forces, are better described as commando units. The Vietnamese term "đặc công" can be literally translated as "special task". Thousands of specially trained elite fighters served in the PAVN and Viet Cong commando/sapper units which were organized as independent formations. While not always successful due to lack of appropriate personal weapon types for combat and assault like other special forces, at times they inflicted heavy damage against their enemies. They have been armed with various types of bombs, mines, explosive charges, grenades and even steel-pellet mines which were much more devastating than the U.S M18 Claymore and are still the main weapons of the Dac cong. These elite units served as raiders against American/ARVN troops, and infiltrated spearheads during the final Ho Chi Minh Campaign in 1975 – where they seized key road and bridge assets, destroyed installations, attacked command and control nodes located deep inside enemy territory, and otherwise helped the PAVN's rapid mobile forces advance. A typical PAVN/VC Dac cong organization is shown in the diagram. The raiding force was usually grouped into assault teams, each broken down into several 3–5 man assault cells. Overall, there were generally 4 operational echelons.

## Chapter 4

# Combat Engineering Corps

### Israeli Engineering Corps



Israeli Combat Engineering Corps symbols

---

<b>Active</b>	1947 - today
<b>Country</b>	Israel
<b>Branch</b>	GOC Army Headquarters

<b>Type</b>	Combat Engineering
<b>Role</b>	Combat Engineering, EOD, counter-NBC
<b>Part of</b>	Israel Defense Forces
<b>Nickname</b>	"Muhandesim", "Palasim", "Ksoofim"
<b>Motto</b>	"Rishonim Tamid" ("Always First"), "Rishonim BaHazit" ("First in the Front"), "Lech Beyekvot Haksufim" ("Follow the Silver ones")
<b>Colors</b>	Silver berets
<b>March</b>	"Handasa Kravit Theme"
<b>Mascot</b>	"BobCat" lynx
<b>Engagements</b>	All of Israel's wars, notable are: Suez War; Yom Kippur War (Operation Abirey Lev - breaching the Suez Canal); Second Intifada (Battle of Jenin), Second Lebanon War, Operation Cast Lead
<b>Decorations</b>	Israel Defense Prize
<b>Commanders</b>	
<b>Current commander</b>	Brigadier General Moshe Sheli
<b>Notable commanders</b>	Emmanuel Shachar, Elchanan Klein, Avishay Katz, Shimon Daniel



The Israeli **Combat Engineering Corps** (Hebrew: חיל ההנדסה הקרבית, *Heil HaHandasa HaKravit*) is the combat engineering forces of the Israel Defense Forces.

The Combat Engineering Corps beret's color is grey and their symbol features a sword on a defensive tower with a blast halo on the background. The Combat Engineering Corps mottos are "*Always First*" (דִּימַת פִּינוּשָׂאָר) (*Rishonim Tamid*) and the unofficial "*The hard - we shall do today, the impossible - we shall do tomorrow*".

Their roles include mobility assurance, road breaching, defense and fortifications, counter-mobility of enemy forces, construction and destruction under fire, sabotage, explosives, bomb disposal, counter-NBC and special engineering missions.

In addition to Combat Engineering Corps sappers, each infantry brigade has an engineering company trained with basic engineering and EOD (Explosive Ordnance Disposal) skills (called חֵלֶפּ) (*Chelpe*). Combat Engineering Corps sappers and heavy equipment operators are often attached to other units (such as armored or infantry brigades) in order to help them breach through obstacles and handle explosive threats.

## **Roles**

Beside extensive training in basic combat engineering, Combat Engineering Corps are specialized and go through advanced training in their profession. The professions are:

- **Sapper:** trained with all the basic engineering skills and also trained at high infantry level (07 יאבור). Their main role is to breach through terrain obstacles (natural and artificial), breach through minefields and enable ground forces to advance in the battle field. They are trained to supply close combat support for both armored fighting vehicles and infantry. Some of them are trained in driving the Combat Engineering Corps standard CEV: the IDF Puma. Their professional ranks after advance training are Rifleman 07 (07 יאבור) and Sapper 06 (06 סלפ).
- **Engineering Vehicles Operator (EVO):** less combatant but nonetheless important, these soldiers are skilled in the operation of heavy mechanical equipment and engineering vehicles such as heavy bulldozers, excavators, cranes, tractors and mine-breaching devices. EVO units are called ה"מצ (Tzama) in Hebrew, acronym of *Tziyud Mechani Handasi* (Mechanical Engineering Equipment). Their professional ranks are Rifleman 05 (05 יאבור) and EVO Operator 07 (07 ה"מצ ליעפמ).
  - **Bulldozer Operators:** belong to the EVO, these soldiers are operating the IDF Caterpillar D9 armored bulldozers, including under heavy fire. Their roles are versatile and differ according to the units whom they are attached. The D9 operators perform construction, destruction, breaching and EOD missions while assisting to tanks, infantry and even special forces during battle.
- **NBC Disposal:** called "purifiers", they are expert in handling nuclear, biological and chemical threats.
- **EOD experts:** the Explosive Ordnance Disposal are experts in detonating explosives without damage and bomb disposal. Among their equipment you can find the Barrett M82A1 and remote-control EOD robots with shotguns and mechanic-arms. The EOD are the military equivalent of the police's bomb squad. In the IDF, they are a part of the elite Engineering unit Yahalom.
- **Demolition experts:** they are specially trained in blowing up things in the most accurate and effective way. They explode things ranging from cellular phones and doorlocks up to tanks and large buildings. In the IDF, the demolition experts are united in Sayeret Yael of Yahalom (Sayeret is the Israeli name for SF elite unit) and therefore gain high infantry training as well.
- **Fortification experts:** assigned on designing and overseeing the construction of bases, outposts, bridges and fortifications. Construction itself is usually done by the EVOs.
- **Counter-Tunnels experts:** established in 2003 by the late Captain Aviv Hakani, these Combat Engineering Corps soldiers are expert in finding smuggling tunnels and weapon caches, and demolishing them. They operated in Rafah during the al-Aqsa Intifada and received recommendation of honor for their activity. After 2004 APC incident the Rafah tunnel team was united with the Combat Engineering Corps elite unit Yahalom and was renamed Sayeret Samur ("Samur" means "Weasel" in Hebrew).



IDF Puma.

Puma is a heavy armed engineering vehicle, used to transfer Combat Engineering Corps through minefields or a hostile urban terrain.



IDF Caterpillar D9.

Armored bulldozers are standard combat engineering tools, as they can perform construction, destruction and EOD missions under heavy fire.



RemoTec ANDROS EOD robot.



Armoured front loader.

## **Units**

- Combat Engineering Battalions
  - Asaf 601 ףסא
  - HaMachatz 605 ןחמה
  - Lahav 603 בהל
- Command's Engineering Units
  - North
  - Center
  - South
- Special Engineering Vehicles (TZAMA ה"מצ) units
  - Knights of Steel יריבא הדלפה - Tzama Gaza
  - Wild Cats רבה ילותח - Tzama Yeuda and Shomron
  - Beit Hilel ללה תיב - Tzama North
- Yahalom - special engineering unit ם"להי
  - Sayeret Yael - engineering commando
  - SAP - EOD and bomb disposal
  - SAMUR - counter-tunnels
  - Hevzek - Robotics
- Counter-NBC and purifiers
  - Counter-NBC battalion 76
  - Yanshuf - NBC training center
- Military Engineering School (Bahad 14) תיב 14 ד"הב - תיאבצ הסדנהל רפסה

## ***History***

### **Founding of the corps**

The Israeli Combat Engineering Corps are based upon the sabotage unit of the Palmach and the tractors operators units of the Israeli War of Independence. In the first years, the Combat Engineering Corps drew their soldiers mainly from Jews who served in the British Royal Engineers.

The Combat Engineering Corps have record of great professional achievements and breaking-through decorations. The Engineering Corps' most famous operation is the breaching of the Suez Canal in Yom Kippur War.

### **In the Israeli wars**

In the Israeli War of Independence, the Combat Engineering Corps blasted bridges over the Jordan River and the streams of the southern Coastal plain in order to stop the advance of the Arab armored forces into the Israeli civilian rear. The Combat Engineering Corps also helped in breaching the "Burma Road" into the then besieged Jerusalem.



"Road of Heroism" memorial for the fallen soldiers of the Israeli Engineering Corps, near Hulda forest, at Burma Road, Israel.

In the 1956 Sinai war the Combat Engineering Corps destroyed the Egyptian military infrastructure in the Sinai Peninsula and were awarded with a battalion recommendation of honor (TZALASH).

In the 1967 Six Day War the Combat Engineering Corps stormed the Jordanian fortifications, which were the walls of the Old City of Jerusalem. After the Israelis annexed the entire Old City, the Combat Engineering Corps removed landmines planted in the city by the Jordanians. This was the first war in which Caterpillar D9 bulldozers were employed by the Combat Engineering Corps.

After the war, the Combat Engineering Corps helped to build a fortification line of defense along the Suez Canal and was awarded the Israel Security Prize in 1969. The Israeli Engineering Corps were the first corps to ever win such an award.

In the 1973 Yom Kippur War the Combat Engineering Corps battalions attached to Ariel Sharon's armored Brigade breached the Suez Canal and built bridges over it in "Operation Knights of Heart" while carrying tanks and paratroopers across the canal with Gillois amphibious tank-carriers. This effort enabled Sharon and Avraam "Bren" Adan's armored divisions to pass the canal and surround the 3rd Egyptian Army, forcing it to surrender. The bridging of the canal is regarded by many as the turning point of the war in the southern front. On the northern front, a Combat Engineering Corps Caterpillar D9 bulldozer was the first ever motorized vehicle to reach the peak of the Hermon.

In the Operation Peace for Galilee the Combat Engineering Corps worked intensively to open routes to Israeli forces. Their duties also included the disarming landmines and IEDs as well as building fortifications and outposts.

In the 1991 Gulf War, the NBC purifiers of the Combat Engineering Corps were on a "code red" alert for disarming Iraqi Scud missiles, armed with non-conventional warheads.

### **The October 2000 Lebanon abduction**



"Timsach" (crocodile) Gillois amphibious tank-carrier

On October 7, 2000 three Israeli combat engineering soldiers were kidnapped by Hezbollah from the Shebaa Farms, in the Golan Heights. The soldiers, Beni Avraham, Adi Avitan and Omar Sawaed, suffered fatal injuries during their abduction. Their bodies were retrieved in 2004 at a prisoner swap deal with Hezbollah.

A series of accusations were made against the United Nations Interim Force in Lebanon (UNIFIL) by press and partisan web sites for having cooperated with the abduction. Those accusations stem from a video, whose existence was originally denied by U.N. officials, recorded by Indian peacekeepers one day after the abduction. The video, which the U.N. agreed to provide to Israeli officials in June 2001 with civilian faces blurred, showed abandoned vehicles with fake U.N. license plates and uniforms, and Hezbollah supporters intercepting U.N. efforts to retrieve the vehicles. A U.N. investigation also found no evidence to support accusations of peacekeepers involvement in the abduction. Although the bereaved families met with Kofi Annan, they refused to accept the UN version. On September 2004, the bereaved families announced their intention to sue the UN, Hezbollah, Iran, Syria and Lebanon for their parts in the abduction.

### **The al-Aqsa Intifada**



IDF D9L, which won the Battle of Jenin 2002 during Operation Defensive Shield. The armored Caterpillar D9 bulldozers were cited by military experts as a key factor in keeping IDF casualties low.

During the al-Aqsa Intifada, which erupted in September 2000, the Combat Engineering Corps were employed to disarm many Palestinian IED explosive charges and booby traps. In many cases, the Combat Engineering Corps also detonated explosive belts captured on Palestinian suicide bombers. The Combat Engineering Corps also dynamited Palestinian houses, bomb labs and smuggling tunnels.

However, the Combat Engineering Corps were most known for operating the armored IDF Caterpillar D9 bulldozers, which are cited by many Israelis and military experts as a key factor in keeping IDF casualties low and successfully fighting terrorism. On the other side, for Palestinians, the bulldozers became a nightmare, as they bulldozed many Palestinian buildings and shrubbery, and were almost impervious to Palestinian attacks. The Combat Engineering Corps bulldozers' operators unit received an honor of recommendation for its activity in Jenin during Operation Defensive Shield.

Bulldozers were also massively employed in Rafah to counter terrorist smuggling tunnels. Human Rights Watch published a report criticizing the extensive destruction of Palestinian houses in the southern Gaza strip, and said it was unlawful, claiming that Israel uses the Palestinian smuggling tunnels as a pretext to create a "buffer zone" along the Gaza-Egypt border. In Rafah, the Combat Engineering Corps formed a special unit, designated for searching and destroying smuggling tunnels, it is called SAMUR and now belongs to Yaalom. They also received an honor of recommendation, for their conduct. Until the Disengagement plan, the Combat Engineering 603 battalion's Reconnaissance platoon (ר"סחמ) held a record of over 70 terrorists killed in 2004-2005 on the border between the Gaza Strip and Israel. They received an honor of recommendation for this achievement.

## **Second Lebanon War**

The Combat Engineering Corps took significant part in the Second Lebanon War that erupted in 2006 after Hizbullah attacked IDF patrol, abducted two soldiers and killed another 8 with anti-tank missiles and IED that hit the rescuers.

On July 16 combat engineering forces from Asaf battalion were the first to enter Lebanon. Their mission was to clear IEDs, open safe routes to ground forces and demolish Hizbullah infrastructures. Yahalom bomb disposal experts and IDF Caterpillar D9 bulldozers cleared most of Hizbullah's IEDs. During the war, a D9 went over a 500 kg belly charge IED but survived without taking significant damage.

During the war, combat engineers used bulldozers and explosives to destroy Hizbullah outposts, bunkers, warehouses and HQs - mainly along the border. The works intensified as the war reached near end, and indeed the borderline was cleared in time.

Combat engineers also rescued damaged tanks, often under fire.

Two combat engineers were awarded with Medal of Distinguished Service and other two awarded a recommendation of honor from the General Chief of Staff. Many other awarded with recommendation of honor from less senior commanders.

## Operation Cast Lead

During the Gaza War (2008-2009) codenamed "Operation Cast Lead" by the IDF, combat engineering forces were the first to enter the Gaza Strip to clear IEDs, booby traps and open safe routes to armor and infantry.

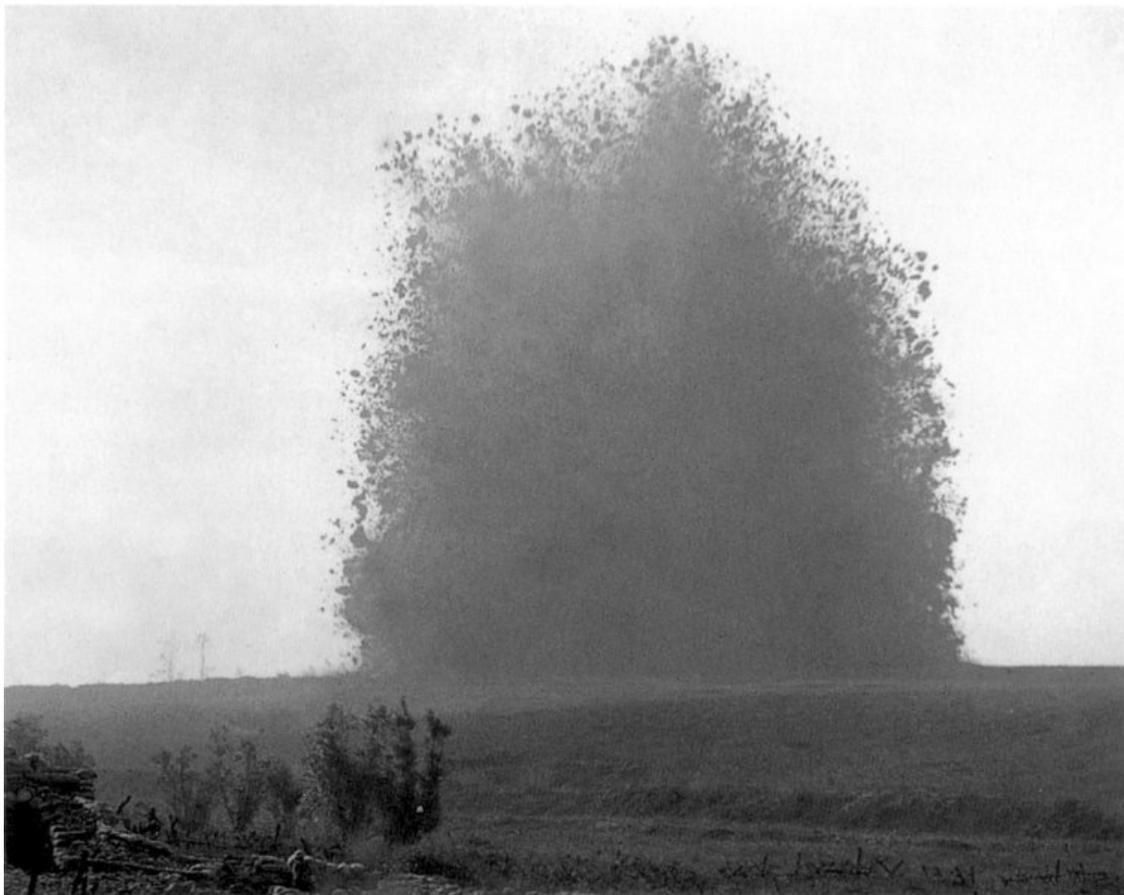
Many booby traps, rigged structures and tunnels were present in the Gaza Strip as part of Hamas efforts to prepare for the Gaza war. These were often concealed in civilian structures, and were even found in schools and mosques. However, most of the Palestinian booby traps were successfully countered by the IDF Combat Engineering Corps bomb disposal experts (part of Yahalom Special Engineering Unit) which dismantled the bombs and armored D9 bulldozers which detonated bombs and booby traps while sustaining no damage from the explosions. IDF Caterpillar D9R and unmanned "Raam HaShachar" D9N armored bulldozers which opened routes in dangerous areas have taken a lot of IEDs, landmines, explosive charges and RPG hits, but no crewmen were killed. However, a Yahalom bomb disposal expert was killed after entering a house and encountering a suicide bomber. He was the only fatality of the Combat Engineering Corps during the war.

Besides neutralizing Hamas IEDs and traps, combat engineering forces demolished Hamas infrastructure and other structures which were used as outposts, shooting positions, traps, cover for tunnels, HQs or warehouses. The head officer of the Combat Engineering Corps (ר"ניהק) estimated that about 600 buildings were bulldozed or exploded by his troops.

The war upgraded the Combat Engineering Corps' status and reputation within the IDF and in the Israeli public. This was manifested in an increased number of conscripts who chose the Combat Engineering Corps as their first priority in their draft preference questionnaire ("הלינימ מניל" - a form in which the conscript chooses in what unit he would like to serve, the IDF tries to fulfill his request as much as possible). On the August 2010 draft, there were 1.1 conscripts who chose Combat Engineering as first priority over each slot.

## Chapter 5

# Mining (Military)



Explosion of the mine beneath Hawthorn Ridge Redoubt on the Western Front during World War I (July 1 1916). Photo by Ernest Brooks

**Mining, landmining or undermining** is a siege method which has been used since antiquity against a walled city, fortress, castle or other strongly-held and fortified military position.

### ***In antiquity***

The Greek historian Polybius, in his *Histories*, gives a graphic account of mining and counter mining at the Roman siege of Ambracia:

The Aetolians [...] offered a gallant resistance to the assault of the siege artillery and [the Romans], therefore, in despair had recourse to mines and underground tunnels. Having safely secured the central one of their three works, and carefully concealed the shaft with wattle screens, they erected in front of it a covered walk or stoa about two hundred feet long, parallel with the wall; and beginning digging from that, they carried it on unceasingly day and night, working in relays. For a considerable number of days the besieged did not discover them carrying the earth away through the shaft; but when the heap of earth thus brought out became too high to be concealed from those inside the city, the commanders of the besieged garrison set to work vigorously digging a trench inside, parallel to the wall and to the stoa which faced the towers. When the trench was made to the required depth, they next placed in a row along the side of the trench nearest the wall a number of brazen vessels made very thin; and, as they walked along the bottom of the trench past these, they listened for the noise of the digging outside. Having marked the spot indicated by any of these brazen vessels, which were extraordinarily sensitive and vibrated to the sound outside, they began digging from within, at right angles to the trench, another underground tunnel leading under the wall, so calculated as to exactly hit the enemy's tunnel. This was soon accomplished, for the Romans had not only brought their mine up to the wall, but had under-pinned a considerable length of it on either side of their mine; and thus the two parties found themselves face to face.

According to Polybius, this was the first time poison gas was used.

Another extraordinary usage of siege-mining in the ancient Greece, where during Philip V of Macedon's siege of the little town of Prinassos, according to Polybius, "the ground around the town were extremely rocky and hard, making any siege-mining virtually impossible. However, Philip ordered his soldiers during the cover of night collect earth from elsewhere and throw it all down at the fake tunnel's entrance, making it look like the macedonians were almost finished completing the tunnels. Eventually, when Philip V announced that large parts of the town-walls were undermined the citizens surrendered without delay.

Mining was a siege method used in ancient China from at least the Warring States (481–221 BC) period forward. When enemies attempted to dig tunnels under walls for mining or entry into the city, the defenders used large bellows (the type the Chinese commonly

used in heating up the blast furnace for smelting cast iron) to pump smoke into the tunnels in order to suffocate the intruders.

## ***In the Middle Ages***

In warfare during the Middle Ages, a "mine" was a tunnel dug to bring down castles and other fortifications. The technique was used when the fortification was not built on solid rock, and was developed as a response to stone built castles that could not be burned like earlier-style wooden forts. A tunnel would be excavated under the outer defenses either to provide access into the fortification or to collapse the walls. These tunnels would normally be supported by temporary wooden props as the digging progressed. Once the excavation was complete, the wall or tower being undermined would be collapsed by filling the excavation with combustible material that, when lit, would burn away the props leaving the structure above unsupported and thus liable to collapse. Later, explosives were used for greater effect.

A tactic related to mining is sapping the wall, where engineers would dig at the base of a wall with crowbars and picks. Peter of les Vaux-de-Cernay recounts how at the battle of Carcassonne, during the Albigensian Crusade, "after the top of the wall had been somewhat weakened by bombardment from petraries, our engineers succeeded with great difficulty in bringing a four-wheeled wagon, covered in oxhides, close to the wall, from which they set to work to sap the wall"

As in the siege of Carcassonne, defenders worked to prevent sapping by dumping anything they had down on attackers who tried to dig under the wall. Successful sapping usually ended the battle since either the defenders would no longer be able to defend and surrender, or the attackers would simply charge in and engage the defenders in close combat.

There were several methods to resist under mining. Often the siting of a castle could be such as to make mining difficult. The walls of a castle could be constructed either on solid rock or on sandy or water logged land making it difficult to dig mines. A very deep ditch or moat could be constructed in front of the walls, as was done at Pembroke Castle, or even artificial lakes as was done at Kenilworth Castle. This makes it more difficult to dig a mine and even if a breach is made the ditch or moat makes exploiting the breach difficult. The defenders could also dig counter mines. From these they could then either dig into the attackers' tunnels and sortie into them to either kill the miners or to set fire to the pit-props to collapse the attackers' tunnel. Alternatively they could under mine the attackers' tunnels and create a camouflet to collapse the attackers' tunnels. Finally if the walls were breached they could either place obstacles in the breach for example a chevaux de frise to hinder a forlorn hope, or construct a coupure. The great concentric ringed fortresses like Beaumaris Castle on Anglesey were designed in such a way that the inner walls were ready built coupures so that if an attacker succeeded in breaching the outer walls would have left them in a killing field between the lower outer walls and the higher inner walls.

## ***In the American Civil War***

During the Siege of Vicksburg in 1863 Union troops led by General Ulysses S. Grant tunnelled under the Confederate trenches and detonated the mine beneath the 3rd Louisiana Redan on June 25, 1863. The following assault led by General John A. Logan gained a foothold in the Confederate trenches where the crater was formed but the attackers were eventually forced to withdraw.

A more famous instance occurred during the Siege of Petersburg, Union troops dug a tunnel under the Confederate lines at Elliott's Salient and packed its end with vast amounts of gunpowder. When set off, the resulting explosion killed about 300 soldiers. It might have been decisive if not for the faulty Union tactic of storming into, rather than around, the resulting crater, allowing the defenders to shoot down onto attackers unable to climb the steep crater sides. The combat was accordingly known as the Battle of the Crater. (The horror of this engagement was portrayed in the Charles Frazier novel and subsequent Anthony Minghella movie *Cold Mountain*.)

## ***In modern warfare***



Contractors manually clear a mine field on Bagram Airfield, Afghanistan in 2007

Mining saw a brief resurgence as a military tactic during the First World War when army engineers attempted to break the stalemate of trench warfare by tunneling under no man's land and laying large quantities of explosives beneath the enemy's trench. As in siege warfare, mining was possible due to the static nature of the fighting.

A notable example was the Battle of Messines, when 450 tonnes of high explosive were placed in 21 mines after about two years of sapping. Approximately 10,000 German troops were killed when 19 of the mines were simultaneously detonated. One of the explosive caches exploded years later. The 21st cache was never found and there are still several tonnes of high explosive buried somewhere in the Belgian countryside.

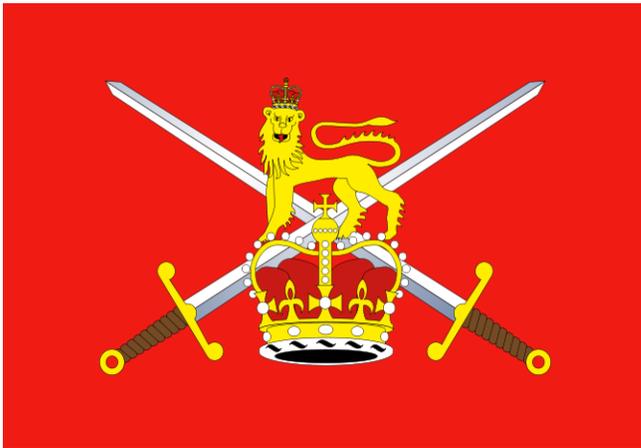
Another example is recorded in Louis Trenker's *Berge in Flammen*. Whole mountain peaks in the Alps, such as Col di Lana, Lagazuoi and Marmolata, were exploded during the mountain war.

Because troop movements in World War II were too fluid, and tunneling too slow, mining proved not to be worth the investment of effort in that conflict.

## Chapter 6

# Royal Engineers

### British Army Arms and Services



#### Combat Arms

Royal Armoured Corps

Infantry

- Guards Division
- Scottish Division
- King's Division
- Queen's Division
- Prince of Wales' Division
- Royal Irish Regiment
- Parachute Regiment
- Royal Gurkha Rifles
- The Rifles
- Special Air Service

Army Air Corps

### Combat Support Arms

Royal Artillery

**Royal Engineers**

Royal Corps of Signals

Intelligence Corps

### Combat Services

Royal Army Chaplains Department

Royal Logistic Corps

Army Medical Services

- Royal Army Medical Corps
- Royal Army Dental Corps
- Royal Army Veterinary Corps
- Queen Alexandra's Royal Army Nursing Corps

Royal Electrical and Mechanical Engineers

Adjutant General's Corps

- Educational and Training Services Branch
- Army Legal Services Branch
- Royal Military Police
- Military Provost Staff Corps

Small Arms School Corps

Royal Army Physical Training Corps

General Service Corps

Corps of Army Music

The **Corps of Royal Engineers**, usually just called the **Royal Engineers (RE)**, and commonly known as the **Sappers**, is one of the corps of the British Army. It provides military engineering and other technical support to the British Armed Forces. It is headed by the Chief Royal Engineer.

The Regimental Headquarters and the Royal School of Military Engineering are in Chatham in Kent, England. The corps is divided into several regiments, barracked at various places in the United Kingdom of Great Britain and Northern Ireland and Germany.

## *History*



Cap Badge of the Corps of Royal Engineers

**ROYAL ENGINEERS.**

**1<sup>ST</sup> & 2<sup>ND</sup> NORTH MIDLAND FIELD COMPANY R.E.**  
and  
**NORTH MIDLAND DIVISIONAL TELEGRAPH COMPANY.**

**Head Quarters.**

**SMETHWICK, NORTON, CANNOCK CHASE, AND SHELTON.**

**THE FOLLOWING ARE ELIGIBLE TO JOIN.**

- (1). N.C.O.'s, and Men of Yeomanry, &c.
- (2). Ex-soldiers.
- (3). Recruits, age between 17 & 35 years of age on enlistment.

Craftsmen of all sorts are invited to enlist. Royal Engineers are all trained as Soldiers but their training consists of a shortened and modified course.

**JOIN THE CORPS OF SOLDIER CRAFTSMEN**  
*The Best Paid ARM in the SERVICE.*

**.. PAY ..**

Sergeant, 3s. 3d., Corporal, 2s. 6d., & Sapper, 1s. 1½d., per day.  
Engineer pay at rates varying from 4d. to 2s. a day will be given according to rank & rating.

**FREE KIT, FREE RATIONS, &c.**  
These rates of pay and allowances are paid during training.

The total strength of a Field Company is limited to 216 all ranks  
The total strength of a Div. Telegraph Co. is limited to 40 all ranks

**GOD SAVE THE KING.**

Royal Engineers recruitment poster



### Corps of Royal Engineers Cypher

The Royal Engineers trace their origins back to the military engineers brought to England by William the Conqueror, specifically Bishop Gundulf of Rochester Cathedral, a talented military engineer, and claim over 900 years of unbroken service to the crown. Engineers have always served in the armies of the Crown; however, the origins of the modern corps, along with those of the Royal Artillery, lie in the Board of Ordnance established in the 15th century. In 1717, the Board established a **Corps of Engineers**, consisting entirely of commissioned officers. The manual work was done by the **Artificer Companies**, made up of contracted civilian artisans and labourers. In 1782, a **Soldier Artificer Company** was established for service in Gibraltar, and this was the first instance of non-commissioned military engineers. In 1787, the Corps of Engineers was granted the *Royal* prefix and adopted its current name and in the same year a **Corps of Royal Military Artificers** was formed, consisting of non-commissioned officers and privates, to be officered by the RE. Ten years later the Gibraltar company, which had remained separate, was absorbed and in 1812 the name was changed to the **Corps of Royal Sappers and Miners**.

In 1855 the Board of Ordnance was abolished and authority over the Royal Engineers, Royal Sappers and Miners and Royal Artillery was transferred to the Commander-in-Chief of the Forces, thus uniting them with the rest of the Army. The following year, the Royal Engineers and Royal Sappers and Miners became a unified corps as the **Corps of Royal Engineers**. In 1862 the corps also absorbed the British officers and men of the engineer corps of the East India Company.

In 1911 the Corps formed its Air Battalion, the first flying unit of the British Armed Forces. The Air Battalion was the forerunner of the Royal Flying Corps and Royal Air Force.

In 1915, in response to German mining of British trenches under the then static siege conditions of World War One, the corps formed its own tunnelling companies. Manned by experienced coal miners from across the country, they operated with great success

until 1917, when after the fixed positions broke, they built deep dugouts such as the Vampire dugout to protect troops from heavy shelling.

The Corps has no battle honours, but its motto is *Ubique Quo Fas et Gloria Ducunt*. This translates to "Everywhere Where Right and Glory Lead" and is often seen shortened to simply "Ubique" although the full motto should always be used for traditional, heraldic or historical purposes. The motto was granted by King William IV in 1832, signifying that the Corps had seen action in all the major conflicts of the British Army and almost all of the minor ones as well. The Royal Engineers Museum of Military Engineering is in Gillingham in Kent.

A point of some pride to the Sappers is that their name takes the form Corps of Royal Engineers rather than, for example, Royal Engineer Corps. The distinction, they say, is that every Sapper is Royal in his own right, rather than simply being a member of a Royal Corps (such as the Royal Corps of Signals or the Royal Regiment of Artillery).

Before the Second World War, Royal Engineers recruits were required to be at least 5 feet 4 inches tall (5 feet 2 inches for the Mounted Branch). They initially enlisted for six years with the colours and a further six years with the reserve or four years and eight years. Unlike most corps and regiments, in which the upper age limit was 25, men could enlist in the Royal Engineers up to 30 years of age. They trained at the Royal Engineers Depot in Chatham or the RE Mounted Depot at Aldershot.

### ***Honourable Conquests and Historical Construction***

Britain having acquired an Empire, it fell to the Royal Engineers to conduct some of the most significant 'civil' engineering schemes around the world. Some examples of great works of the era of empire can be found in A.J. Smithers' book; 'Honourable Conquests':

## Royal Albert Hall



The Royal Albert Hall, designed by Captain Francis Fowke RE.

The Royal Albert Hall is one of the UK's most treasured and distinctive buildings, recognisable the world over. Since its opening by Queen Victoria in 1871, the world's leading artists from every kind of performance genre have appeared on its stage. Each year it hosts more than 350 performances including classical concerts, rock and pop, ballet and opera, tennis, award ceremonies, school and community events, charity performances and lavish banquets.

The Hall was designed by Captain Francis Fowke and Major-General Henry Y.D. Scott of the Royal Engineers and built by Lucas Brothers. The designers were heavily influenced by ancient amphitheatres, but had also been exposed to the ideas of Gottfried Semper while he was working at the South Kensington Museum.

## Indian Infrastructure

Much of the infrastructure of India, still enjoyed today, was created by engineers of the three presidencies armies and the Royal Engineers. Lieutenant (later General Sir) Arthur Thomas Cotton (1803–99), Madras Engineers, was responsible for the design and construction of the great irrigation works on the river Cauvery, which watered the rice corps of Tanjore and Trichinopoly districts in the late 1820s. In 1838 he designed and built sea defences for Vizagapatam. He masterminded the Godavery Delta project where 720,000 acres (2,900 km<sup>2</sup>) of land were irrigated and 500 miles (800 km) of land to the

port of Cocanada was made navigable in the 1840s. Such regard for his lasting legacy was shown when in 1983, the Indian Government erected a statue in his memory.

Other irrigation and canal projects included the Ganges Canal, where Colonel Sir Colin Scott-Moncrieff (1836–1916) acted as the Chief Engineer and made modifications to the original work. Scott-Moncrieff went on to become Under Secretary of State Public Works, Egypt where he restored the Nile barrage and irrigation works of Lower Egypt.

## **Rideau Canal**

The construction of the Rideau Canal was proposed shortly after the War of 1812, when there remained a persistent threat of attack by the United States on the British colony of Upper Canada. The initial purpose of the Rideau Canal was military, as it was intended to provide a secure supply and communications route between Montreal and the British naval base in Kingston, Ontario. Westward from Montreal, travel would proceed along the Ottawa River to Bytown (now Ottawa), then southwest via the canal to Kingston and out into Lake Ontario. The objective was to bypass the stretch of the St. Lawrence River bordering New York State, a route which would have left British supply ships vulnerable to attack or a blockade of the St. Lawrence. The construction of the canal was supervised by Lieutenant-Colonel John By of the Royal Engineers. In 2007 it was inscribed as a UNESCO World Heritage Site recognizing it as a work of human creative genius. The Rideau Canal was recognized as the best preserved example of a slack water canal in North America demonstrating the use of European slackwater technology in North America on a large scale. Lt. Denison was one of the junior Royal Engineers who worked under Lt. Colonel John By, RE on the Rideau Canal in Upper Canada (1826–1832). Of note, Denison carried out experiments under the direction of Lt. Col. By to determine the strength, for construction purposes of the old growth Canadian timber in the vicinity of Bytown. His findings were published by the Institution of Civil Engineers in England who bestowed upon him the prestigious Telford Medal.

## Dovers' Western Heights



Drop Redoubt.

The Western Heights of Dover are one of the most impressive fortifications in Britain. They comprise a series of forts, strong points and ditches, designed to protect the country from invasion. They were created to augment the existing defences and protect the key port of Dover from both seaward and landward attack. First given earthworks in 1779 against the planned invasion that year, the high ground west of Dover, England, now called Dover Western Heights, was properly fortified in 1804 when Lieutenant-Colonel William Twiss was instructed to modernise the existing defences. This was part of a huge programme of fortification in response to Napoleon's planned invasion of the United Kingdom. To assist with the movement of troops between Dover Castle and the town defences Twiss made his case for building the Grand Shaft in the cliff:

‘...the new barracks.....are little more than 300 yards horizontally from the beach.....and about 180 feet (55 m) above high-water mark, but in order to communicate with them from the centre of town, on horseback the distance is nearly a mile and a half and to walk it about three-quarters of a mile, and all the roads unavoidably pass over ground more than 100 feet (30 m) above the barracks, besides the footpaths are so steep and chalky that a number of accidents will unavoidably happen during the wet weather and more especially after floods. I am therefore induced to recommend the construction of a shaft,

with a triple staircase....the chief objective of which is the convenience and safety of troops....and may eventually be useful in sending reinforcements to troops or in affording them a secure retreat.’

Twiss’ plan was approved and building went ahead. The shaft was to be 26 feet (7.9 m) in diameter, 140 feet (43 m) deep with a 180 feet (55 m) gallery connecting the bottom of the shaft to Snargate Street, and all for under an estimated £4000. The plan entailed building two brick-lined shafts, one inside the other. In the outer would be built a triple staircase, the inner acting as a light well with ‘windows’ cut in its outer wall to illuminate the staircases. Apparently, by March 1805 only 40 feet (12 m) of the connecting gallery was left to dig and it is probable that the project was completed by 1807.

## **Pentonville Prison**

Two Acts of Parliament allowed for the building of Pentonville Prison for the detention of convicts sentenced to imprisonment or awaiting transportation. Construction started on 10 April 1840 and was completed in 1842. The cost was £84,186 12s 2d. Captain (later Major General Sir) Joshua Jebb designed Pentonville Prison, introducing new concepts such as single cells with good heating, ventilation and sanitation.

## **Boundary Commissions**

Although mapping by what became the Ordnance Survey was borne out of military necessity it was soon realised that accurate maps could be also used for civic purposes. The lessons learnt from this first boundary commission were put to good use around the world where members of the Corps have determined boundaries on behalf of the British as well as foreign governments; some notable boundary commissions include:

- 1839 - Canada-United States
- 1858 - Canada-United States (Captain (later General Sir) John Hawkins RE)
- 1856 and 1857 - Russo-Turkish (Lieutenant Colonel (later Sir) Edward Stanton RE)
- 1857 - Russo-Turkish (Colonel (later Field Marshall Sir) John Simmons RE)
- 1878 - The Bulgarian
- 1880 - Græco-Turkish (Major (later Major General Sir) John Ardagh RE)
- 1884 - Russo-Afghan (Captain (later Colonel Sir) Thomas Holdich RE)
- 1894 - India-Afghanistan (Captain (later Colonel Sir) Thomas Holdich RE)
- 1902 - Chile-Argentina (Colonel Sir Delme Radcliffe RE)
- 1911 - Peru-Bolivia (Major AJ Woodroffe RE)

Much of this work continues to this day. The reform of the voting franchise brought about by the Reform Act (1832), demanded that boundary commissions were set up. Lieutenants Dawson and Thomas Drummond (1797–1839), Royal Engineers were employed to gather the statistical information upon which the Bill was founded, as well as determining the boundaries and districts of boroughs. It was said that the fate of numerous boroughs fell victim to the heliostat and the Drummond light, the instrument

that Drummond invented whilst surveying in Ireland. (In 1835 he resigned his commission on his appointment as Under Secretary of State for Ireland).

## **Abney Level**

A Topographic Abney Level is an instrument used in surveying which consists of a fixed sighting tube, a movable spirit level that is connected to a pointing arm, and a protractor scale. The Topographic Abney Level is an easy to use, relatively inexpensive, and when used correctly an accurate surveying tool. The Abney level was invented by Sir William de Wiveleslie Abney (Born 24 Jul 1843 Died 3 Dec 1920) who was a Royal Engineer, an English astronomer and chemist best known for his pioneering of color photography and color vision. Sir Abney invented this instrument under the employment of the Royal School of Military Engineering in Chatham, England in the 1870s.

## **H.M. Dockyards**



Slip 7 at Chatham Dockyard, designed by Col. G Greene RE.



Slip 3 at Chatham Dockyard, designed and built by the Corps.

In 1873, Captain Henry Brandreth RE was appointed Director of the Department of Architecture and Civil Engineering, later the Admiralty Works Department. Following this appointment many Royal Engineer officers superintended engineering works at Naval Dockyards across the world.

Early in the 19th century, cast, wrought and corrugated iron came to be used in dockyard buildings, replacing wood as the material for frames and cladding. The experience of the Corps made them experts in the use of these new materials.

### **Chatham Dockyard**

Chatham being the home of the Corps, meant that the Royal Engineers and the Dockyard had a close relationship since Captain Brandreth's appointment. At the Chatham Dockyard, Captain Thomas Mould RE designed the iron roof trusses for the covered slips, 4, 5 and 6. Slip 7 was designed by Colonel Godfrey Greene RE on his move to the Corps from the Bengal Sappers & Miners. In 1886 Major Henry Pilkington RE was appointed Superintendent of Engineering at the Dockyard, moving on to Director of Engineering at the Admiralty in 1890 and Engineer-in-Chief of Naval Loan Works, where he was responsible for the extension of all major Dockyards at home and abroad. It was under his supervision that the Royal Naval Hospital, Chatham, was built in 1905.

## ***Trades***

All members of the Royal Engineers are trained combat engineers and all sappers (privates) and non-commissioned officers also have another trade. Women are eligible for all Royal Engineer specialities.



ME - Fabricator in Iraq



ME - Armoured operating an AVRE in Canada

All Sappers train as Military Engineer - Combat. Sappers then qualify one of the following additional trades:

- Military Engineer - Armoured Crewman
- Military Engineer - Bricklayer and Concretor
- Military Engineer - Bomb Disposal
- Military Engineer - Building and Structural Finisher
- Military Engineer - Carpenter and Joiner
- Military Engineer - Command, Communications and Information Systems Specialist
- Military Engineer - Construction Materials Technician
- Military Engineer - Draughtsman (Design)
- Military Engineer - Draughtsman (Electrical and Mechanical)
- Military Engineer - Driver
- Military Engineer - Electrician
- Military Engineer - Fabricator (Welder)
- Military Engineer - Fitter (Air Conditioning and Refrigeration)
- Military Engineer - Fitter (General)
- Military Engineer - Geographical Technician
- Military Engineer - Heating and Plumbing
- Military Engineer - Plant Operator Mechanic
- Military Engineer - Resources Specialist
- Military Engineer - Surveyor (Engineering)

- Military Engineer - Surveyor (Topographical)

Later, sappers can specialise in further trades and specialities, including:

- Counter Terrorist Advanced Search
- Explosive Ordnance Disposal
- Amphibious Engineer
- Clerk of Works (Construction)
- Clerk of Works (Electrical)
- Clerk of Works (Mechanical)
- Commando Engineer
- Army Diver
- Military Plant Foreman
- Parachute Engineer
- Regimental Signals Instructor

Senior NCOs who have passed the appropriate Clerk of Works course can be commissioned as Garrison Engineers (Construction, Electrical or Mechanical).

## ***Units***

The Royal Engineers comprises units of both the Regular Army and the Territorial Army. There is also a higher engineer formation:

## Theatre Troops



Combat Engineers prepare a bridge for demolition in Malaya.



Royal Engineers' Surveyors in Europe



Combat Engineers of 20 Field Squadron, 36 Engineer Regiment practice landmine clearance.

- 8 Force Engineer Brigade
  - 12 (Air Support) Engineer Group (25, 39, 529 Specialist Teams (STRE)RE)
  - 29 (Land Support) Engineer Group (33 and 101 (V) Regiments)
  - 170 (Infrastructure Support) Engineer Group (previously Military Works Force)
    - HQ Works Group
      - Royal Engineers Specialist Advisory Team (RESAT)
      - Technical Information Centre Royal Engineers
    - 62 Works Group (Water utilities, water development and well drilling)
      - 506 STRE (Water Infrastructure) (Volunteers)
      - 519 STRE (Works)
      - 523 STRE (Works)
      - 521 STRE (Water Development)
    - 63 Works Group (Electrical power generation and distribution)
      - 504 STRE (Power Infrastructure) (Volunteers)
      - 518 STRE (Works)
      - 528 STRE (Power)

- 535 STRE (Works)
- 64 Works Group (Fuels, fuel production and distribution)
  - 516 STRE (Fuels)
  - 524 STRE (Works)
  - 527 STRE (Works)
- 65 (Volunteers) Works Group (Civilian infrastructure, railway and ports infrastructure)
  - STRE
  - STRE
  - STRE
  - STRE
  - STRE
- 66 Works Group (Air Support and geotechnical engineering)
  - 510 STRE (Volunteers)
  - 517 STRE (Works)
  - 522 STRE (Works)
  - 530 STRE (Materials)
- 67 Works Group
  - 502 STRE (Works)
  - 505 STRE (Works)

## Regiments



Armoured Vehicle Royal Engineers, Bobbin, on D Day



RE Plant Operators construct foundations for a new bridge in Workington after floods



Sappers launching a Logistic Support Bridge at Workington in order to reduce effects of collapsed bridges



An AVLB and Armoured Engineer Squadron in Canada



Royal Engineers Bomb Disposal Team, from 33 Engineer Regiment (EOD) in Coventry.



RE Rigid Raider Crew working with HMS Dasher of the Royal Navy Cyprus Squadron off Cyprus.



TROJAN AVRE with Full Width Mine Plough and Fascine.

- 21 Engineer Regiment
  - 7 Headquarters and Support Squadron
  - 1 Armoured Engineer Squadron
  - 4 Armoured Engineer Squadron
  - 73 Armoured Engineer Squadron
  
- 22 Engineer Regiment
  - 6 Headquarters and Support Squadron
  - 3 Armoured Engineer Squadron
  - 5 Armoured Engineer Squadron
  - 52 Armoured Engineer Squadron (2008)
  
- 23 Engineer Regiment (Air Assault) - part of 16 Air Assault Brigade
  - 12 (Nova Scotia) Headquarters and Support Squadron (Air Assault)
  - 9 Parachute Squadron
  - 51 Parachute Squadron
  - 299 Para Field Squadron (V) [Wakefield/Hull/Gateshead]
  
- 24 Commando Engineer Regiment - (Attached to 3 Commando Brigade, Royal Marines).(based at Chivenor)

- 54 Commando Headquarters and Support Squadron
- 56 Commando Field Squadron
- 59 Commando Squadron
- 131 Commando Squadron (TA)

NB: As part of the restructuring of the armed forces in 2004, it was announced that the engineering support for 3 Commando Brigade would be increased to a full regiment, with 24 (Commando) Engineer Regiment to be formed.

- 25 Engineer Regiment
  - 43 Headquarters and Support Squadron (Air Support)
  - 34 Field Squadron (Air Support)
  - 53 Field Squadron (Air Support)
- 26 Engineer Regiment
  - 38 Headquarters and Support Squadron
  - 8 Armoured Engineer Squadron
  - 30 Armoured Engineer Squadron
  - 33 Armoured Engineer Squadron (2008)
- 28 Engineer Regiment
  - 64 Headquarters and Support Squadron
  - 23 Amphibious Engineer Squadron + 412 Troop(Volunteers) TA
  - 42 Field Squadron
  - 45 Field Support Squadron
  - 65 Field Support Squadron
- 32 Engineer Regiment
  - 2 Headquarters and Support Squadron
  - 26 Armoured Engineer Squadron
  - 31 Armoured Engineer Squadron
  - 39 Armoured Engineer Squadron
- 33 Engineer Regiment (Explosive Ordnance Disposal) [Hybrid Regiment with Regular & Territorial Army Squadrons]
  - 49 Field Squadron (EOD)
  - 58 Field Squadron (EOD)
  - 61 Field Squadron (EOD)
  - 217 (London) Field Squadron (EOD)(V) {Holloway}
- 101 (City of London) Engineer Regiment (Explosive Ordnance Disposal) [Hybrid Regiment with Regular & Territorial Army Squadrons]
  - 22 Headquarters and Support Squadron (EOD)
  - 17 Field Squadron (EOD)
  - 21 Field Squadron (EOD)
  - 221 Field Squadron (EOD)(V) {Rochester/Catford}

- 579 Field Squadron (EOD)(V) {Tunbridge Wells}
- 35 Engineer Regiment
  - 44 Headquarters and Support Squadron
  - 29 Armoured Engineer Squadron
  - 37 Armoured Engineer Squadron
  - 77 Armoured Engineer Squadron
- 36 Engineer Regiment (Search)
  - 50 Headquarters and Support Squadron (Search)
  - 20 Field Squadron (Search)
  - 69 Gurkha Field Squadron (Search), Queen's Gurkha Engineers
  - 70 Gurkha Field Support Squadron (Search), Queen's Gurkha Engineers
- 38 Engineer Regiment
  - 32 Headquarters and Support Squadron
  - 11 Field Squadron
  - 15 Field Support Squadron
  - 25 Field Squadron
- 39 Engineer Regiment
  - 60 Headquarters and Support Squadron (Air Support)
  - 10 Field Squadron (Air Support) based at RAF Leeming
  - 48 Field Squadron (Air Support)
- 42 Engineer Regiment (Geographic)
  - 13 Geographic Squadron
  - 14 Geographic Squadron ( based in Munchengladbach)
  - 16 Geographic Support Squadron
- 62 Cyprus Support Squadron Royal Engineers (British Forces Cyprus)

## The Royal School of Military Engineering



HQ Royal School of Military Engineering.

The Royal School of Military Engineering is the British Army's Centre of Excellence for Military Engineering, Explosive Ordnance Disposal (EOD), and counter terrorist search training. Located on several sites in Chatham, Kent, Camberley in Surrey and Bicester in Oxfordshire the Royal School of Military Engineering offers superb training facilities for the full range of Royal Engineer skills.

The RSME was founded by Major (later General Sir) Charles Pasley, as the **Royal Engineer Establishment** in 1812. It was renamed the **School of Military Engineering** in 1868 and granted the "Royal" prefix in 1962.

- Royal School of Military Engineering
  - Combat Engineer School
    - 3 Royal School of Military Engineering Regiment
      - 55 Training Squadron Royal Engineers
      - 57 Training Squadron Royal Engineers
      - 63 Training Support Squadron Royal Engineers
    - Battlefield Engineering Wing
      - United Kingdom Mine Information and Training Centre
    - Communication Information Systems Wing
  - Construction Engineer School
    - 1 Royal School of Military Engineering Regiment
      - 24 Training Squadron Royal Engineers
      - 36 Training Squadron Royal Engineers
    - Command Wing

- Civil Engineering Wing
  - Electrical and Mechanical Wing
- Defence Explosive Munitions and Search School (formally Defence EOD School and the National Search Centre)
- Defence Animal Centre
- Royal School of Military Survey (until 1 April 2006)
- 28 Training Squadron, Army Training Regiment Basingbourn
- Diving Training Unit (Army), (DTU(A))
- Band of the Corps of Royal Engineers

## **Territorial Army**



Royal Monmouthshire RE (Militia) Capbadge.

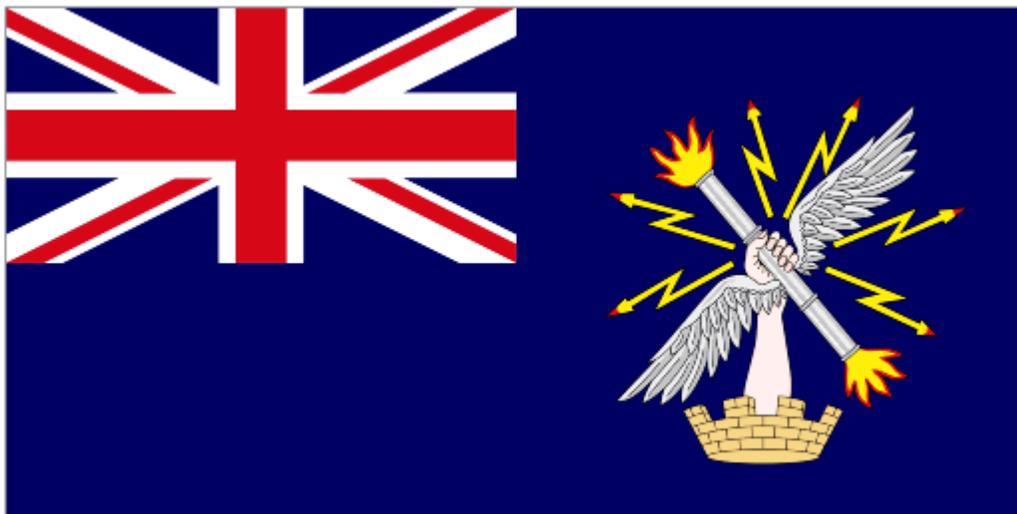
- Royal Monmouthshire Royal Engineers (Militia)
  - 100 Field Squadron [Cwmbran/Bristol/Cardiff]
  - 101 Headquarters Troop [Monmouth]
  - 108 (Welsh) Field Squadron [Swansea/Gorseinion]
  - 225 Field Squadron [Birmingham]
  - The Jersey Field Squadron [St Helier]
- 71 Engineer Regiment (Volunteers) (Air Support)
  - 102 (Clyde) Field Squadron (Air Support) [Paisley/Barnsford Bridge]
  - 124 Field Squadron (Cumbernauld)
  - 236 Field Squadron [Elgin]
  - Headquarters Troop RAF Leuchars
  - 10 Orkney Field Troop [Orkney Islands]
- 72 Engineer Regiment (Volunteers) Close Support
  - 103 (Tyne Electrical Engineers) Field Squadron (Air Support) [Newcastle/Sunderland(2Tp)]
  - 106 (West Riding) Field Squadron [Sheffield/Bradford]
- 73 Engineer Regiment (Volunteers) (Air Support)

- 129 Headquarters and Support Squadron [Nottingham]
- 350 Field Squadron (Air Support) [Nottingham]
- 575 (Sherwood Foresters) Field Squadron (Air Support) [Chesterfield]
- 75 Engineer Regiment (Volunteers) (Field)
  - 107 (Lancashire and Cheshire) Field Squadron [Birkenhead]
  - 125 (Staffordshire) Field Support Squadron [Stoke-on-Trent]
  - 202 Field Support Squadron [Manchester]
- 101 (City of London) Engineer Regiment (EOD) [Hybrid Regiment - Regular & TA]
  - 221 Field Squadron (EOD)(V) [Rochester/Catford]
  - 579 Field Squadron (EOD)(V) [Tunbridge Wells]
- 33 Engineer Regiment (EOD) [Hybrid Regiment - Regular & TA]
  - 217 (London) Field Squadron (EOD) [Holloway]
- 131 Independent Commando Squadron Royal Engineers (Volunteers) [London/Bath/Plymouth/Birmingham] ' formed 24 Commando Regiment Royal Engineers in early 2007
- 135 Independent Geographic Squadron Royal Engineers (Volunteers) [Ewell]
- Engineer and Logistic Staff Corps (Volunteers)
- 170 (Infrastructure Support) Engineer Group (previously Military Works Force)
  - 62 Works Group [Regular]
    - 506 STRE (Water Infrastructure)
  - 63 Works Group [Regular]
    - 504 STRE (Power Infrastructure)
  - 64 Works Group [Regular]
    - 503 STRE (Fuels Infrastructure)
  - 65 Works Group
    - 507 STRE (Railway Infrastructure)
    - 509 STRE (Ports Infrastructure)
    - 508 STRE (Works)
    - 525 STRE (Works)
    - 526 STRE (Works)
- 591 Independent Field Squadron
  - Is the only Royal Engineer TA Unit in Northern Ireland.

## Corps' Ensign



Camp Gate Flag of the Royal Engineers



Royal Engineers' Ensign

The Royal Engineers, Ports Section, operated harbours and ports for the army and used mainly specialised vessels such as tugs and dredgers. Although the former Submarine Mining Service badge had been incorporated into their Ensign, which was been designated 'Royal Engineers' after Submarine Mining was transferred to the Admiralty in 1904, the badge was made obsolete in 1909. However at the beginning of the 1914-1918 War, Inland Water Transport (IWT), previously part of the War Department Fleet, was transferred to the Royal Engineers and in 1915 the old Submarine Mining/Royal Engineers badge was reintroduced with pattern again sealed (L of C 17226).

IWT ran barges on rivers and canals up to the front line in France. Later their responsibilities were extended, and by 1916 they were also operating ships and train

ferries across the Channel from a purpose built port at Richborough. IWT vessels were also in East Africa, and Mesopotamia (Iraq) where they moved supplies on the Tigris and Euphrates from Basra to Baghdad; by 1918 over 1600 vessels were there, mainly chartered or requisitioned. IWT was disbanded in 1924, but revived in 1939. During the 1939-1945 War IWT was active in North Africa, India, British Malaya, Burma, Iraq, Normandy, Belgium, and the Netherlands.

In November 1942 the Director of Transportation asked whether the flag issued to Royal Engineers small craft was correct. He seems to have been concerned with the form of the thunder-bolt. The original 1806 crest from which the badge was derived; "Out of a mural crown a dexter hand holding a thunderbolt all proper", had been changed in 1823 to "Out of a mural crown, argent, a dexter cubit arm the hand grasping a thunderbolt, winged and in flames, proper". Sir Gerald W. Wollaston, Inspector of Regimental Colours, wrote "thunderbolts are always subject to treatment", and in a later letter, "Wings and lightning should emanate from the body of the thunder-bolt of which they are a constituent part. In the badge the wings seem to float behind the hand. A thunder-bolt is a winged body (of no very definite formation perhaps) from which emanate flashes of lightning."

Ensigns with the revised badge were made in two sizes, 6' x 3' and 3' x 1.5', (183/ 91/ 46 cm). Small numbers were ordered in 1943 and early 1944, probably for training units, but in June orders were placed for 2,514 six feet ensigns and 1,982 three feet ensigns, for operational service.

After the war the army continued to have two separate water-borne transport organisations, Royal Engineers (Transport Services) operating ports and bulk movement in bases and on lines of communication, and Royal Army Service Corps responsible for intercommunication and distribution movements. In July 1965 the Royal Army Service Corps Fleet (civilian and military) and the Royal Engineers Fleet (Port Squadrons & Inland Water Transport) merged to form the Royal Corps of Transport Fleet.

The Royal Engineers ensign was later flown on boats of the RE Berlin Squadron and at the Royal Engineers Diving Training Wing at Gunwharf, Portsmouth. It presumably disappeared in 1996, when all Service diving moved to the Joint Service Defence Diving School on Hornsea Island, Portsmouth, it made a brief reappearance on one of the landing- craft beached at Arromanches during the 60th anniversary of D-Day celebrations and was flown by both 37 and 29 Armoured Engineer Squadrons on boats conducting anti-rocket patrols in the rivers and marshes of Southern Iraq in 2009.

***Bishop Gundulf, Rochester and King's Engineers***



Rochester Castle from across the Medway. Engraving from image by G.F. Sargent c1836.



Rochester Cathedral from the West

Bishop Gundulf, a monk from the Abbey of Bec in Normandy came to England in 1070 as Archbishop Lafranc's assistant at Canterbury. His talent for architecture had been spotted by King William I and was put to good use in Rochester where he was sent as Bishop in 1077. Almost immediately the King appointed him to supervise the construction of the White Tower, now part of the Tower of London in 1097. Under William Rufus he also undertook building work on Rochester Castle. Having served three Kings of England and earning 'the favour of then all' Gundulf is accepted as the first "King's Engineer". Gundulf died in 1108 and his statue adorns the West door of Rochester Cathedral.

Because of his military engineering talent, Bishop Gundulf is regarded as the 'father of the Corps of Royal Engineers'. The Corps claims a line of Kings' Engineers pre-dating the Engineers of the Board of Ordnance, 1414, and the formal founding of the Corps in 1716, all the way back to Gundulf. This shared heritage and the close proximity to the Cathedral of the Royal School of Military Engineering in Brompton, Medway means the Corps of Royal Engineers and Rochester Cathedral maintain strong links to this day, including holding the Corps' annual veterans and remembrance services at the Cathedral.

There are over 25 memorials to individual Officers and Soldiers of the Corps of Royal Engineers and a number of memorials representing members of the Corps that have given their lives in the discharge of their duty, including many stained glass windows presented by the Corps. The interior wall surrounding the West Door (the main entrance) is entirely given over to a mosaic memorial to the Corps' dead from campaigns of the Victorian era, including previous forays into Afghanistan.

### ***The Institution of Royal Engineers (InstRE)***



The Institution Badge, taken from the Corps' Cypher

The **Institution of Royal Engineers (InstRE)**, the professional institution of the **Corps of Royal Engineers**, was established in 1875 and in 1923 it was granted its Royal Charter by King George V. The Institution is co-located with the Royal Engineers

Museum, within the grounds of the Royal School of Military Engineering at Brompton in Chatham, Kent.

## The Institution Today

The present objectives of the Institution are to promote and advance the science of military engineering and to promote the military efficiency of the Corps of Royal Engineers. In pursuit of these objects the Institution provides a forum for debate through its sponsorship of joint professional meetings; the publication of articles in its Journal; the maintenance of a Museum and Library for the Corps' heritage and archive collection; and the administration of prize funds, a memorials fund and a scholarship fund.

Members of the InstRE are awarded the post-nominal letters MInstRE. The Institution is a licensed member of the Engineering Council and was granted permission to award Engineering Technician (EngTech) status in 2007. In 2010 the institution was granted the ability to award Incorporated Engineer (IEng) and Chartered Engineer (CEng) status to suitably experienced and qualified Military Engineers who are members of the Institution.

There are several categories of membership:

- **Fellowship (FInstRE)** of the Institution is conferred on members of note by the Council. This is a personal honour and is not conferred on the holder of an office as such.
- **Membership (MInstRE)** of the Institution is open to serving and retired officers, warrant officers, senior and junior NCOs, both Regular and Territorial, of the Corps of Royal Engineers, and to those who are of similar rank in the engineer arm of the land forces of Commonwealth countries, and such other friendly nations as the Council of the Institution shall determine.
- **Honorary Members (HonMInstRE)** are elected by the Council. This is a personal honour and is not conferred on the holder of an office as such. Members of the Royal Engineers are not eligible for election as Honorary Members.
- **Honorary Associate Membership** is reserved for the Chief Engineers of the armed forces of friendly nations and others who by their appointment hold an office with whom the Institution have an affiliation.
- **Associate Membership** is no longer offered. In the streamlining of membership existing Associate Members were granted permission to become full members on application.

The Institution currently publishes a journal, less formal magazine and supports a number of books and papers:

- **Royal Engineers Journal** is published tri-annually and contains articles that have some military engineering connection. The first Journal was published in August 1870. The idea for the publication was proposed at the Corps Meeting of May 1870 by Major R Harrison and seconded By Captain R Home, who became its

first editor. (The Journal eventually superseded the Professional Papers, which were started by Lieutenant WT Denison in 1837 and continued to be published until 1918).

- **Royal Engineers List** is a list of all serving and retired officers and warrant officers. The first list was published in 1876 as part of the Journal, in 1905 it became a separate publication.
- **History of the Corps of Royal Engineers** is currently in its 11th volume. The first two volumes were written by Major General Whitworth Porter and published in 1889.
- **The Sapper** is a monthly magazine for all ranks first published in August 1895. It was originally proposed by three Corporals; Piggott, Avis and Beaumont and was taken up by Engineer Clerk Sergeant SW Hirst. The first few editions were published at the School of Military Engineering (SME) Printing School. Today, past issues of The Sapper Magazine can be viewed, free, online.

The Institution, in line with the aims of the Engineering Council supports Continuous Professional Development of all serving members of the Corps. The Corps manages CPD through the Royal Engineers Continuous Personal Development (RE-CPD) Team. The RE CPD Team is still managed and funded by the Royal Engineers Vocational Education & Training Trust (REVETT). The Trust is a registered Charity (number 1068709) largely funded through the Learning & Skills Council but also has access to limited Ministry of Defence funding.

Based in Chatham at the Royal School of Military Engineering, the RE CPD Team is the driving force behind most RE CPD activity and is directly involved in many qualifications schemes. The Team supports the provision of qualifications & training in many of the skills areas associated with military engineering, including construction, civil, electrical and mechanical engineering, surveying, cartography and telecommunications.

## History of the Institution



The Ravelin Building at the Royal School of Military Engineering, Chatham, is now home to the Institution and Corps Museum.

The expansion of the British Empire during the 1860s, and in particular the absorption of the officer engineer elements from the former East India Company Army into the **Corps of Royal Engineers** in 1862 created the need and wish for further opportunities for the officers to study technical issues to better enable them to meet the challenges of their work. This led to the suggestion of a **Royal Engineer Institute**, to house a technical library and a Museum.

In 1869 a Royal Commission on Military Education was set up to investigate education within the armed services. In 1871 a proposal to build accommodate for both the Institute and parts of the **School of Military Engineering** was laid before the Commission. The proposal was accepted and construction began on the building. It was designed by Lieutenant (later Sir) Montague Ommanney, Royal Engineers in 1872, who went on to become King of Arms of the Order of St Michael and St George, the herald of the Order of St Michael and St George. The Institute Building was completed at the end of 1873, since the Institutions move the building has become the Headquarters of the Royal School of Military Engineering.

In 1875 a report on the proposed founding of an Institute was submitted to the Commander-in -Chief and the Secretary of State for War, who approved it. Thereafter the Institute came into being when it was accepted at the Corps Meeting in May 1875.

It was initially called the 'Royal Engineer Institute', but in 1882 an 's' was added to the name 'Engineer' in all Corps Associations, so the Institute became the 'Royal Engineers Institute'. The title was again changed to the 'Institution of Royal Engineers' (InstRE) in 1923 when it was incorporated by Royal Charter.

Captain VG Clayton, Royal Engineers, acted as a temporary Secretary until Major WH Collins, Royal Engineers, was appointed Secretary in August 1875, but soon resigned and the position was taken over by Captain RH Vetch, Royal Engineers, in July 1876. He held the post until January 1884 and laid the foundations on which the Secretary's duties grew and continued until the First World War (1914–18).

In 1910, owing to a shortage of Royal Engineer Officers, permission to employ an officer in the post of Secretary on the active list was withdrawn, but a Government grant was secured to cover the salary of the Secretary who was to be elected from officers on the reserve or retired lists.

The home of the Institute was the Institute Building at Chatham although in 1887 a committee was appointed to consider the question of the provision of premises in London. In 1984 the Institution moved into the Ravelin Building to be co-located with the Corps museum and other 'regimental' activities.

### ***The Royal Engineers' Association***

The Royal Engineers Association was formed under the conditions of a Deed of Declaration of Trust by the amalgamation of the original Royal Engineers Association and the Royal Engineers Benevolent Fund Ltd on 19 November 1968. The original Royal Engineers Association was founded in 1912 under the name of The Royal Engineers Old Comrades Association. Its name was changed to the Royal Engineers Association in 1952. The Royal Engineers Benevolent Fund Ltd was originally established as the RE Charitable Fund in 1868. It was incorporated as a Friendly Society on 29 January 1925 and changed its name to the RE Benevolent Fund on 23 July 1943.

The Aims of The Association are to promote and support the Corps among members of the Association in the following ways:

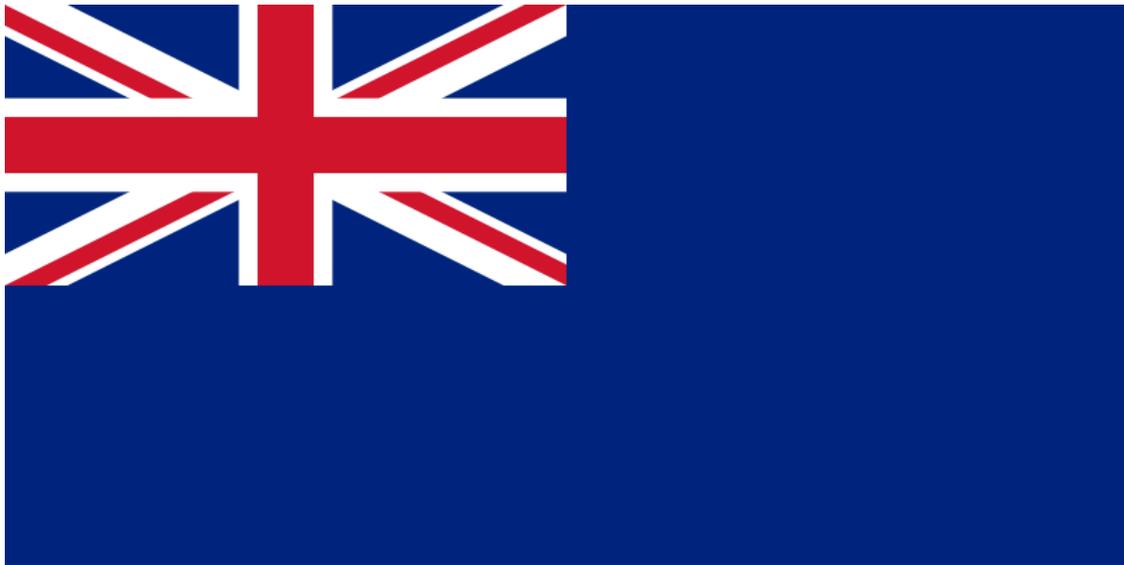
- By fostering esprit de corps and a spirit of comradeship and service.
- By maintaining an awareness of Corps traditions.
- By acting as a link between serving and retired members of the Corps.
- To provide financial and other assistance to serving and former members of the Corps, their wives, widows and dependants who are in need through poverty.
- To make grants, within Association guidelines, to the Army Benevolent Fund and to other charities which further the objectives of the Association.

The Association is organised into a Headquarters, Groups and Branches. The Association Headquarters are located at the Royal School of Military Engineering at Brompton, Chatham. Group Headquarters are located geographically to supervise and organise

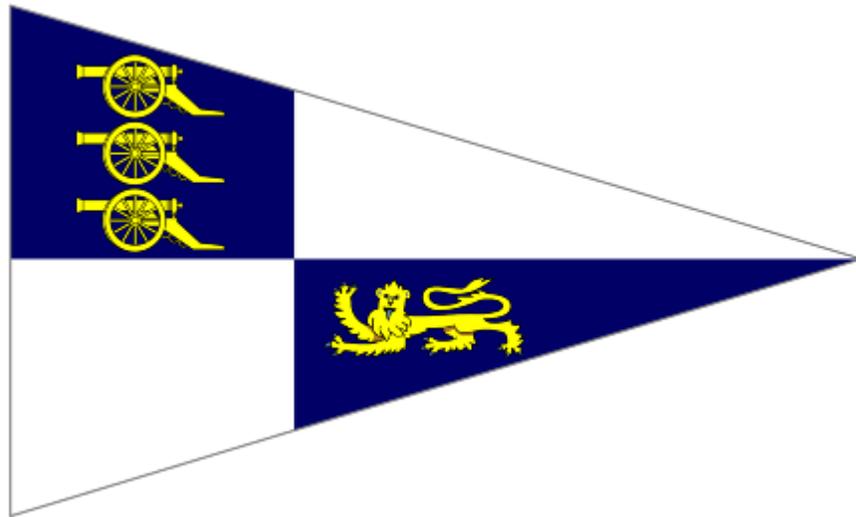
Branches. Branches are established in towns, districts or units of the Corps and are administered by their elected Branch officials. There are also a growing number of National Branches which relate to various activities within the Corps. Currently these are:

- Bomb Disposal,
- Military Survey,
- Armoured Engineers,
- Radio,
- Junior Leaders,
- Airborne Engineers,
- Amphibious Engineers,
- Commando Engineers,
- Plant,
- Postal and Courier (RE).

***Royal Engineers' Yacht Club***



Un-defaced Blue Ensign flown by members of the REYC.



REYC Burgee.

Watermanship being one of the many skills required of the Sapper led to the formation of a sailing club in 1812 and later to the development of cutter rowing teams.

In 1899 the General Officer Commanding Thames and Medway, the Royal Engineer General Sir Charles Warren (1840–1927) presented a challenge shield for a championship cutter race on the River Medway against the Royal Navy. The Sapper teams were drawn from members of the Submarine Mining School, but when the service was disbanded in 1905, the tradition of cutter rowing was continued by the fieldwork squads.

The club developed and became the Royal Engineer Yacht Club in 1846, making it one of the most senior yacht clubs in the United Kingdom. The REYC continues to this day, operating three club yachts and competing on behalf of the Corps at races around the world. The club is one of the oldest sports clubs in the British Army.

Members of the REYC, as one of the oldest clubs in the UK, are permitted to apply for permission to fly an Un-defaced Blue Ensign along with the REYC Burgee which is formed from cannons and lions of the shield of the coat of arms of the Board of Ordnance.

### ***The Royal Engineers A.F.C.: The first combination team (late 1860s to mid 1870s)***

Sir Frederick Wall (who was the secretary of the Football Association from 1895–1934) states in his biography that the early combination game was first used by the Royal Engineers A.F.C. in the early 1870s, in particular prior to their 1873 tour of Nottingham, Derby and Sheffield. Wall states that the "Sappers moved in unison" and showed the "advantages of combination over the old style of individualism". He goes on to state that they were the first "to show the value of combination in Sheffield and Nottingham. Wall

attended and regularly refers to the 1872 international match in his account (see below) and speaks very highly of many Scottish teams and players he does not attribute the combination game to either of these. The Engineers were also capable of dribbling the ball, for example one 1868 match reports states "Lieut Morris got off and dribbling the ball quite round his opponents, brought it in front of the goal and a kick from Lieut Dorward scored the first goal for the Royal Engineers".



The Royal Engineers: the first passing side. The team that reached the first FA Cup final

### **Royal Engineers in 1868**

By early 1868 a contemporary match report states "For the R.E.s Lieuts Campbell, Johnon and chambers attracted especial attention by their clever play"

### **Royal Engineers in 1869**

As early as 1869 the Royal Engineers football club is documented in a contemporary match report as having "worked well together" and "had learned the secret of football success - backing up". In this match failure of the opposite team was attributed to "a painful want of cooperation" against the Engineers.

## **Royal Engineers in 1870**

Another contemporary match report clearly shows that by 1870, ball passing was a feature of the Engineers style: "Lieut. Creswell, who having brought it up the side then kicked it into the middle to another of his side, who kicked it through the posts the minute before time was called"

## **Royal Engineers in 1871**

Although brief, contemporary match reports confirm that passing was a regular feature of the Engineers' style. For example in a match of February 1871 against Crystal Palace it is noted that "Lieut Mitchell made a fine run down the left, passing the ball to Lieut. Rich, who had run up the centre, and who pined another [goal]" The Engineers used their team playing style with effect against the Wanderers FC, a side considered as early as 1870 to be the MCC of football. In a match of March 1871 against Wanderers their victory was due to "irreproachable organisation" and in particular that both their attacks and their backing up were both "so well organised" In November 1871 similar passing tactics are described in a contemporary account of a game against the Wanderers in which two goals were scored through tactical passing: "Betts, however, soon seized his opportunity, and by a brilliant run down the left wing turned the ball judiciously to Currie, who as judiciously sent it flying through the strangers' goal in first rate style" Later in the match it is reported that "Lieut G Barker, turning the ball to Lieut Renny-Tailyour who planted it between the posts" "Turning" the ball clearly points to the short pass.

## **Royal Engineers in 1872**

There is evidence that opponents sometimes adjusted their playing style to counteract the organisation and passing of the Engineers. For example in February 1872 against Westminster school a brief contemporary match report states that: "The school captain took the precaution of strengthening his backs, deputizing HDS Vidal to cooperate with Rawson and Jackson and so well did these three play in concert... they succeeded in defying the... RE forwards" What is most notable about this report is that it confirms that the Royal Engineers "played beautifully together" That the engineers were the first side to break the trend of dribbling is shown in a contemporary account of their victory against Crystal Palace in early 1872. This said that: "very little dribbling was displayed"

## **Summary of the Royal Engineers early playing style**

The evidence above contains detailed descriptions of passing that are lacking in reports of the 1872 Glasgow international. For example, in a lengthy account the Scotsman newspaper makes no mention of passing or combination by the Scottish team and specifically describes the Scottish attacks in terms of dribbling: "The Scotch now came away with a great rush, Leckie and others dribbling the ball so smartly that the English lines were closely besieged and the ball was soon behind" and "Weir now had a splendid run for Scotland into the heart of his opponents' territory." Although the Scottish team are

acknowledged to have worked better together during the first half, this contemporary account acknowledges that in the second half England played similarly: "During the first half of the game the English team did not work so well together, but in the second half they left nothing to be desired in this respect." The Scotsman concludes that the difference in styles in the first half is the advantage the Queens' Park players had "through knowing each others' play" as all came from the same club. Unlike the 1872 Glasgow international - which was drawn - the contemporary evidence above shows that the Engineers' team playing style benefited their team play by winning games. Similarly, the 5th March 1872 match between Wanderers and Queens park contains no evidence of ball passing

The early accounts cited above all confirm that the Engineers were the first club to play a passing game of cooperation and organisation with both their forwards and their defence. Although they could also play rough - as would be expected for an army team - The Engineers are the first side to be considered to play the football "beautifully". All of these developments clearly occurred before and independent of the 1872 match between England and Scotland (Queen's Park FC). It is probable that Queen's Park FC observed the Engineers' passing game during one of their visits to England to participate in the 1871–72 FA Cup. Undoubtedly, their representatives in London were well aware of the Sheffield and Engineers' style.

## ***Rugby***

The Army were represented in the very first international by two members of the Royal Engineers, both playing for England, Lieutenant Charles Arthur Crompton RE and Lieutenant CW Sherrard RE.

## ***Successor units***

Several units have been formed from the Royal Engineers.

- The Air Battalion Royal Engineers (formed 1911) was the precursor of the Royal Flying Corps (formed 1912) which evolved into the Royal Air Force in 1918.
- The Telegraph Battalion Royal Engineers became the Royal Engineers Signals Service, which in turn became the independent Royal Corps of Signals in 1920.
- The Royal Engineers were responsible for railway and inland waterway transport, port operations and movement control until 1965, when these functions were transferred to the new Royal Corps of Transport.
- In 1908, the Army Postal Corps (formed in 1882) and the Royal Engineers Telegraph Reserve (formed in 1884) amalgamated to form the Royal Engineers Postal Section. This later became the Army Postal and Courier Service and remained part of the RE until the formation of the Royal Logistic Corps in 1993 - see (British Forces Post Office).

The Royal Engineers from just after the Second World War until the early 1970s also had 4 Plant Troops located in the United Kingdom which were RE reinforced Plant &

Engineering troops attached to various Home Commands. The Command Plant Troops were initially set up in the late 40s to clear up the beach defences around the coast and remove the minefields and were equipped with Armoured Bulldozers. In the 1950s once all this work was complete they took responsibility of maintaining and building all Army Ranges and various civil works in support of the civilian population and in support of civilian organisations in the event of natural disasters and crises such as the Torrey Canyon disaster where the Southern Command Plant Troop was deployed to the West Country to clean up the mess on the beaches caused by the large volume of oil that floated ashore. The 4 Command Plant Troops were based in various locations across the United Kingdom with Southern Command Plant Troop initially based in Tidworth, then Perham Down in Wiltshire and eventually Longmoor in Hampshire. The Midlands Plant Squadron was based in Walsall and the Northern Command plant troop was based in Ripon. The other command plant troop was based in Scotland. In Germany there was an Entire Engineering group based in Willich near Düsseldorf called the Military Civilian Plant & Engineering group that had a similar large scale Engineering, Plant and Support role for British Army of the Rhine. Each Command Plant Troop was commanded by an RE Major supported by a Military Plant Foreman.

In 1969, it was decided to amalgamate all of the Command Plant Troops into one large Squadron which had 4 troops, an HQ Troop and a large REME Attachment to it and the Squadron - 66 Plant Squadron became the largest squadron in the entire Royal Engineers, in terms of Plant Engineering and Equipment as well as staff. Its last home was in Longmoor Hampshire - Engineer Stores Depot attached to Longmoor Military Camp, which was also home to a Field Support Squadron. Longmoor Military Railway was from 1901 until the late 1960s the preserve of the Royal Engineers but subsequently Royal Corps of Transport and eventually Royal Logistic Corps Railway Training Centre. Its role also changed with a much wider role to support Military operations throughout NATO.

In late 1976 a Mr Trotter in Parliament asked the Secretary of State for Defence which units, apart from 66 Plant Squadron Royal Engineers, are specialists in heavy plant; whether he still intends to disband this squadron; if so, what unit will take its place; and what will be the reduction in the engineers' heavy plant capacity.

In answer to Mr Trotter 's question Mr. Robert C. Brown replied ...There is no directly comparable regular unit containing a similar concentration of specialist plant expertise, but specialist capability exists in parts of various regular field and base units in the United Kingdom, BAOR and elsewhere. In addition, there are two TAVR plant squadrons. As a consequence of the Defence Review, 66 Plant Squadron, Royal Engineers will disband by early 1978, but most of its heavy equipment will be taken over by other engineer units notably in the TAVR. As a result, there will be some reduction in the capacity of the Royal Engineers to plan and conduct major projects in peacetime.

## ***Equipment***

- Chieftain Armoured Vehicle Royal Engineer (ChAVRE)

- Chieftain Armoured Vehicle Layer Bridge (ChAVLB)

These are being replaced by 66 Armoured Support Vehicles ;

- **TROJAN** is a minefield breaching vehicle. It prepares routes, mark safe routes using an Obstacle Marking System, breach complex obstacles and provide short dry and wet gap crossing utilising its excavator arm, earth moving blade and a midi fascine. It will plough through minefields, build trenches and dig defensive ditches
- **TITAN** will carry and lay the current range of In-Service Close Support bridges laying them faster, and in a wider variety of terrain conditions, than previous equipment. TITAN can lay a bridge over a 26 metre gap in two minutes, making it the fastest Support Vehicle in the world at this task. This gives commanders a potential battle winning edge and allows them to choose from a more flexible range of armoured vehicles.

Both vehicles which weigh over 60 tonnes and are capable of speeds of up to 56 km/h, are designed to mount and tow the current range of in-service Royal Engineer equipment (PYTHON, AVRE Trailer, Track/Full Width Mineploughs and earth moving blades). They have purpose designed hulls, will incorporate Special to Role equipment and have major assemblies common to the Challenger 2 Main Battle Tank.

### ***Order of precedence***

Preceded by:  
**Royal Regiment of  
Artillery**

**Order of Precedence**

Succeeded by:  
**Royal Corps of Signals**

### ***Decorations***

#### **Victoria Cross**



Victoria Cross and Bar

The following Royal Engineers have been awarded the Victoria Cross (VC), the highest and most prestigious award for gallantry in the face of the enemy that can be awarded to British and Commonwealth forces.



Rorke's Drift, 22 - 23 January 1879, a battle fought under the command of Lt. John Chard, RE. Eleven Victoria Crosses were won during the battle, including one by Chard. Painting by Alphonse de Neuville

- Tom Edwin Adlam, 1916, Thiepval, France
- Adam Archibald, 1918, Ors, France
- Fenton John Aylmer, 1891, Nilt Fort, India
- Mark Sever Bell, 1874, Battle Of Ordashu, Ashanti (now Ghana)
- John Rouse Merriott Chard, 1879, Rorke's Drift, South Africa
- Brett Mackay Cloutman, 1918, Pont-Sur-Sambre, France
- Clifford Coffin, 1917, Westhoek, Belgium
- James Morris Colquhoun Colvin, 1897, Mohmand Valley, India
- James Lennox Dawson, 1915, Hohenzollern Redoubt, France
- Robert James Thomas Digby-Jones, 1900, Ladysmith, South Africa
- Thomas Frank Durrant, 1942, St. Nazaire, France
- Howard Craufurd Elphinstone, 1855, Sevastopol, Crimea
- George de Cardonnel Elmsall Findlay, 1918, Catillon, France
- Gerald Graham, 1855, Sevastopol, Crimea
- William Hackett, 1916, Givenchy, France
- Reginald Clare Hart, 1879, Bazar Valley, Afghanistan
- Lanoe Hawker, 1915 {While serving with the RFC}
- Charles Alfred Jarvis, 1914, Jemappes, Belgium
- Frederick Henry Johnson, 1915, Hill 70, France

- William Henry Johnston, 1914, Missy, France
- Frank Howard Kirby, 1900, Delagoa Bay Railway, South Africa
- Cecil Leonard Knox, 1918, Tugny, France
- Edward Pemberton Leach, 1879, Maidanah, Afghanistan
- Peter Leitch, 1855, Sevastopol, Crimea
- William James Lendrim, 1855, Sevastopol, Crimea
- Wilbraham Oates Lennox, 1854, Sevastopol, Crimea
- Henry MacDonald, 1855, Sevastopol, Crimea
- James John McLeod INNES, 1859, Sultanpore, India
- Cyril Gordon Martin, 1915, Spanbroek Molen, Belgium
- James McPhie, 1918, Aubencheul-Au-Bac, France
- Philip Neame, 1914, Neuve Chapelle, France
- John Perie, 1855, Sevastopol, Crimea
- Claude Raymond, 1945, Talaku, Burma (now Myanmar)
- John Ross, 1855, Sevastopol, Crimea
- Michael Sleavon, 1858, Jhansi, India
- Arnold Horace Santo Waters, 1918, Ors, France
- Thomas Colclough Watson, 1897, Mamund Valley, India
- Theodore Wright, 1914, Mons, Belgium

## Chapter 7

# Military Engineer



Polish military engineers during humanitarian aid after the 2005 Pakistan earthquake.

A **military engineer** is a soldier whose occupation involves military engineering. According to NATO, "Military Engineering is that engineer activity undertaken, regardless of component or service, to shape the physical operating environment." Military Engineering incorporates support to manoeuvre and to the force as a whole,

including military engineering functions such as engineer support to Force Protection, Counter - Improvised Explosive Devices, Environmental Protection, Engineer Intelligence and Military Search. Military Engineering does not encompass the activities undertaken by those 'engineers' who maintain, repair and operate vehicles, vessels, aircraft, weapon systems and equipment."

The military engineer is primarily responsible for the design and construction of offensive, defensive, and logistical structures for warfare. Other duties include the layout, placement, maintenance and dismantling of defensive minefields and the clearing of enemy minefields and the construction and destruction of bridges. In some cases an engineer may be required to destroy something that that same engineer designed and constructed. In many armies the military engineers are also called pioneers or sappers. There are also many modern armies that use the term combat engineer to describe the military engineer well forward in battle and under fire. *For more modern aspects of military engineering and tools of the combat engineering corps, see combat engineering.* The construction, management and maintenance of infrastructure is another responsibility associated with the military engineer.

## **Terminology**

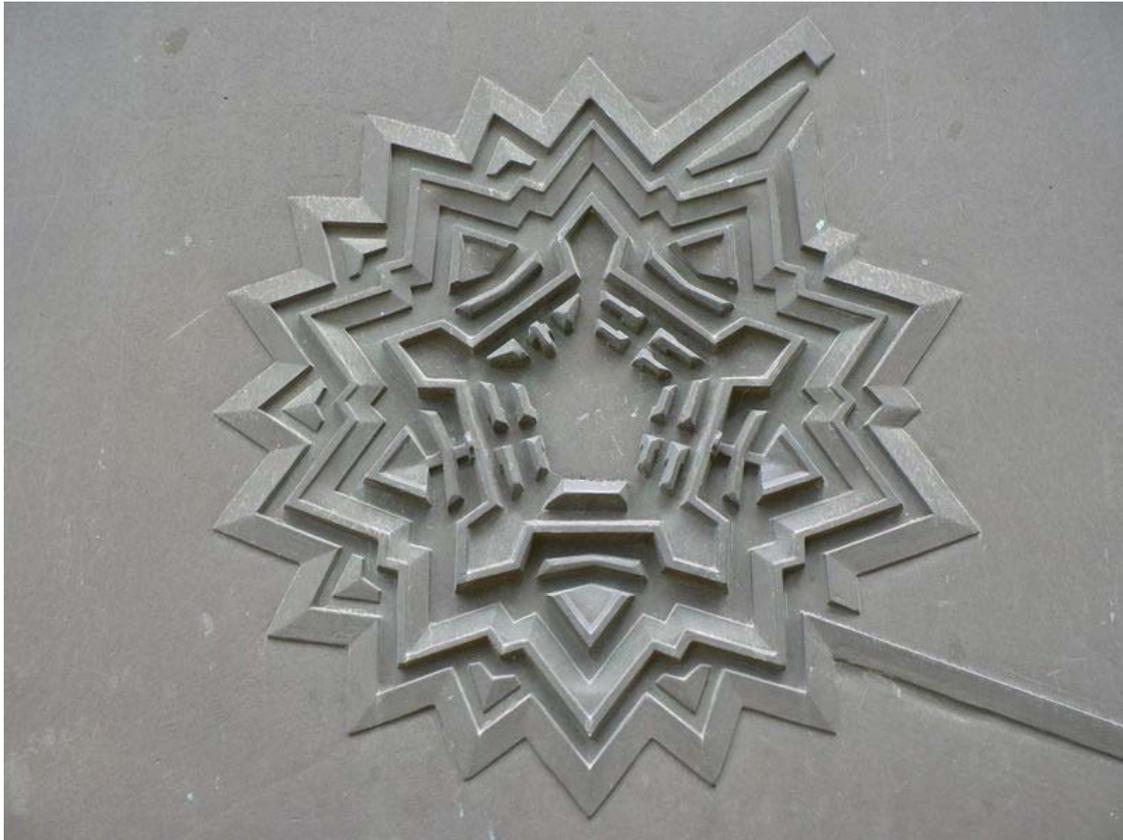
The term engineering is derived from the word engineer, which itself dates back to 1325, when an engine'er (literally, one who operates an engine) was originally referred to "a constructor of military engines." In this context, now obsolete, an "engine" referred to a military machine, i. e., a mechanical contraption used in war (for example, a catapult).

Later, as the design of civilian structures such as bridges and buildings matured as a technical discipline, the term civil engineering entered the lexicon as a way to distinguish between those specializing in the construction of such non-military projects and those involved in the older discipline. As the prevalence of civil engineering outstripped engineering in a military context and the number of disciplines expanded, the original military meaning of the word "engineering" is now largely obsolete. In its place, the term "military engineering" has come to be used.

## **History**

Perhaps the first civilization to have a dedicated force of military engineering specialists were the Romans, whose army contained a dedicated corps of military engineers known as *architecti*. Roman military engineering was pre-eminent amongst its contemporaries, and the scale of certain military engineering feats, such as the construction of a double-wall of fortifications 30 miles (48 km) long in total (both walls combined total) in just six weeks to completely encircle the besieged city of Alesia in 52 B.C. Such military engineering feats would have been completely new, and probably bewildering and demoralizing, to the Gallic defenders. The best known of these Roman army engineers due to his writings surviving is Vitruvius.

In ancient times, military engineers were responsible for siege warfare and building field fortifications, temporary camps and roads. The most notable engineers of ancient times were the Romans and Chinese, who constructed huge siege-machines (catapults, battering rams and siege towers) and were responsible for constructing fortified wooden camps and paved roads for their legions. Many of these Roman roads are still in use two thousand years later.



Relief map of the Citadel of Lille, designed in 1668 by Vauban, the foremost military engineer of his age.

In the Middle Ages military engineering focused on siege warfare. They planned castles and fortresses. When laying siege, they planned and oversaw efforts to penetrate castle defences. When castles served a military purpose, one of the tasks of the sappers was to weaken the bases of walls to enable them to be breached before means of thwarting these activities were devised. Broadly speaking, sappers were experts at demolishing or otherwise overcoming or bypassing fortification systems.

With the 14th century development of gunpowder, new siege engines in the form of cannons appeared. Initially military engineers were responsible for maintaining and operating these new weapons just as had been the case with previous siege engines. In England, the challenge of managing the new technology resulted in the creation of the Office of Ordnance around 1370 in order to administer the cannons, armaments and

castles of the kingdom. Both military engineers and artillery formed the body of this organization and served together until the office's predecessor, the Board of Ordnance was disbanded in 1855.

In comparison to older weapons, the cannon was significantly more effective against traditional medieval fortifications. Military engineering significantly revised the way fortifications were built in order to be better protected from enemy direct and plunging shot. The new fortifications were also intended to increase the ability of defenders to bring fire onto attacking enemies. Fort construction proliferated in 16th century Europe based on the trace italienne design.

The dawn of the internal combustion engine marked the beginning of a very significant change for military engineering. With the arrival of the automobile at the end of the 19th century and heavier than air flight at the start of the 20th century, military engineers would absorb a major new role to support the movement and deployment of these systems in war.

## ***Defensive***



Defensive fortifications are designed to prevent intrusion into the inner works by siege infantry. For minor defensive locations these may only consist of simple walls and ditches. The design principle is to slow down the advance of attackers to where they can be destroyed by defenders from sheltered positions. Most large fortifications are not a single structure but rather a concentric series of fortifications of increasing strength. Fortified cities would typically include an inner "old town" within walls. Should the city

be attacked, those residing outside the walls would enter the inner city. Within this would be a redoubt, or citadel, to which defenders could retreat should the walls or gates be breached.

The placement of mines to create minefields and their maintenance and disassembly is another defensive task.

When the defender must retreat it is often desirable to destroy anything that may be of use to the enemy, particularly bridges, as their destruction can slow the advance of the attackers. The retreating forces may also leave booby traps for enemy soldiers, even though these often wreak their havoc upon non-combatant civilians.

### ***Famous military engineers***

- Mozi
- Gundulf of Rochester - Considered father of the UK's Corps of Royal Engineers
- John Chard, Royal Engineers, who won the Victoria Cross in 1879 for his actions and leadership during the defence of Rorke's Drift
- Henri Alexis Brialmont
- Menno van Coehoorn
- Giovanni Fontana
- Leslie Groves
- John Rosworm
- Pierre Charles L'Enfant
- Charles Pasley - Founder of the UK's Royal School of Military Engineering
- Vauban
- Marc René, marquis de Montalembert
- Charles George Gordon
- Francis Fowke - Royal Engineer designer of the Royal Albert Hall
- Paul R. Smith
- Vitruvius
- Tadeusz Kościuszko.
- Leonardo da Vinci
- Zahid Ali Akbar Khan
- Robert E. Lee
- Herman Haupt
- Douglas MacArthur
- Tommy Franks
- George Washington - Surveyor

### ***Multinational military engineering institutions***

The NATO Military Engineering Center of Excellence (MilEng CoE) is co-located with the German Army Military Engineer School in Ingolstadt. Prior to becoming a NATO CoE, the institute was known as the Euro NATO Training Engineer Centre (ENTEC) and it was located in Munich. As ENTEC, the institute was mandated to conduct military

engineer interoperability training for participating nations. As the MilEng CoE, the institute's mandate has expanded to include doctrine and NATO standardization agreements (STANAGs) related to military engineering.

## Chapter 8

# Pioneer (Military)

A **pioneer** is a soldier employed to perform engineering tasks. The term is in principle similar to sapper.

Pioneers were originally part of the Artillery branch of European armies. Their primary job was to assist other Arms in tasks such as construction of field fortifications or military camps. During the First World War pioneers were often engaged in construction and repair of military railways.

Later pioneers have been in the engineering branch, in the logistic branch, part of the infantry, or a branch in their own right.

Many British Commonwealth military forces distinguish between small units of "assault pioneers" belonging to infantry regiments as opposed to separate pioneer regiments (as in the former Royal Pioneer Corps). The United States Marine Corps have sometimes organized their sappers into "Pioneer Battalions".

### ***History of the word***

The word pioneer is originally from France.

The word (French: *pionnier*) was borrowed into English, from Old French *pionnier*, which meant a "foot soldier", from the root 'peon' recorded in 1523. It was used in a military sense as early as 1626–1627. Captain George Smith defines it as

PIONEERS, in war-time, are such as are commanded in from the country, to march with an army, for mending the ways, for working on intrenchments, and fortifications, and for making mines and approaches: the soldiers are likewise employed in all these things. Most of the foreign regiments of artillery have half a company of pioneers, well

instructed in that important branch of duty. Our regiments of infantry and cavalry have 3 or 4 pioneers each, provided with aprons, hatchets, saws, spades, and pick-axes.

### ***Pioneer units***

- 1st Pioneer Battalion (New South Wales) First Division, 1 AIF
- 2nd Pioneer Battalion Second Division, 1 AIF
- 3rd Pioneer Battalion Second Division, 1 AIF
- 4th Pioneer Battalion Second Division, 1 AIF
- 5th Pioneer Battalion Second Division, 1 AIF
- 2/1 Australian Pioneer Battalion
- 2/2 Australian Pioneer Battalion
- 2/3 Australian Pioneer Battalion
- 2/4 Australian Pioneer Battalion
- 2/5 Australian Pioneer Battalion
- 1st Bavarian Pioneer Battalion, First Bavarian Division had 12 destruction squads during First World War
- 2nd Bavarian Pioneer Battalion
- British Garrison at Calais Pioneers
- Pioneer Corps
- 4th (Pioneer) Battalion Coldstream Guards with the Guards Division, 1917 alternatively known as Guards Pioneer Battalion
- 6th East Yorkshire Regiment (Pioneer Battalion) with Division, 1917 (3-company establishment)
- 3rd Salford Pals Battalion (19th Battalion, Lancashire Fusiliers) (converted to a 'pioneer' battalion)
- 9th Battalion, Seaforth Highlanders Regiment (Pioneer Battalion) with 9th Division, 1917
- 1/6th Argyll and Sutherland Highlanders (Pioneer Battalion) with 5th Division, 1917
- 9th Battalion, South Staffordshire Regiment (Pioneer Battalion) with 23rd Division, 1917
- 19th Battalion, Middlesex Regiment (Pioneer Battalion) with 41st Division, 1917
- 1/5th Royal Sussex Regiment (Pioneer Battalion) with 48th Division, 1917
- 8th (Pioneer) Battalion, Royal Sussex Regiment divisional pioneer battalion
- 12th (Pioneer) Battalion Sherwood Foresters
- Pioneer Battalion, The Royal Scots
- 19th Battalion (Pioneers), The Welsh Regiment (Glamorgan Pioneers)
- 15th (Pioneer) Battalion, the Royal Fusiliers (City of London Regiment) recruited at Oxford, Thame, Dover, Elham and Lyminge, Bude, Woolacombe and Truro areas during the Second World War
- 5th (Pioneer) Battalion, Cheshire Regiment was appointed "in consequence of earning a high reputation as diggers and as constructors of field works"
- 25th (Pioneer) Battalion, King's Royal Rifle Corps
- Pioneer Battalion, 5th Royal Irish Lancers, 1902 - 1922 was created to construct a new railway in the I Corps area on the Western Front.

- 1st Battalions Monmouthshire Regiment Territorial Force 11 November 1915: Pioneer Battalion of 46th Division, south west of Avesnes, France.
- 2nd Battalions Monmouthshire Regiment Territorial Force 1 May 1916: Joined 29th Division as Pioneer Battalion.
- 3rd Battalions Monmouthshire Regiment Territorial Force 28 September 1915: Became Pioneer Battalion 28th Division.
- 16th (Pioneer) Battalion, Royal Irish Rifles
- 605th Pioneer Battalion, Pioneer Corps, The British Army - used for light engineering tasks
- 606th Pioneer Battalion, Pioneer Corps, The British Army - used for light engineering tasks
- 23 Pioneer Regiment, Royal Logistics Corps
- 168 Pioneer Regiment, Territorial Army
- African Pioneer Corps
- British Indian Army Pioneer Battalion (enlisted, drilled and trained as any other native infantry battalion of the line, but received additional construction training)
- 2nd Canadian Pioneer Battalion, Canadian Expeditionary Force with over a thousand men whose training gave them a combination of engineering and infantry skills.
- 48th Battalion served in the field as the 3rd Canadian Pioneer Battalion (48th Canadians), with the 3rd Canadian Division
- 67th "Western Scots" (Pioneer Battalion) (Canadian Expeditionary Force) 1916
- 107th Pioneer Battalion (Canada)
- Imperial German Army pioneers were regarded as a separate combat arm trained in construction and demolition or fortifications, but were often used as emergency infantry. One battalion was assigned to each Corps

The Guard Pioneer Battalion 1. (6 companies with 20 large and 18 small flame-throwers each)

The Guard Pioneer Battalion 2.

The Guard Pioneer Battalion 3.

The Guard Reserve Pioneer Battalion - created from reservists who had been civilian firemen, and were issued with experimental flame-throwers

- Independent Pioneer Battalion (4th Hazara Pioneers), Indian Army
- First Jangi Auxiliary Pioneer Battalion (1000 strong) of the Nepalese Army
- Jagannath Auxiliary Pioneer Battalion of the Nepalese Army
- The New Zealand Pioneer Battalion, sometimes referred to as the Pioneer Maori Battalion.

The battalion included four companies, each with two Maori and two European (Pakeha) platoons, and included remnants of the Otago Mounted Rifles

- Prussian Army pioneer battalions

1 Prussian Pioneer Battalion of the Guards - 3 Field companies, one Reserve company

12 Prussian Pioneer Battalions of the Line (18 officers, 495 men and 6 other persons)

2nd Pioneer Battalion at Stettin

4th Pioneer Battalion at Magdeburg

- 1st Pioneer Battalion, Imperial Russian Army
- 2nd Pioneer Battalion, Imperial Russian Army
- 3rd Pioneer Battalion (later 5th Pioneer Battalion), Imperial Russian Army
- 4th Pioneer Battalion, Imperial Russian Army
- Saxon Pioneer Battalion
- South African Army Pioneer Battalion
- First Pioneer Battalion of Engineers, Mounted, United States Army (1st Bn. mtd. Engra.) (3 companies)
- First Pioneer Battalion of Engineers, United States Army (1st Bn. Engrs.) (3 companies)
- 9th Pioneer Battalion, US Army
- 18th Reserve Pioneer Battalion, US Army
- Jefferson County Pioneer Battalion, Pennsylvania (CO Lieutenant-Colonel, Hance Robinson)
- 1st Pioneer Battalion United States Marine Corps
- 2nd Pioneer Battalion United States Marine Corps
- 3rd Pioneer Battalion United States Marine Corps
- 4th Pioneer Battalion United States Marine Corps
- 5th Pioneer Battalion United States Marine Corps
- Wehrmacht Heer Pioneer battalions

Panzer-pionier-bataillon (armoured pioneer battalion performing engineering tasks during an assault from manoeuvre)

Sturmpionierbataillon (assault pioneer battalion performing engineering tasks during an infantry assault)

- Gebirgs-pionier-bataillon 95, Wehrmacht Heer, a pioneer unit trained for the mountain terrain
- Pionier-bataillon 233 (divisional pioneer unit)
- Heeres-pionier-bataillon 73 (Corps pioneer unit)
- Pioneer Battalion Leibstandarte SS Adolf Hitler, Waffen-SS
- Pioneer Battalion, Estonian Defence Forces

### ***Pioneer regiments in the Indian Army***

Extensive use was made of pioneers in the British Indian Army because of the demands of campaigning in difficult terrain with little or no infrastructure. In 1780 two companies of pioneers were raised in Madras, increasing to 16 in 1803 divided into two battalions. Bombay and Bengal pioneers were formed during the same period. In the late nineteenth

century a number of existing Indian infantry regiments took the title and the construction role of pioneers. The twelve Indian Pioneer regiments in existence in 1914 were trained and equipped for road, rail and engineering work, as well as for conventional infantry service. While this dual function did not qualify them to be regarded as elite units, the frequency with which they saw active service made postings to pioneer regiments popular with British officers.

Prior to World War I each sepoy in a Pioneer regiment carried a pickaxe or a light spade in special leather equipment as well as rifle and bayonet. NCOs and buglers carried axes, saws and billhooks. Heavier equipment such as explosives was carried by mule. The unit was therefore well equipped for simple field engineering tasks, as well as being able to defend itself in hostile territory. During the War the increased specialisation required of Pioneers made them too valuable to use as regular assault infantry. Accordingly in 1929 the Pioneer regiments were taken out of the line infantry and grouped into the Corps of Madras Pioneers (four battalions), the Corps of Bombay Pioneers (four battalions), the Corps of Sikhs Pioneers (four battalions), and the Corps of Hazara Pioneers (one battalion).

All four Pioneer Corps were disbanded in 1933 and their personnel mostly transferred into the Corps of Sappers and Miners, whose role they had come to parallel. An Indian Pioneer Corps was re-established in 1943

### ***Pioneers in the British Army***

Historically, British infantry regiments maintained small units of pioneers for heavy work and engineering, especially for clearing paths through forests and for leading assaults on fortifications. These units evolved into assault pioneers. They also inspired the creation of the Royal Pioneer Corps.

The **Royal Pioneer Corps** was a British Army combatant corps used for light engineering tasks. The Royal Pioneer Corps was raised on 17 October 1939 as the Auxiliary Military Pioneer Corps. It was renamed the Pioneer Corps on 22 November 1940. It was renamed the Royal Pioneer Corps on 28 November 1946. On 5 April 1993, the Royal Pioneer Corps united with other units to form the Royal Logistics Corps.

There are currently 3 specialist pioneer units in the Royal Logistics Corps.

- 23 Pioneer Regiment based at Bicester, Oxfordshire
- The ARRC Support Battalion based at Rheindahlen, Germany
- 168 Pioneer Regiment a specialist pioneer regiment in the Territorial Army, formed in 1995 with headquarters at Grantham.

All British infantry regiments still maintain assault pioneer units.

## Chapter 9

# Fortification



Krak des Chevaliers is one of the best-preserved Crusader castles.



Bourtange star fort, restored to 1750 situation, Groningen (province), Netherlands.



The well preserved Bulgarian medieval fort Baba Vida.

**Fortifications** are military constructions and buildings designed for defence in warfare and military bases. Humans have constructed defensive works for many thousands of years, in a variety of increasingly complex designs. The term is derived from the Latin *fortis* ("strong") and *facere* ("to make").

## ***Nomenclature***

Many military installations are known as **forts**, although they are not always fortified. Larger forts may class as **fortresses**; smaller ones formerly often bore the name of **fortalices**. The word fortification can also refer to the practice of improving an area's defence with defensive works. City walls are fortifications but not necessarily called fortresses.

The art of setting out a military camp or constructing a fortification traditionally classifies as castramentation, since the time of the Roman legions. The art/science of laying siege to a fortification and of destroying it has the popular name of siegecraft or 'siege warfare' and the formal name of poliorcetics. In some texts this latter term also applies to the art of building a fortification.

Fortification is usually divided into two branches, namely **permanent fortification** and **field fortification**. Permanent fortifications are erected at leisure, with all the resources that a state can supply of constructive and mechanical skill, and are built of enduring materials. Field fortifications are extemporized by troops in the field, perhaps assisted by such local labour and tools as may be procurable and with materials that do not require much preparation, such as earth, brushwood and light timber, or sandbags.

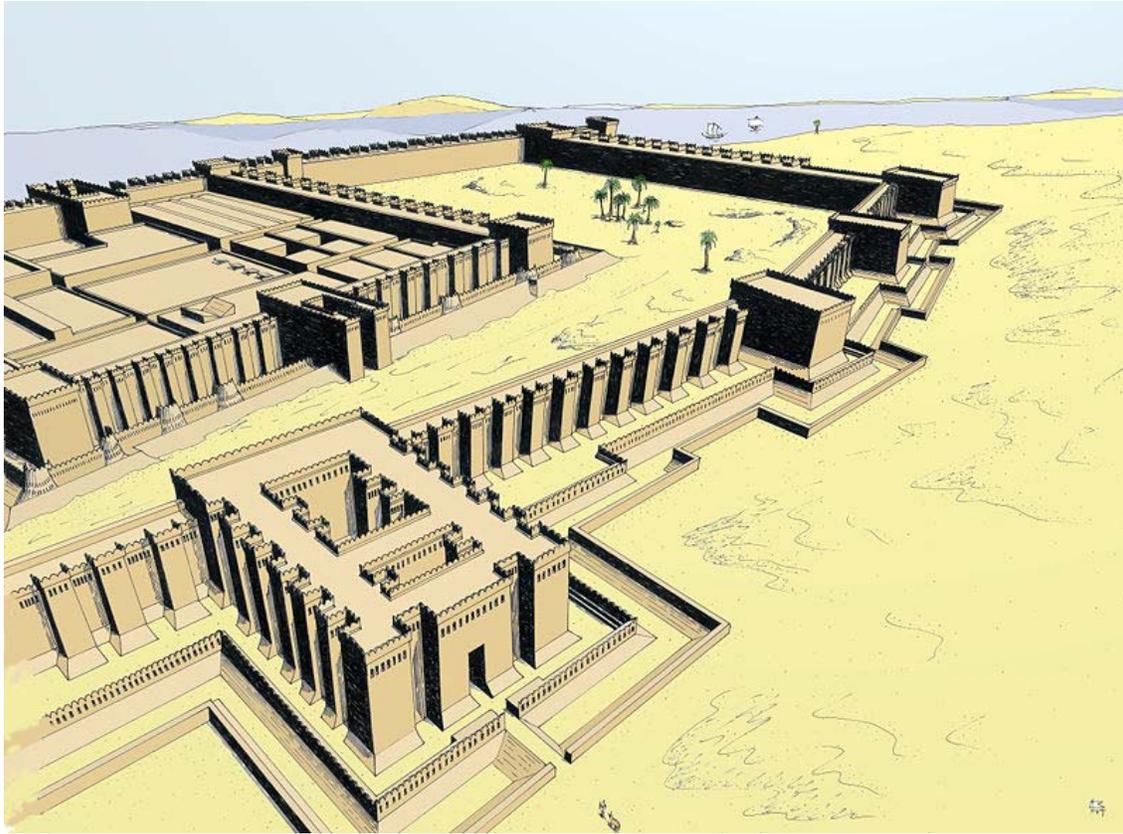
There is also an intermediate branch known as **semi-permanent fortification**. This is employed when in the course of a campaign it becomes desirable to protect some locality with the best imitation of permanent defences that can be made in a short time, ample resources and skilled civilian labour being available.

Castles are fortifications which are regarded as being distinct from the generic fort or fortress in that it describes a residence of a monarch or noble and commands a specific defensive territory.

## ***History***

### **Ancient**

From very early history to modern times, walls have been a necessity for many cities. Uruk in ancient Sumer (Mesopotamia) is one of the world's oldest known walled cities. Before that, the city (or rather proto-city) of Jericho in what is now the West Bank had a wall surrounding it as early as the 8th millennium BC. The Ancient Egyptians also built fortresses on the frontiers of the Nile Valley to protect against invaders from its neighbouring territories. Many of the fortifications of the ancient world were built with mud brick, leaving many no more than mounds of dirt for today's archaeologists.



Artists impression of the battlements at Buhen fortress in Egypt about 1800BC

The Assyrians deployed large labour forces to build new palaces, temples and defensive walls.

Some settlements in the Indus Valley Civilization were also fortified. By about 3500 B.C., hundreds of small farming villages dotted the Indus floodplain. Many of these settlements had fortifications and planned streets. The stone and mud brick houses of Kot Diji were clustered behind massive stone flood dykes and defensive walls, for neighbouring communities bickered constantly about the control of prime agricultural land. Mundigak (c. 2500 B.C.) in present day south-east Afghanistan has defensive walls and square bastions of sun dried bricks.



Model of Ishtar Gate and part of the walls of Babylon built by Nebuchadnezzar

Babylon was one of the most famous cities of the ancient world, especially as a result of the building program of Nebuchadnezzar, who expanded the walls and built the Ishtar Gate.

Exceptions were few — notably, ancient Sparta and ancient Rome did not have walls for a long time, choosing to rely on their militaries for defence instead. Initially, these fortifications were simple constructions of wood and earth, which were later replaced by mixed constructions of stones piled on top of each other without mortar.

In Central Europe, the Celts built large fortified settlements known as oppida, whose walls seem partially influenced by those built in the Mediterranean. The fortifications were continuously being expanded and improved.

In ancient Greece, large stone walls had been built in Mycenaean Greece, such as the ancient site of Mycenae (famous for the huge stone blocks of its 'cyclopean' walls). In classical era Greece, the city of Athens built a long set of parallel stone walls called the Long Walls that reached their guarded seaport at Piraeus.



The Great Wall of China.

Large tempered earth (i.e. rammed earth) walls were built in ancient China since the Shang Dynasty (c. 1600-1050 BC), as the capital at ancient Ao had enormous walls built in this fashion. Although stone walls were built in China during the Warring States (481-221 BC), mass conversion to stone architecture did not begin in earnest until the Tang Dynasty (618-907 AD).

In terms of China's longest and most impressive fortification, the Great Wall had been built since the Qin Dynasty (221-207 BC), although its present form was mostly an engineering feat and remodelling of the Ming Dynasty (1368-1644 AD). The large walls of Pingyao serve as one example. Likewise, the famous walls of the Forbidden City in Beijing were established in the early 15th century by the Yongle Emperor.

The Romans fortified their cities with massive, mortar-bound stone walls. The most famous of these are the largely extant Aurelian Walls of Rome and the Theodosian Walls of Constantinople, together with partial remains elsewhere. These are mostly city gates, like the Porta Nigra in Trier or Newport Arch in Lincoln.

Hadrian's Wall was built by the Roman Empire across the width of what is now northern England following a visit by Roman Emperor Hadrian (AD 76–138) in AD 122.

## Medieval



Genoese fortress in Sudak, Ukraine



Ávila city walls, Spain

Roman forts and hill forts were the main antecedents of castles in Europe, which emerged in the 9th century in the Carolingian Empire.



Rumelihisari, İstanbul, Turkey

The Early Middle Ages saw the creation of some towns built around castles. These cities were only rarely protected by simple stone walls and more usually by a combination of both walls and ditches. From the 12th century AD hundreds of settlements of all sizes were founded all across Europe, which very often obtained the right of fortification soon afterwards.



Castle of the Teutonic Order in Malbork: the world's largest brick gothic castle, in Poland



The fortified city of Valença, Portugal as seen from across the Minho River (Portugal's northern border with Spain)

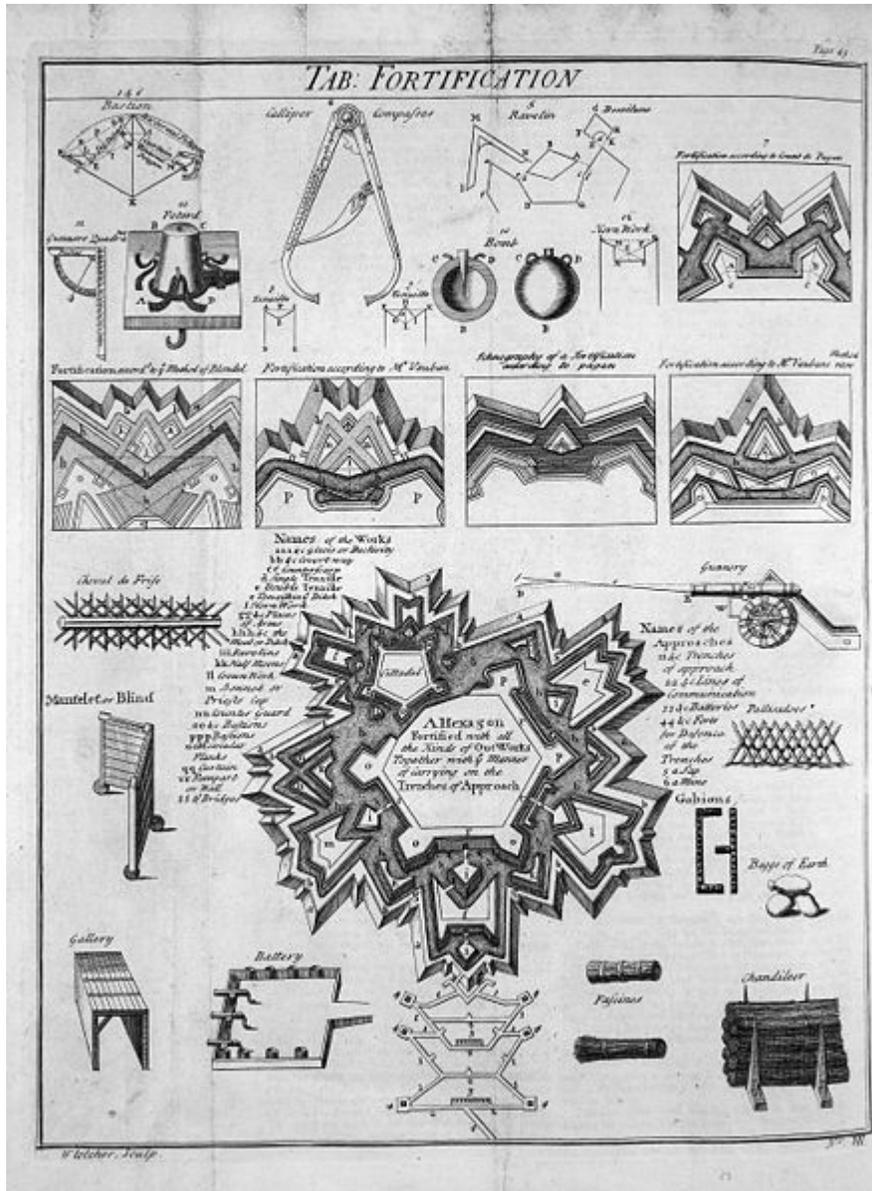


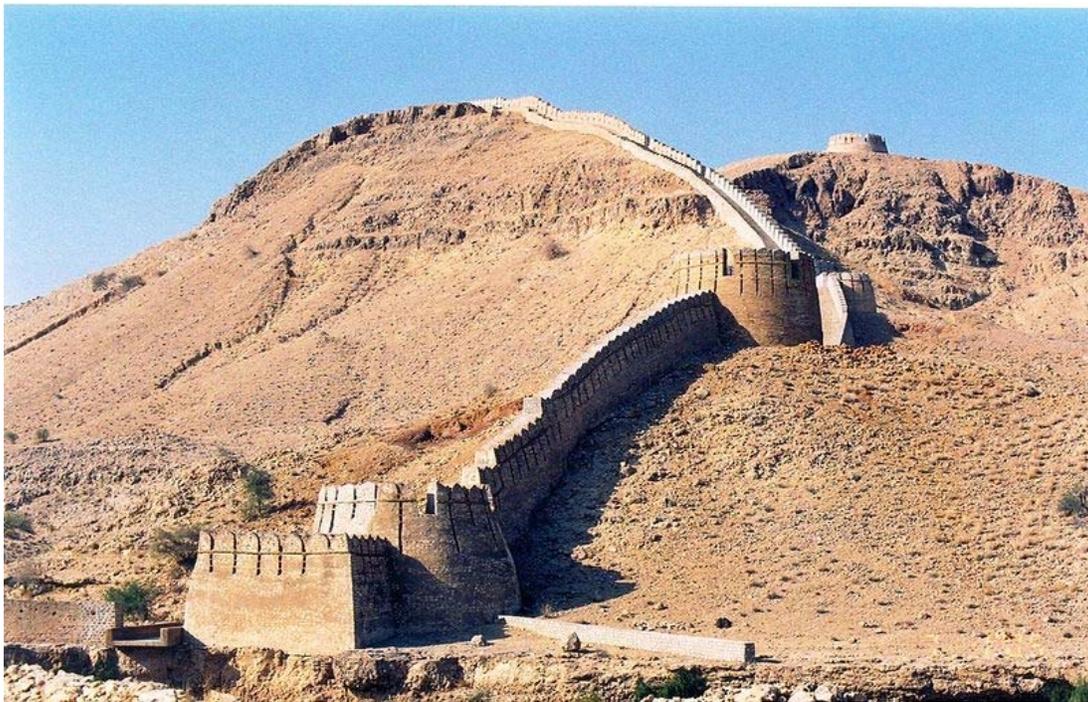
Table of Fortification, from the 1728 *Cyclopaedia*.



Austro-Hungarian Fort 31 *Benedykt* of Kraków fortress



Austro-Hungarian Fort I "Salis Soglio" of Przemyśl fortress



Ranikot Fort in Sindh, one of the largest forts in the world.

The founding of urban centres was an important means of territorial expansion and many cities, especially in eastern Europe, were founded precisely for this purpose during the period of Eastern Colonisation. These cities are easy to recognise due to their regular layout and large market spaces. The fortifications of these settlements were continuously improved to reflect the current level of military development.

During the Renaissance era, the Venetians raised great walls around cities threatened by the Ottoman empire. The finest examples are, among others, in Nicosia (Cyprus) and Chania (Crete), and they still stand, to this day.

## **Early Modern**

Medieval-style fortifications were largely made obsolete by the arrival of cannons on the 14th century battlefield. Fortifications in the age of blackpowder evolved into much lower structures with greater use of ditches and earth ramparts that would absorb and disperse the energy of cannon fire. Walls exposed to direct cannon fire were very vulnerable, so were sunk into ditches fronted by earth slopes.

This placed a heavy emphasis on the geometry of the fortification to allow defensive cannonry interlocking fields of fire to cover all approaches to the lower and thus more vulnerable walls.

The evolution of this new style of fortification can be seen in transitional forts such as Sarzanello in North West Italy which was built between 1492 and 1502. Sarzanello consists of both crenallated walls with towers typical of the medieval period but also has a ravelin like angular gun platform screening one of the curtain walls which is protected from flanking fire from the towers of the main part of the fort.

Fortifications also extended in depth, with protected batteries for defensive cannonry, to allow them to engage attacking cannon to keep them at a distance and prevent them bearing directly on the vulnerable walls.

The result was star shaped fortifications with tier upon tier of hornworks and bastions, of which Bourtange illustrated to the right is an excellent example. There are also extensive fortifications from this era in the Nordic states and in Britain, the fortifications of Berwick-upon-Tweed and the harbour archipelago of Suomenlinna at Helsinki being fine examples.

## **19th Century**

The arrival of explosive shells in the 19th century led to yet another stage in the evolution of fortification. Star forts of the cannon era did not fare well against the effects of high explosive and the intricate arrangements of bastions, flanking batteries and the carefully constructed lines of fire for the defending cannon could be rapidly disrupted by explosive shells.

Worse, the large open ditches surrounding forts of this type were an integral part of the defensive scheme, as was the covered way at the edge of the counter scarp. The ditch was extremely vulnerable to bombardment with explosive shells.

In response, military engineers evolved the polygonal style of fortification. The ditch became deep and vertically sided, cut directly into the native rock or soil, laid out as a series of straight lines creating the central fortified area that gives this style of fortification its name.

Wide enough to be an impassable barrier for attacking troops, but narrow enough to be a difficult target for enemy shellfire, the ditch was swept by fire from defensive blockhouses set in the ditch as well as firing positions cut into the outer face of the ditch itself.

The profile of the fort became very low indeed, surrounded outside the ditch by a gently sloping open area so as to eliminate possible cover for enemy forces, while the fort itself provided a minimal target for enemy fire. The entrypoint became a sunken gatehouse in the inner face of the ditch, reached by a curving ramp that gave access to the gate via a rolling bridge that could be withdrawn into the gatehouse.

Traditional fortification however continued to be applied by European armies engaged in warfare in colonies established in Africa against lightly armed attackers from amongst the indigenous population. A relatively small number of defenders in a fort impervious to iron-age weaponry could hold out against high odds, the only constraint being the supply of ammunition.



Underground passages, Middle Head Fortifications, Sydney

Much of the fort moved underground, with deep passages and tunnels to connect the blockhouses and firing points in the ditch to the fort proper, with magazines and machine rooms deep under the surface.

The guns however, were often mounted in open emplacements and protected only by a parapet - both in order to keep a lower profile and also because experience with guns in

closed casemates had seen them put out of action by rubble as their own casemates were collapsed around them.

## 20th and 21st Centuries

Steel-and-concrete fortifications were common during the 19th and early 20th centuries, however the advances in modern warfare since World War I have made large-scale fortifications obsolete in most situations. Only underground bunkers are still able to provide some protection in modern wars. Many historical fortifications were demolished during the modern age, but a considerable number survive as popular tourist destinations and prominent local landmarks today.

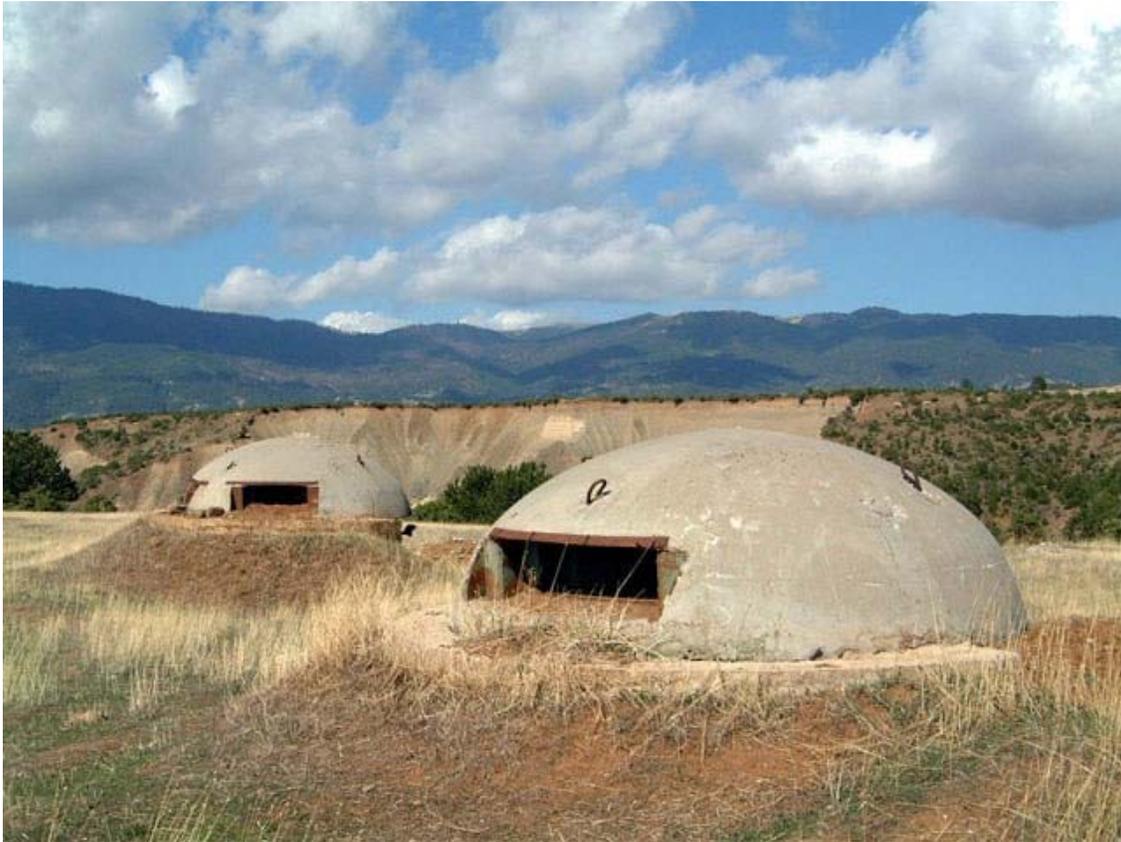


Dragon's teeth — tank traps in the Eifel

The downfall of permanent fortifications had two causes:

- The ever escalating power, speed, and reach of artillery and air power meant that almost any target that could be located could be destroyed, if sufficient force were massed against it. As such, the more resources a defender devoted to reinforcing a fortification, the more combat power that fortification justified being devoted to destroying it, if the fortification's destruction was demanded by an attacker's strategy. By 1950, nuclear weapons were capable of destroying entire cities, and produced dangerous radiation. This led to the creation of civilian nuclear air raid shelters. In the late 20th century, bunker busters were being used against bunkers.

- The second weakness of permanent fortification was its very permanency. Because of this it was often easier to go around a fortification and, with the rise of mobile warfare in the beginning of World War II, this became a viable offensive choice. When a defensive line was too extensive to be entirely bypassed, massive offensive might could be massed against one part of the line allowing a breakthrough, after which the rest of the line could be bypassed. Such was the fate of the many defensive lines built before and during World War II, such as the Maginot Line, the Siegfried Line, the Stalin Line and the Atlantic Wall.



Bunkers in Albania

Instead field fortification rose to dominate defensive action. Unlike the trench warfare which dominated World War I, these defences were more temporary in nature. This was an advantage because since it was less extensive it formed a less obvious target for enemy force to be directed against.

If sufficient power were massed against one point to penetrate it, the forces based there could be withdrawn and the line could be re-established relatively quickly. Instead of a supposedly impenetrable defensive line, such fortifications emphasized defence in depth, so that as defenders were forced to pull back or were overrun, the lines of defenders behind them could take over the defence.

Because the mobile offensives practised by both sides usually focused on avoiding the strongest points of a defensive line, these defences were usually relatively thin and spread along the length of a line. The defence was usually not equally strong throughout however.

The strength of the defensive line in an area varied according to how rapidly an attacking force could progress in the terrain that was being defended — both the terrain the defensive line was built on and the ground behind it that an attacker might hope to break out into. This was both for reasons of the strategic value of the ground, and its defensive value.

This was possible because while offensive tactics were focused on mobility, so were defensive tactics. The dug in defences consisted primarily of infantry and antitank guns. Defending tanks and tank destroyers would be concentrated in mobile "Fire Brigades" behind the defensive line. If a major offensive was launched against a point in the line, mobile reinforcements would be sent to reinforce that part of the line that was in danger of failing.

Thus the defensive line could be relatively thin because the bulk of the fighting power of the defenders was not concentrated in the line itself but rather in the mobile reserves. A notable exception to this rule was seen in the defensive lines at the Battle of Kursk during World War II, where German forces deliberately attacked into the strongest part of the Soviet defences seeking to crush them utterly.

The terrain that was being defended was of primary importance because open terrain that tanks could move over quickly made possible rapid advances into the defenders' rear areas that were very dangerous to the defenders. Thus such terrain had to be defended at all cost.

In addition, since in theory the defensive line only had to hold out long enough for mobile reserves to reinforce it, terrain that did not permit rapid advance could be held more weakly because the enemy's advance into it would be slower, giving the defenders more time to reinforce that point in the line. For example, the battle of the Hurtgen Forest in Germany during the closing stages of World War II is an excellent example of how impassable terrain could be used to the defenders' advantage.

After World War II, ICBMs capable of reaching much of the way around the world (and rockets capable of reaching the Moon and other nearby celestial bodies) were developed, and so speed became an essential characteristic of the strongest militaries and defenses. Missile silos were developed, so missiles could be fired from the middle of a country and hit cities and targets in another country, and airplanes (and air carriers) became major defenses and offensive weapons (leading to an expansion of the use of airports and airstrips as fortifications). Mobile defenses could be had underwater, too, in the form of nuclear submarines capable of firing missiles. Some bunkers in the mid to late 20th century came to be buried deep inside mountains and prominent rocks, such as Gibraltar and Cheyenne Mountain. On the ground itself, minefields have been used as hidden

defences in modern warfare, often remaining long after the wars that have produced them have ended.

Demilitarized zones along borders are arguably another type of fortification, although a passive kind, providing a buffer between potentially hostile militaries.

## **Forts**

Forts in modern usage often refer to space set aside by governments for a permanent military facility; these often do not have any actual fortifications, and can have specializations (military barracks, administration, medical facilities, or intelligence). In the United States usage, forts specifically refer to Army fortifications; Marine Corps fortifications are referred to as camps.

However there are some modern fortifications that are referred to as forts. These are typically small semi permanent fortifications. In urban combat they are built by upgrading existing structures such as houses or public buildings. In field warfare they are often log, sandbag or gabion type construction.

Such forts are typically only used in low level conflict, e.g., counterinsurgency conflicts or very low level conventional conflicts, e.g., the Indonesia–Malaysia confrontation saw the use of log forts for use by forward platoons and companies. The reason for this is that static above ground forts can not survive modern direct or indirect fire weapons larger than mortars, RPGs and small arms.

## **American West**



Fort Snelling on the confluence of the Mississippi and Minnesota Rivers, 1844. Image painted by John Caspar Wild (1804-1846).

Forts in the American Old West during the Indian Wars were lightly fortified enclosures with log or adobe walls. They were sometimes only fortified trading posts or a combination of a trading post and an Army post. Famous forts included Fort Laramie and Fort Bridger on the Emigrant Trail and Bent's Fort on the Arkansas River.

### ***Prisons, concentration camps, and other like facilities***

Fortifications designed to keep the inhabitants of a facility in rather than out can also be found, in prisons, concentration camps, and other such facilities, with supermaxes having some of the strongest of those. Those are covered in other articles, as most prisons and concentration camps are not primarily military forts (although forts, camps, and garrison towns have been used as prisons and/or concentration camps).