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Concrete Cloth

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Abstract— Worldwide there is increasing demand for construction and construction materials, for that concrete is the most extensively used material in construction. These days concrete is being used for so many purposes in many different adverse conditions. There are many advantages of concrete, but there is one drawback is that, it is not flexible, when it is hardened. To overcome this drawback of concrete. A new construction material is in evolutioncalled concretecloth.

***Key words*:** concrete cloth, PVC sheets, hydrophilic fibre, dry concrete mix, 3d fibre matrix

I. INTRODUCTION

Concrete cloth is an upcoming revolution in civil world, which in turn have a wide range of application in rapid construction, in state of emergency etc... Due to it's own physical property namely flexible and easy to use. They are cement impregnated fabric that hardens when hydrated to form a thin, durable, water and fire proof concrete layer. This evolution may lead to a new way of construction without the use of the mixing equipment. Thus it make construction mush more easily in just two steps placing them in passion by adding water. They have faster development around the world due to the significantly quicker and economical comparatively.

Literally meaning

In general concrete cloth is a flexible cement impregnated fabric that hardens on hydration to form a thin, durable, water and fire proof layer.

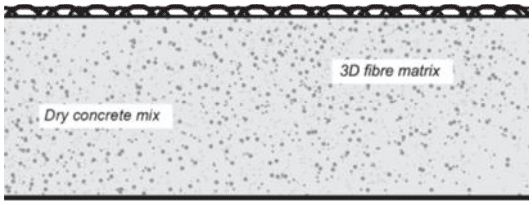
What Is Concret Cloth?

Concrete cloth is a flexible, concrete impregnated fabric that hardens when hydrated to form a thin, durable, water proof and fire resistant concrete layer. CC allows concrete construction without the need for plant or mixing equipment. Simply position the cloth and just add water.

Concrete cloth consists of a 3- dimensional fiber matrix containing a specially formulated dry Concrete mix. A PVC backing on one surface is to prevent it, to be attacked by moisture or water from surrounding, makes it water proof. On the other side of the cloth is aided with a hydrophilic fiber (polyethylene and polypropylene yarns) thus forms hydration is done by drawing water into the mixture.

The cloth may be hydrated either by spraying or by being fully immersed in water. They can be easily nailed, stapled or coated with an adhesive for easy attachment to other surface. Once set, the fibers reinforce the concrete, preventing crack propagation & providing a safe plastic failure mode. Compared to traditional concrete solutions, it is faster, easier and, more cost effective to install and has the additional benefit of reducing the environmental impact of concreting works by up to 95%.

Concrete canvas can be laid at a rate of 200sqm/hour by a 3 man team. Typical installation speeds are up to 10 times faster than conventional concrete solutions.it is available in man portable rolls eliminating the need for plant on site and allowing concrete installation in areas with limited access. Prior to hydration, Concrete cloth layers can be cut to length using basic hand tools eliminating the hazards associated with using power tools in high risk environments. The concrete is pre-mixed so there is no need for mixing, measuring or compacting but just add water.



The speed and ease of installation mean it is more cost-effective than conventional concrete, with less logistical burden.it greatly reducing transportation logistics and on site storage.it is a low mass, low carbon technology which uses up to 95% less material than conventional concrete for many applications.

II. HISTORY OF CONCRETE CLOTH

With an intension of finding a new material in practice with a property of flexibility and easy to work, the British engineering company had found the revolutionary material, concrete cloth. This revolutionary new material takes its own place in the history of civil engineering, took the concrete work in a completely new way.

A. Path crossed by concrete cloth

The technology was first found for emergency shelters, application to military world and believed that it may not be commercialized to commercial construction work. But further research in the concrete cloth made incredible changes in the construction field.

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B. Concrete cloth as reinforcing sandbags

At first British army saw the potential of concrete clothes and adopted it there daily use replacing the regular construction materials, some of them were the method of reinforcing sand bag for defence, this reduces the degradation of sandbags in extreme climates of Afghanistan, where the combination of wind, sand and extreme temperature affects the sandbags for a frequent repair. In addition to that it can be maid fire proof which resist the incoming fire and the sparks produced by the muzzles.

This was further tested by them using small and medium calibre weapons. They are made compact to work even in remote areas by manufacturing them in a compact size (10m or 33ft), made them easy to handle without any of the heavy lifting equipment's or planting machinery's. That forms a biggest advantage when work in remote area where the helicopter is the only way to mode of transport. As I said earlier the usage of the material is more easier just by unroll the pack and just add water, as a result there forms a new concrete layer.

The magic behind the concrete cloth is that the fibers used in them forms a reinforcing matrix within the concrete cloth. Thus when impacted this property of fibers used helps to serve the structural integrity of concrete. A ballistic attack may pass through them, but crack propagation is limited, as a result the sandbags remains safe inside the concrete shell.

In January 2008, a notable amount of concrete cloths are laid in the frontline in Afghanistan to analyse the field usage and the performance which is satisfactory for the U.K army, as a reward the manufacturer got a huge order of the concrete cloths of 5500 m^2 to the frontlines of Afghanistan by U.K ministry of defence.

C. Concrete cloth as Deployable Shelters

The research of concrete cloths is to develop rapid hardening shelters only using the water and air. The original concept for Concrete cloth was to create rapidly deployable hardened shelters that required only water and air for construction. The key was the use of inflation to create a surface that was optimized for compressive loading. This allowed thin-walled concrete structures that are both robust and lightweight. The shelter, such as the one shown in Fig 3, is deployed in the following four stages: Delivery-the shelter is supplied folded and sealed in a sack. The 16 m^2 (19 yd^2) variant is light enough to transport in a pickup truck or light aircraft.

Inflation-once delivered, an electric fan is activated to inflate the inner PVC liner and lift the structure until it is self-supporting. The shelter is then pegged down with ground anchors around the base; Hydration the shelter is sprayed with water. Hydration is aided by the fiber matrix, which wicks water into the mixture; and Setting-the Concrete Cloth cures in the shape of the inflated inner PVC liner. The structure is ready to use 24 hours later. Access holes allow the installation of services such as water, power, air conditioning, and heating units. The structures are designed as part of a modular system. Units can be easily linked together, allowing the space to be tailored to the application. If required, they can be demolished using basic tools. The thin-walled structure has a very low mass, leaving little material for disposal.The University of Bath in Bath, UK, has conducted finite element analysis of the shelters, showing that the structures can withstand a high distributed compressive load. This allows sandbags, earth, or snow to be piled on top-giving the shelters excellent thermal properties and protection against shrapnel, blasts, and small arms fire.

Concrete cloth Shelters are specified to withstand 0.75 m (2.5 ft) of wet sand on the sides (sufficient to stop 7.62 mm [.30 calibers] rounds) and 0.5 m on the roof (to protect against shell fragments).

III. MARKET AVAILABILITY

Concert cloth is available in two standard roll sizes; bulk rolls or smaller batched rolls. The quantity per roll differs between the Concrete cloth types. Bulk rolls weigh 1.6T and are supplied on 6 inch cardboard tubes which can be hung from a spreader beam and unrolled using suitable plant equipment (see below). Bulk rolls provide the fastest method of laying Concrete cloth and have the additional advantage of reducing the number of joints required. Batched rolls are supplied on 3 inch cardboard cores with carry handles designed as a 2 to 4 man lift. All Concrete cloth thicknesses can be supplied batched to custom lengths for a small additional charge.There are 3 Concrete cloth types available with the following indicative specifications:

Table 1: Specifications of CC

CC Type	Thickness (mm)	Roll Width (mm)	Dry Weight (kg/sqm)	Batched Roll Coverage (sqm)	Batched Roll Length (m)	Bulk Roll Coverage (sqm)	Bulk Roll Length (m)
CC5	5	1000	7.0	10	10	200	200.0
CC8	8	1100	12.0	5	4.5	125	113.6
CC13	13	1100	19.0	N/A	N/A	80	72.7

The shelter is supplied folded and sealed in a sack. The 16 m^2 (19 yd^2) variant is light enough to transport in a pickup truck or light aircraft.

Some examples of applications for the different Concrete cloth types are given in Table 2.

Table 2:

Application	CC5	CC8	CC13	Comment
Dust Suppression	●	○		Use CC8 if the area is to be regularly trafficked.
Foundation Blinding	●	○		Use CC8 for heavy duty application.
Weather Proofing / Slope Stabilisation	●	●		Use CC5 for CC8 depending on ground conditions.
Ditch Lining	○	●	○	Use CC5 for light duty applications. Use CC8 for medium duty applications. Use CC13 for heavy duty applications.
Bund Lining	●	●	●	All thicknesses may be used depending on level of traffic.
Sandbag / Gabion Reinforcement	○	●	●	CC8 has been tested by the British Army of sandbag reinforcement
Trackway / Flooring		●	●	Use CC8 to CC13 depending on loading or substrate.
Pipe Protection	●	●	●	All thickness may be used depending on protection requirements.
Cable Covering	○	○	●	All thickness may be used depending on protection requirements.

IV. MATERIAL PROPERTY

Strength

Very high early strength is a fundamental characteristic of concrete cloth. Typical strengths and physical characteristics are as follows:

Compressive testing

This test based on ASTM C473 – 07
- 10 day compressive failure stress (MPa) 40
- 10 day compressive Young's modulus (MPa) 1500

Bending test

This tests based on BS EN 12467:2004
- 10 day bending failure stress (MPa) 3.4
- 10 day bending Young's modulus (MPa) 180

Abrasion Resistance (ASTM C1353-8)

- CC lost 60% less weight than marble over 1000 cycles.

Tensile Test
Abrasion Resistance (DIN 52108)
- Similar to twice that of OPC Max 0.10 gm/cm^2

Table 3: Tensile Test Data

	Tensile Strength (kN/m)	
	Length direction	Width direction
CC5	6.7	3.8
CC8	8.6	6.6
CC13	19.5	12.8

CBR Puncture Resistance EN ISO 12236: 2007 (CC8 & CC13 only)

- Min. Push-through force 2.69kN
- Max. Deflection at Peak 38mm

Resistance to Imposed Loads on Vehicle Traffic Areas EN 1991-1-1:2002 (CC8 & CC13 only)

- Category G compliant
- Gross weight of 2 axle vehicle 30 to 160kN
- Uniformly distributed load not exceeding 5kN/sq. m

Physical Properties

Initial Set≥ 120 min, Final Set ≤ 240 min.

Table 4: Physical Properties of CC

CC	Thickness (mm)	Batch Roll Size (sqm)	Bulk Roll Size (sqm)	Roll Width (m)
CC5	5	10	200	1.0
CC8	8	5	128	1.1
CC13	13	N/A	80	1.1
CC	**Mass (unset) (kg/m2)**	**Density (unset) (kg/m3)**	**Density (set) (kg/m3)**	
CC5	7.0	1500	+30-35%	
CC8	12.0	1500	+30-35%	
CC13	19.0	1500	+30-35%	

V. METHOD OF HYDRATION

Concrete cloth can be hydrated using saline or non-saline water. The minimum ratio of water to Concrete Cloth is 1:2 by weight. It cannot be over hydrated so an excess is recommended. The recommended methods are: In a hot/arid environment, re-wet the material 2 - 4 hours after the initial hydration.

A. Immersion:

Immerse Concrete cloth in water for a minimum of 90 seconds.

B. Spraying:

Spray the dry Concrete cloth with water until it is saturated. Do not use a direct jet of pressurized water as this may wash a channel in the material and create a weakened area.

VI. APPLICATIONS OF CONCRETE CLOTH

A. Ditch lining

Concrete cloth can be rapidly unrolled to form ditch or tank lining. It is significantly quicker and less expensive to install than conventional concrete ditch lining and requires no specialist plant equipment. The 30m ditch shown below was lined in 45min.

Traditionally, the most common renovations were to replace smaller canals with pipelines and line larger canals

with concrete, Fipps said. But lining canals with concrete is expensive and requires significant upkeep.

It is rapidly becoming the ditch lining material of choice for engineers and contractors around the world. Concrete Cloth is typically 10 times faster to install than conventional concrete solutions, with installation speeds of up to 200sqm/hr possible with only a 3 man crew for a longitudinal layup.it provides a ditch lining solution which is fast, easy and cost effective to install.

B. Slope Protection

Landslides can be triggered by many often concomitant causes. In addition to shallow erosion or reduction of shear strength caused by seasonal rainfall, causes triggered by anthropic activities such as adding excessive weight above the slope, digging at mid-slope or at the foot of the slope, can also be included.

concert cloth can be used as slope stabilization and other erosion control applications such as temporary and permanent slope protection, retaining walls, boulder fences, low level bunds and river bank and dam revetments.

C. Pipeline Protection

Concrete cloth can be used as a coating for overland or underwater pipeline protection, providing a superior tough rock shield. In remote areas it can be used to coat steel pipe on site without expensive wet concrete application plants.it will set underwater and provide negative-buoyancy.

D. Ground Resurfacing

Concrete cloth can be secured with ground anchors to rapidly create a concrete surface for flooring, pedestrian walk-ways or dust suppression. CC8 and CC13 have been tested to EN 1991-1-1:2002 (Resistance to Imposed Loads on Vehicle Traffic Areas)

Repairing existing concrete infrastructure can prove costly, difficult and time-consuming, typically requiring the removal and replacement of existing concrete which is extremely difficult, requires heavy plant and a large site team.

E. Mining Applications

Concrete cloth can be used as an alternative to poured or sprayed concrete or as a quick way of erecting strong permanent or temporary blast and vent structures and spall lining. it has been successfully tried in Mpumalanga, South Africa.

It can be used as an alternative to brattice cloth, plaster board or concrete block-work to construct blast and vent wall structures for underground mining applications. Trials have shown that CC typically provides cost savings of over 20% compared to conventional solutions.

F. Bund Lining

Earth containment bunds can be quickly lined with Concrete Cloth to provide an efficient, chemically resistant alternative to concrete walling. Bunding, also called a bund wall, is a constructed retaining wall designed to prevent inundation or breaches from a known source. It is a secondary containment system commonly used to protect environments from spills where chemicals are stored.

G. Gabion Reinforcement / Capping

Gabion is a cage, cylinder, or box filled with rocks, concrete, or sometimes sand and soil for use in civil engineering, road building, and military applications. For erosion control, caged riprap is used. For dams or in

foundation construction, cylindrical metal structures are used. In a military context, earth- or sand-filled gabions are used to protect artillery crews from enemy fire.

concrete cloth can be used to cap or repair gabion walls to provide long-term protection and prevent FOD (Foreign Object Damage). Covering gabions with concrete cloths also prevents water ingress which can cause slump, whilst protecting the geo-textile membrane from the effects of UV degradation.

H.Dust suppression system in helipad

The turbulent air currents created by the helicopter rotor wash drives loose soil particles into the air. The airborne dust particles negatively impact humans and wildlife, including aquatic life and vegetation. The dust also increases vehicle, helicopter, and equipment wear and damage due to mechanical abrasion.

Dust Suppression was developed as a result of in-theatre feedback, for use as a dust suppression surface around Helicopter Landing Sites.

Benefits include: speed of installation, durability, and good coverage will conform to the underlying ground conditions.

VII. MODE OF USE OF CONCRETE CLOTH

A. Cutting of concrete cloth

A 'snap off' type disposable blade is the most suitable tool for cutting concrete cloths before it is hydrated or set. When cutting dry concrete cloth, a 20mm allowance should be left from the cut edge due to lost fill. This can be avoided by wetting the concrete cloths prior to cutting.concrete cloth can also be cut using handheld self sharpening powered disc cutters.

B. Cutting Set concrete cloth

Set concrete cloths can be cut as with conventional concrete, with angle grinders, construction disc cutters or good quality tile cutters.

C. Concrete cloth Mechanical Fixing

There are a large number of mechanical fixings that are suitable for use with concrete cloths. Some of these fixings can be used in conjunction with the non-echanical joining methods described later in this to improve the mechanical strength or water proofing properties of joints.

D.Staples

The versatility of concrete cloths means that a wide range of manual, electric or gas powered staplers are suitable for attaching concrete cloths to soft substrates such as wooden boarding for building cladding. Commercially available hand staplers are suitable for fixing 2 layers of concrete cloths together where a small amount of compression force is required.

VIII. ADVANTAGES OF CONCRETE CLOTH

- Rapid-the material can be hydrated by either spraying it or fully immersing it in water. Once hydrated, it remains workable for 2 hours and hardens to 80% of its final strength within 24 hours.
- Easy to use-dry Concrete Cloth can be cut or tailored using simple hand tools such as utility knives. The PVC side can be supplied with an adhesive backing and the fibrous side bonds well to concrete or brick surfaces when set. It can be easily repaired or upgraded using existing cement products
- Flexible-Concrete Cloth can be easily nailed through before setting. It has good drape characteristics, allowing it to take the shape of complex surfaces including those with double curvature;
- Strong-the fiber reinforcement acts to prevent cracking, absorbs energy from impacts, and provides a stable failure mode;
- Fireproof-Concrete Cloth is a ceramic-based material and will not burn;
- Waterproof-the PVC backing on one surface ensures that Concrete Cloth is completely waterproof;
- Adaptable-Concrete Cloth is currently supplied on 1.2 m (4 ft) wide rolls but can be manufactured with a roll width of up to 5 m (16.4 ft). The cloth can be produced in a range of thicknesses from 5 to 20 mm (0.2 to 0.8 in.); and
- Durable-Concrete Cloth is chemically resistant and will not degrade in ultraviolet light.
- Environmentally Friendly

Concrete cloth is a low mass, low carbon technology which uses up to 95% less material than conventional concrete for many applications. It has minimal impact on the local ecology due to its limited alkaline reserve and very low wash rate.

IX. Limitations of Concrete cloth

- Concrete cloth cannot be over hydrated and an excess of water is always recommended.
- Do not jet high pressure water directly onto the Concrete cloth as this may wash a channel in the material..
- Concrete cloth has a working time of 1-2 hours after hydration. So do not move CC once it has begun to set.
- Working time will be reduced in hot climates.
- If Concrete cloth is not fully saturated, the set may be delayed and strength reduced.

X. Analysis of Rates

Engineers Incorporated Ltd (EIL) was commissioned by Concrete Canvas Ltd (CCL) to prepare a comparison of costs for lining an open, trapezoidal ditch 900x900x900mm, 500m in length.

Table 5: Cost Comparison for Ditch Lining

Lining Materials	Materials £/sqm	Labour and Plant £/sqm	Total (inc o/heads) £/sqm	Installation time Sqm/day
1. Insitu concrete	£16.02	£18.13	£42.25	40
2. Precast concrete paving slabs	£19.76	£12.98	£40.51	40
3. Spayed concrete (Gunite)	£42.53	£4.84	£58.61	130
4. Concrete Cloth CC8	£29.40	£0.99	£37.60	412

The comparison for construction costs requested, were:-

- In Situ concrete lining, average thickness 150mm.
- Precast Concrete Paving Slabs, laid on sand / cement screed.
- Sprayed Concrete (Gunite) average thickness 100mm with mesh.
- Concrete Canvas CC8.

Table 6: In-situ Concrete Lining

		Rate	Qty	£/hr	
A. Gang Rate					
Labour	Ganger	£14.60 /hr	1	£14.60	
	Gen Ops	£13.10 /hr	4	£52.40	
	Total/hr			£60.00	
	Total labour/day		9		£603.00 /day
Plant	6tn Dumper	£145.00 /week			£29.00 /day
	Single tool comp plus poker	£40.00 /week			£8.00 /day
	Small tool etc-allow	£5.00 /day			£5.00 /day
	2.5t Excavator	£400.00 /week			£80.00 /day
	Total Labour and Plant				£725.00 /day
B. Material Supply Cost					
	C30N SR Concrete (150mm thick)	£88.00 /m3	0.15		£13.20 /m2
	Wastage (10%)	10%			£1.32 /m2
	Allow construction joints/consumables	£10.00 /m3			£1.50 /m2
	Total Material /m2				£16.02 /m2
C. Output Rate Calculation					
	Ditch lining volume (3x0.9x0.15)	0.405 m3/lm			
	Average rate	6.0 m3/day			40.0 m2/day
A.	Labour and Plant	£725.00 /day			£18.13 /m2
B.	Materials	£16.02 /m2			£16.02 /m2
	Total Per Sqm Cost				£ 34.15
	Add prelims-supervision/transport/welfare	10.0%			£37.56 /m2
	Add overheads and profit	12.5%			£42.25 /m2

Table 7: Precast Concrete Paving Slabs

		Rate	Qty	£/hr	
A. Gang Rate					
Labour	Ganger	£14.60 /hr	1	£14.60	
	Gen Ops	£13.10 /hr	3	£39.30	
	Total/hr			£53.90	
	Total labour/day		9		£485.10 /day
Plant	6tn Dumper	£145.00 /week			£29.00 /day
	Small tool etc-allow	£5.00 /day			£5.00 /day
	Total Labour and Plant				£519.10 /day
B. Material Supply Cost					
	900x600x50 slabs	£5.50 each			£10.19 /m2
	Wastage (0%)	0%			£0.00
	Sand/cement screed (3:1) (60mm thick)	£145.00 /m3			£8.70 /m2
	Wastage (10%)	10%			£0.87 /m2
	Total Material /m2				£19.76 /m2
C. Output Rate Calculation					
	Average rate	6.0 m3/day			40.0 m2/day
A.	Labour and Plant	£519.10 /day			£12.98 /m2
B.	Materials	£19.76 /m2			£19.76 /m2
	Total Per Sqm Cost				£ 32.73
	Add prelims-supervision/transport/welfare	10.0%			£36.01 /m2
	Add overheads and profit	12.5%			£40.51 /m2

Table 8: Sprayed Concrete (Gunite)

		Rate	Qty	£/hr	
A. Gang Rate					
Labour	Ganger	£14.60 /hr	1	£14.60	
	Gen Ops	£13.10 /hr	3	£39.30	
	Total/hr			£53.90	
	Total labour/day		9		£485.10 /day
Plant	Mobilisation	£1,500.00			£144.44 /day
	Total Labour and Plant				£629.54 /day
B. Material Supply Cost					
	Spray concrete (includes equipment costs)	£28.00 /m2			£28.00 /m2
	Steel mesh	£12.50 /m2			£12.50 /m3
	Wastage (5%)	5%			£2.03 /m2
	Total Material /m2				£42.53 /m2
C. Output Rate Calculation					
	Average rate	130 m2/day			130. 0 m2/day
A.	Labour and Plant	£629.54 /day			£4.84 /m2
B.	Materials	£42.53 /m2			£42.53 /m2
	Total Per Sqm Cost				£ 47.37
	Add prelims-supervision/transport/welfare	10.0%			£52.10 /m2
	Add overheads and profit	12.5%			£58.62 /m2

Table 9: Concrete Cloth – Type CC8

		Rate	Qty	£/hr	
A. Gang Rate					
Labour	Ganger	£14.60 /hr	1	£14.60	
	Gen Ops	£13.10 /hr	4	£26.20	
	Total/hr			£40.80	
	Total labour/day		9		£367.20 /day
Plant	6tn Dumper	£145.00 /week			£29.00 /day
	Water Bowser plus hoses	£25.00 /week			£5.00 /day
	Small tool etc-allow	£5.00 /day			£5.00 /day
	Total Labour and Plant				£406.20 /day
B. Material Supply Cost					
	Concrete Cloth type CC8	£28.00 /m2			£28.00 /m2
	Wastage (5%)	5%			£1.40 /m2
	Total Material /m2				£29.40 /m2
C. Output Rate Calculation					
	Average rate (based on actual from Bam Nuttall)	412 m2/day			412.0 m2/day
A.	Labour and Plant	£406.20 /day			£0.99 /m2
B.	Materials	£29.40 /m2			£29.40 /m2
	Total Per Sqm Cost				£ 30.39
	Add prelims-supervision/transport/welfare	10.0%			£33.42 /m2
	Add overheads and profit	12.5%			£37.60 /m2

The above rates assume that the initial ditch excavation to form the trapezoidal shape is complete prior to commencement of lining and therefore has been excluded in the costs.The above rates assume that the site has tarmac access for pouring in-situ concrete, delivery of sprayed concrete and paving slabs.

XI. CONCLUSION

Concrete cloth (CC) is a unique proprietary material. It is a time & material saving technique. It is very easy to place & handle. Concrete cloth is a flexible; cement impregnated fabric that hardens when hydrated to form a thin, durable, water & fire proof concrete layer. CC allows concrete construction without the need for plant or mixing equipment. Simply position the canvas & just add water. CC has a design life of 10 years and is significantly quicker and less expensive to install compared to conventional concrete. It is specially used, where the workmanship is very difficult. It is specially used in emergency works such as in military.

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