

Revolution in construction: Concrete Cloth

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Abstract :-Since a very long time, Construction has followed conventional methods. And there is no provisions for very rapid and emergency workable concrete installation methods. A private company and its R&D department has taken the initiative to introduce a ground breaking product called as **Concrete Cloth**. The original idea was to create a rapidly deployable emergency shelter, so as to enter a design competition run by British Cement Association. The product used for making the same has found its varied application in civil engineering works. The designer had no idea that their entry for a rapidly deployable emergency shelter would result in the launch of their own technology development company involving research trips to disaster zones around the world, and the concept has matured into a technology that has applications far beyond emergency shelter. Following development, funded through a combination of private equity investment and grants, and the company is setting up the volume production facility for concrete canvas shelters (CCS) and concrete cloth.

Keywords: - Concrete cloth, Emergency deployable shelter, Impregnated Fabric

I. INTRODUCTION

Manufactured by a private organization Milliken, Concrete canvas is a ground breaking material technology that allows concrete to be used in completely new ways. Concrete cloth was originally developed for award winning concrete canvas shelter, a building in a bag that requires only water and air for construction. Concrete cloth can be used in unlimited application such as civil construction, agriculture, Military application and much more. The shelters have been enabled by the development of a core material technology called concrete cloth – a unique proprietary material that has a very wide range of applications throughout engineering. The cloth consists of a three-dimensional fiber matrix, containing a dry concrete mix. A PVC backing on one surface of the cloth ensures the material is completely waterproof, while hydrophilic fibers on the opposite surface aid hydration by drawing water into the cement. The original concept was to create rapidly deployable hardened shelters that require only water and air for construction. The key to the idea was the use of inflation to create a surface that is optimized for compressive loading. This allowed thin-walled concrete structures to be formed, which are both robust and lightweight.

1.1 WHAT IS CONCRETE CLOTH?

A flexible cement-impregnated fabric that hardens when hydrated to form a thin, durable concrete layer. It combines the flexibility of Geotextile fabrics with the durability of hardened concrete. It is a flexible mat containing a dry concrete mix trapped within a 3-dimensional fiber matrix with a fibrous surface on one side and a PVC membrane on the other. When water is added, the material remains workable for 2 hours and then hardens to form a concrete sheet. The material is supplied on a roll and comes in a range of thicknesses up to 20mm.

II. CONTENTS

It mainly consists of –

Dry concrete mix, Reinforcing fiber matrix, Fabric top surface, PVC bottom coating the major chemical elements are Al₂O₃, CaO, SiO₂, Fe₂O₃ in concrete mix.

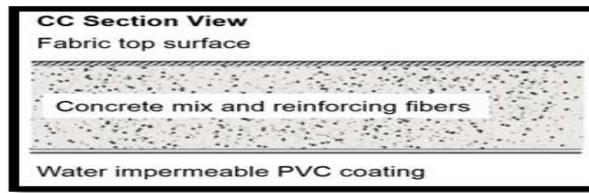


fig1

2.1. Cement

Substance obtained from calcium aluminates clinker. The major chemical elements are Al_2O_3 , CaO , SiO_2 , and Fe_2O_3 appearing predominantly in the following mineralogical compounds:

2.2. PVC Membrane

The principle constituent of the PVC membrane is not a hazardous substance.

2.3. Fibers

The principle constituents of the fibers are Polyethylene and Polypropylene yarns.

III. WORKING

It is bifurcated into four steps

3.1. Unpacking- At the time of installation, CC comes in two forms, Bulk roles or Batched roles which are flexible in nature. CC is available in two standard roll sizes; bulk rolls or smaller batched, portable rolls the quantity per roll differs between the CC types. Bulk rolls weigh about 1.7 Tons (~3400 lbs.) and are supplied on 6 inch cardboard tubes which can be hung from a spreader beam and unrolled using suitable equipment (see picture below). Bulk rolls provide the fastest method of laying CC and have the additional advantage of reducing the number of joints required.

Batched rolls are supplied on 3 inch inner diameter cardboard cores with carry handles, and can be easily handled by 2 to 4 people. All CC thicknesses can be supplied batched to custom lengths for an additional charge. Bulk rolls are individually wrapped and palletized. All CC rolls are provided with a basic hydration guide placed within the packaging. CC batched rolls are individually wrapped in airtight packaging and palletized. 10 batched rolls fit on a standard 4'x 4' pallet. CC13 is not supplied in a standard batch roll size.

CC bulk rolls are individually wrapped and palletized. All CC rolls are provided with a basic hydration guide placed within the packaging. CC batched rolls are individually wrapped in airtight packaging and palletized. 10 batched rolls fit on a standard 4'x 4' pallet. CC13 is not supplied in a standard batch roll size. (Milliken Press-slide) [3]



Fig2. Batched roles and Bulk roles

3.2. Storages-CC should be stored in dry conditions away from direct sunlight and in the manufacturers sealed packaging. If stored correctly CC has a shelf life of 24 months. If stored for longer CC may remain usable in many instances.

3.3. Cutting and Fastening- The cloth is laid on the point of application, cut into proper size and shape, and fastened to the place using staples, Nails and screws. CC A ‘snap off’ type disposable blade is the most suitable tool for cutting CC before it is hydrated or set. When cutting dry CC, a 3/4” allowance should be left from the cut edge due to lost fill. This can be reduced by wetting the CC prior to cutting. Set CC can be cut as with conventional concrete, with angle grinders, construction disc cutters or tile cutters. CC can also be cut using handheld self-sharpening powered disc cutters. CC sheets in all three thicknesses can also be water cut to a fine resolution. There are a large number of mechanical fasteners that are suitable for use with Concrete Cloth. Some of these fasteners can be used in conjunction with the non-mechanical joining methods described later in this guide to improve the mechanical strength or water proofing properties of joints(case study)[*1]

Staples The versatility of CC means that a wide range of manual, electric or gas powered staplers are suitable for attaching CC to soft substrates such as wooden boarding for building cladding. Commercially available hand staplers are suitable for fixing 2 layers of CC together where a small amount of compression force is required - such as with the simple overlap joint described in the CC Non-Mechanical Fastening Techniques section of this brochure. **Nails** Standard nails can be used to attach CC. Alternatively, a power tool such as the Hilti nail gun, provides a quick and effective method of securing CC to hard surfaces such as concrete or rock. This may be appropriate where CC is being used to recondition an existing concrete surface or for spall lining in mining applications. It is important to ensure that the nail is used with at least a 1/2” washer to ensure the head does not penetrate through the surface of the Cloth.



Fig3. Cutting and fastening of CC. (source- Milliken’s gallery)

3.4. Hydrating- After fastening of CC to desired place, It only needs to be hydrated for its final hardening. It is designed in such a way that, it cannot be over hydrated. Only in 24 hours Concrete cloth is ready to serve its purpose.



Fig4. Hydration (source- Milliken’s gallery)

IV. BENEFITS OF CONCRETE CLOTH

Concrete Cloth have huge benefits which are explained as below:

Quick - Unroll, place and wet

Simple - Cannot be over-hydrated

Versatile - One material, many uses

Durable - Wear-resistant concrete

Robust - Fiber matrix reinforcement

Portable - Easily transported and deployed without specialized equipment

Rapid – the material can be hydrated either by being sprayed or by being fully immersed in water. Once hydrated, it remains workable for four hours and hardens to 80% strength within 24 hours. This time can be reduced by adding accelerants into the dry mix at the point of manufacture.

Easy to use – dry concrete cloth can be cut or tailored using simple hand tools such as Stanley 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 up the shape of complex surfaces including those with a 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 1.2m-wide rolls but can be manufactured with a roll width of up to 5m. The cloth can be produced in a range of thicknesses from 5–20mm.

Durable – concrete cloth is chemically resistant and will not degrade in UV.

Inflation – once delivered, an electric fan is activated which inflates the plastic inner to lift the structure until it is self-supporting. The shelter is then pegged down with ground anchors around the base.

Hydration – the 54m² shelter is then sprayed with water (with smaller variants, hydration takes place by filling the sack with water. The volume of the sack controls the water: cement ratio). Hydration is aided by the fiber matrix, which wicks water into the cement.

Setting – the concrete cloth cures in the shape of the inflated inner and 24 hours later the structure is ready to use. Access holes allow the installation of services; water, power, air conditioning and heating units. The structures are designed as part of a modular system; units can be easily linked together enabling 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 has conducted finite element analysis on the shelters, showing that the structures can withstand a high distributed compressive load, enabling sandbags, earth or snow to be piled on top. This gives

the shelters excellent thermal properties and protection against shrapnel, blasts and small arms fire. Concrete canvas shelters are specified to withstand 0.75m of wet sand on the sides (sufficient to stop 7.62mm rounds) and 0.5m on the roof (to protect against shell fragments). In summary, concrete cloth can be used to rapidly create waterproof, fireproof, fiber-reinforced thin concrete forms across a wide range of applications. Some of these applications include: rapid track way or landing surfaces, structural reinforcement, back blinding, ground stabilization, tunnel lining and even improvement of ballistic protection. The British Army has recently placed an order to test the cloth on operational trials.

V. APPLICATIONS OF CC IN CIVIL ENGINEERING

Looking to the advantages of Concrete Cloth it has vast applications in civil Engineering projects, some are mentioned below

- 1) **Ditch Lining**- Protects water from seeping in ditch.
- 2) **Slope protection, weathered rock protection**- Acts as perfect reinforcing agent on loose soil.
- 3) **Bund lining**- Concrete cloth was successfully tested as anti-weathering layer over Bund.
- 4) **External Pipe protection**- Provides safety against corrosion and direct impacts on pipes, (GI pipes, CI pipes)
- 5) **Concrete cloth shelter**-Deployable shelters can be made
- 6) **Mining** - Lining of mines.
- 7) **Military**- Expedient resurfacing, dust suppression
- 8) **Internal culvert repair**
- 9) **Secondary containment**
- 10) **Weed control**
- 11) **Erosion and scour protection**

VI. ADVANTAGES

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VII. DISADVANTAGES

Concrete cloth has disadvantage of undesired hydrating due to excessive moisture. Concrete cloth cannot be stored in open place. Permanent Residential structure capabilities are still under research.

VIII. HAZARD INDICATION TO HUMANS IF NOT USED CORRECTLY.

In contact with water, an alkaline solution occurs (pH 11-11.5). In spite of the pH level, the alkaline reserve is limited and the product has not been classified as an irritant according to criteria defined in the EEC directives (93/21/EEC). A dust problem may occur in confined areas. It is regarded as a nuisance without any known specific effects to health (Wolseley Utilities Limited) [*2].

The concrete mix reacts chemically and hardens when mixed with water. The reaction is exothermic resulting in a temperature rise. In large quantities the temperature may increase enough to cause a risk of burns.

IX. STORAGE

The material should be stored in an environment that is water proof, clean and protected from contamination, dry (internal condensation minimized). Packed products must be stored in unopened bags, clear of the ground in cool, dry conditions and protected from excessive draught.

Contact with water or water vapor during storage will hydrate the product and affect its performance.

X. STABILITY AND REACTIVITY

In a dry environment the product is chemically stable. When mixed with water it reacts chemically and hardens, forming stable calcium aluminates hydrates. This reaction is exothermic and continues for up to 24h. Total heat released is < than 500J/kg. There are no hazardous decomposition products.

XI. CURED CONCRETE CLOTH CHARACTERISTICS

The thickness of cured CC increases upon hydration. The mass per unit area also increases due to the water that has been incorporated in curing the formulated concrete. Strip tensile results are defined as the load where concrete cracking occurred. Three point bending strength is measured for the machine direction and is defined as the flexural strength when the cured concrete component initially cracks. Comparison of Geosynthetic component with the uncured product, then the cured material using strip tensile strengths illuminates the multiphase characteristics of this material.

XII. MISCELLANEOUS

Currently there are only two private companies that are manufacturing the concrete cloth extensive.

- Milliken pvt. Ltd
- Nuna innovations

Currently 3 variants are available in concrete cloth- CC5, CC8, CC13. These variants vary in types of their application, properties and composition.

XIII. CONCLUSION

Concrete cloth is the latest and extremely useful innovation in field of concrete, which can change the perspectives about construction materials and methods. Installation and application of the CC has drastically reduced the manpower and mechanical power consumption, It is one of the most economical and advanced techniques in construction.

Furnished outlook, high durability and low maintenance makes it's a reliable product. Maximizing the use can optimize the economy, and save time. Overall, this innovative project can change the ways of construction.

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