



 **CCHYDRO™**
Concrete Impregnated Containment

USER GUIDE: THERMAL WELDING



RAIL



ROAD



MINING



PETROCHEM



AGRO



UTILITIES



PUBLIC WORKS



DEFENCE



DESIGN



SHELTER



2014 Fast Track 100
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2014 Queen's Award
for Enterprise in
Innovation



2013 MacRobert Award
Finalist



2013 Innovation Award Winner
Railtex Exhibition



2012 R&D 100 Award winner
R&D Magazine



2011 Expert's Choice Winner
Most Innovative Product



2011 Brit Insurance
Designs of the Year Nominee



2009 Winner
Material ConneXion Medium Award
Material of the Year



2007 Winner
D&AD Yellow Pencil Award
Product Design

CC Hydro™ GCCM Thermal Welding

Impermeability Rating : ●●●●●●
Mechanical Strength : ●●●●●●

CC Hydro™ GCCM* can be thermally welded to provide a high strength, high impermeability joint.

The flexible nature of CC Hydro™ means that both joint strength and impermeability can be verified using an air-channel test. In accordance with ASTM D-7177 this negates the need for removal and destructive testing of sample tabs from the body of the geomembrane. In addition to saving time and eliminating patch repairs of sample tabs, this method of joint strength testing challenges the entire joint length rather than only discrete points, significantly improving CQA integrity.

Material

CC Hydro™ consists of a concrete impregnated fabric with a geomembrane liner laminated onto the rear surface.

The concrete hardens on hydration to provide long term protection to the geomembrane from puncture, abrasion, weathering and UV degradation removing the need for concrete, soil or aggregate top cover. CC Hydro™ is available in 2 thicknesses; CCH5™ and CCH8™ (5 and 8mm) for a wide range of containment applications.

Equipment

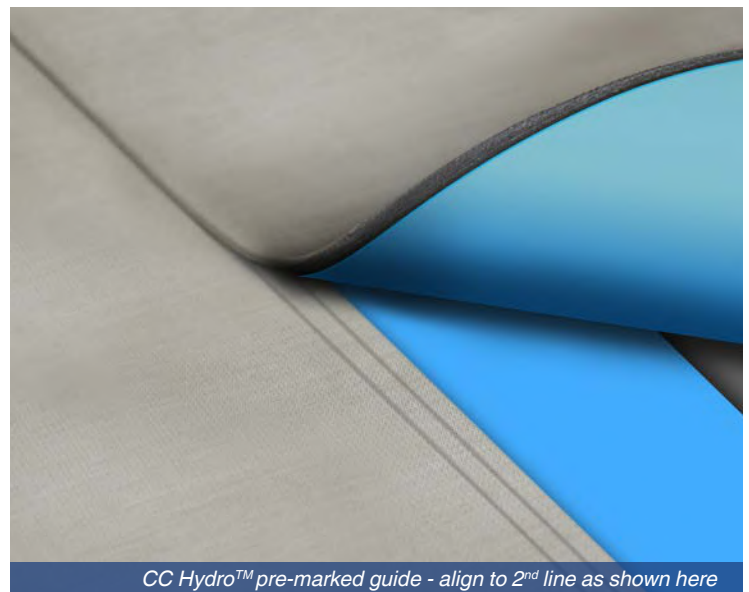
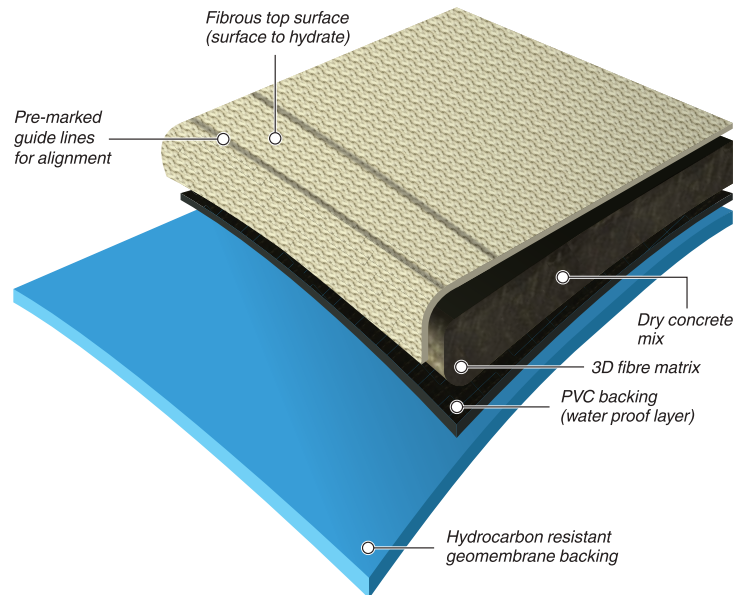
The following equipment is required for thermal welding of joints:

- **Automated hot air welder** (eg Leister Twinny S or T) with a double or triple track set-up. Kits to adapt a double track welder to a triple track welder are available from Concrete Canvas Ltd.
- **Hand-held heat gun** with closed loop temperature control (eg Leister Triac AT)
- **Slot nozzle** 20mm and 40mm perforated
- **Test needle** with pressure gauge and shut-off valve
- **Safety gloves**
- **Mask** (A2P3 filter or equivalent)
- **Power Supply** (sufficient to provide 2.3kVA uninterrupted power to welder)
- **Air compressor** or manual pump sufficient to reach specified pressures

Installation

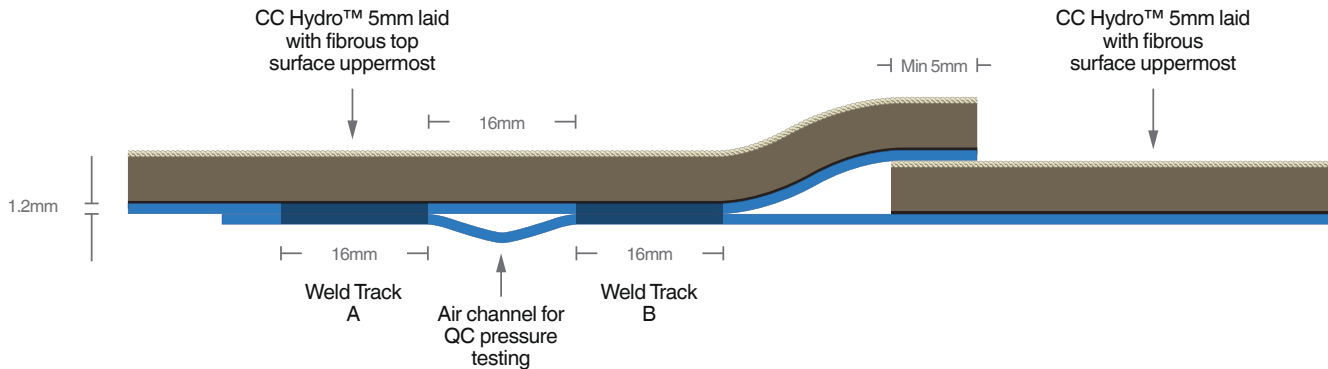
1. Unroll CC Hydro™ with the blue geomembrane side facing down and adjacent sheets laid so that they overlap the welding strip.
2. There are 2 parallel black lines printed along one edge of the CC Hydro™. Align the top layer to the 2nd pre-marked guideline on the bottom layer; this will allow for a testable joint once welded.
3. Wipe down the geomembrane faces to remove any dirt or moisture; this will ensure an optimum weld.
4. The CC Hydro™ can be welded using either a double track or triple track set-up. A double track set-up welds parallel seams (Track A and B) in the membrane and creates an air channel for testing but requires a third weld (Track C) to be added later to bond the concrete surfaces together (see steps 9-11). A triple track set-up forms this third weld in conjunction with the other 2 welds in a single pass. The weld type selected requires a different equipment set-up (modification kits available from CC Ltd) but the calibration and air-channel testing procedure described in the following steps is otherwise identical.

CC Hydro™ section

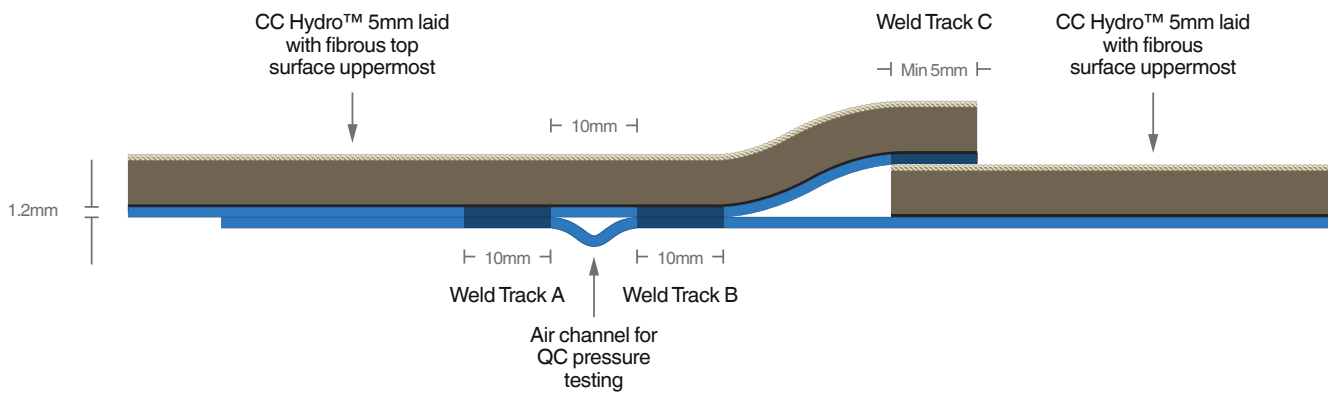


*Geosynthetic Cementitious Composite Mat

Double Track Weld



Triple Track Weld



Trial Welds

5. Complete a trial weld before commencement of field welding. Trial welds should be conducted as a minimum at the start of each day and preferably after every 4 hours of operation or following any period of machine shut down or change of operator.

6. Follow the welding equipment manufacturers recommendations on machine set-up (may vary depending on ambient temperature and humidity). Recommended starting settings for Leister Twinny T and S: Speed = 1.5 Heat = 4.5. Clamping pressure on the pinch rollers should be finger tight. NOTE: Over tightening of the pinch rollers may result in 'splaying' of the weld.

7. Weld a minimum length of 2m and conduct pressure testing as described in 'Air-channel Testing'.

Air-channel Testing

8. Air-channel testing is the recommended method of performing non-destructive testing to verify the strength and impermeability of a thermally welded joint. The test method and pressures below are in accordance with ASTM D-7177 and will effectively test the joint strength to 2.6 kN/m (15lb/in) width minimum peel strength.

8.1 Seal both ends of the continuous air channel with a clamp and carefully insert the test needle directly into the air channel. You may find it useful to mark a line on the blue membrane identifying the location of the air channel to prevent misalignment.

8.2 Connect an air supply to the test needle and pressure gauge and pressurise the air channel to the pressure appropriate for the sheet temperature (see table below). Sheet temperature may be assumed



Air-channel Testing continued...

to be equal to ambient temperature if the material has been stored in ambient conditions long enough for the temperatures to equalise.

8.3 Maintain the minimum pressure (see table below) from the source for a minimum of 30 seconds.

8.4 Inspect the joint from the end opposite the needle for complete inflation. If the joint completely inflates and there is no audible or visible evidence of air leakage, the joint passes the test.

8.5 If the channel will not pressurise there is a leak in the joint, provided air is not leaking at the clamp or test needle interface, then:

Inspect the joint from the end furthest from the needle and locate the leak area normally detectable by sound. Another technique to locate a leak is to have an additional clamp and at 3m increments clamp off the channel to locate the air leak. Because of the flexibility of CC Hydro™, a wrinkle can be made in the seam area and folded over on itself and clamped.

8.6 At completion of the test, open the air channel at the end opposite the test needle. Air should rush out and the pressure gauge should register an immediate drop in pressure, indicating that the entire length of the seam has been tested (if not there is a blockage in the joint).

8.7 It is suggested to mark both ends of the joint with the inspector's initials, joint identification letter or numbers, or both, length inspected, date, sheet temperature and test pressure.



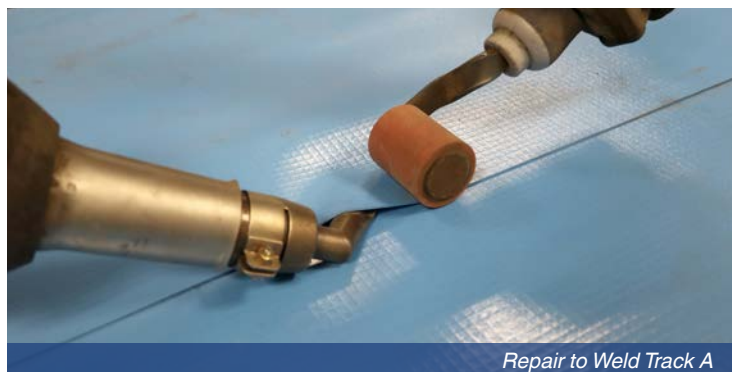
CC Hydro™ Air-channel testing

Sheet Temperature (°C)	Sheet Temperature (°F)	Double Weld (16mm Air Channel)			Triple Weld (10mm Air Channel)			Hold Time (seconds)
		Air Pressure (kPa)	Air Pressure (psi)	Air Pressure (bar)	Air Pressure (kPa)	Air Pressure (psi)	Air Pressure (bar)	
4.5	40	414	60	4.1	662	96	6.6	30s
7	45	386	56	3.9	618	90	6.2	30s
10	50	358	52	3.6	573	83	5.7	30s
13	55	324	47	3.2	518	75	5.2	30s
15.5	60	290	42	2.9	464	67	4.6	30s
18	65	276	40	2.8	442	64	4.4	30s
21	70	248	36	2.5	397	58	4.0	30s
24	75	234	34	2.3	374	54	3.8	30s
26.5	80	200	29	2.0	320	46	3.2	30s
29.5	85	186	27	1.9	298	43	3.0	30s
32	90	172	25	1.7	275	40	2.8	30s
35	95	165	24	1.7	264	38	2.6	30s
37.5	100	152	22	1.5	243	35	2.4	30s
40.5	105	138	20	1.4	221	32	2.2	30s
43.5	110	131	19	1.3	210	30	2.1	30s

Corrective Action

9. Air Channel Blockage - Clamp at the blockage and test in both directions. Due to the flexibility of the geomembrane used in CC Hydro™, inflation of the air channel up to the blockage is easily visible. Therefore releasing the air pressure at the testing device is acceptable in this situation.

10. Weld - When a weld failure is detected the joint should be retested on both sides of the failure if the two parts pass then repair the weld failure point as described in sections 11 & 12.



Repair to Weld Track A

Repair Procedure

11. Weld Track A. Access to the membrane should be made by flipping the material so that rear face is exposed. If possible the faulted area should be re-welded using the 5mm or 20mm slot nozzle. If this is not possible the area will need to be patch repaired, by cutting back to remove all imperfections and overlaying with a single piece of compatible geomembrane to give a minimum overlap of 100mm in all directions from the failure point. The patch material should have rounded corners and bonded onto the surface of the geomembrane using the hand held heat gun and slot nozzle. This method can also be used to repair damage to the body of the geomembrane.

Concrete Canvas Ltd can supply additional rolls of geomembrane for patching purposes.

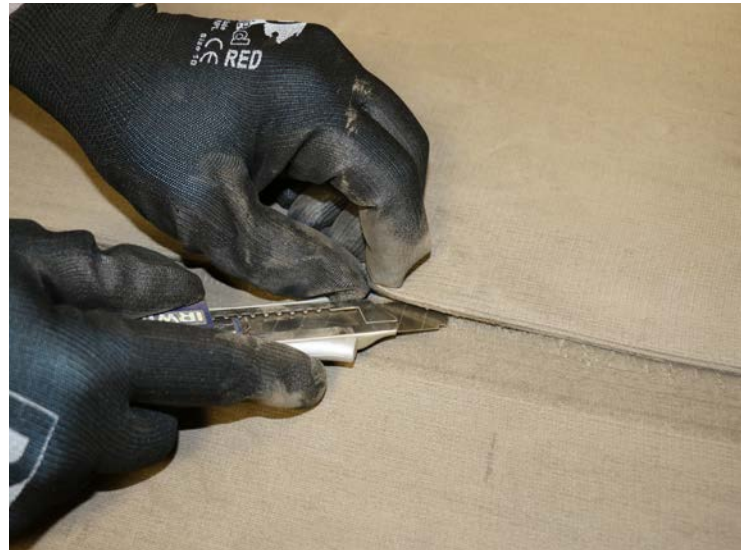
12. Weld Track B. Repairs to Weld Track B can made by accessing the weld from the top face of the material (fibrous side). If a triple track weld has been used, the concrete overlap (Weld Track C) will need to be carefully cut open to provide access to Weld Track B.

The nozzle of the hand-held heat gun should be inserted between the concrete overlap of the affected area and the damaged weld carefully re-welded. A 5mm or 20mm nozzle should be selected depending on size of the repair to be made.

A steel plate or rule can be used to prevent damage to the surface fibres from the hot metal parts of the thermal welder when completing this repair.

Welding Cut Edges

13. It may be necessary to weld cut edges of CC Hydro™, such as when creating pie joints, or when welding the ends of a roll where there is no welding strip. For these situations, Concrete Canvas Ltd can supply geomembrane in 200mm wide strips which can be welded, using the standard method described above, onto the edge to be joined. The CC Hydro™ can then be thermally welded as standard.



Repairs to Weld Track B can made by accessing the weld from the top



Weld Track C would need to be opened carefully to access Weld Track B



Welding on a 200mm strip



A steel rule can be used to prevent damage to the fibrous surface

Creating the 3rd weld (Track C) using a hand-held heat gun

14. If a double weld set-up has been used to create the thermal welded joints, then it is necessary to bond the concrete surfaces together using a hand-held heat gun. This 3rd weld (Weld Track C) is important as it creates a continuous concrete protection layer over the geomembrane and prevents debris and sunlight entering the joint and potentially damaging the liner.

15. This 3rd weld should be applied after the double weld has been completed but must be done prior to hydration. A hand-held heat gun with closed loop temperature feedback and fitted with a perforated slot nozzle should be used. Additionally, a rubber coated roller may be used as a means of applying pressure to the joint immediately after welding.

16. Position the welding nozzle just inside the joint, with the nozzle perforations upper-most, directing the hot air onto geomembrane. Working your way from one end of the joint to the other, follow the welder with the roller to apply pressure to the softened PVC and top fibres to form a bond. Weld rate is approximately 1m/min. Leave the welded joint to cool for approximately 5 minutes prior to applying any load.

17. As with the standard weld, a trial weld should be conducted prior to commencement of a field weld in order to set weld temperature and speed. A successful joint is indicated by failure in the material, rather than that of the weld when loaded to failure.

Other Useful Guidance

18. When deploying the CC Hydro™, care should be taken not to over tension the product during the laying process as this may create stretch marks or wrinkles to be visible when set.

19. When welding CC Hydro™ on top of a soft substrate it is recommended to use a 'skid' made from a spare strip of geomembrane. This can be placed underneath the joint prior to welding in order to ease the path of the welding equipment and prevent it from 'digging-in' to the ground.

20. Routine maintenance of the welding equipment is required and particular attention should be paid to the hot air nozzle which should be regularly cleaned with a wire brush to prevent the build-up of PVC residue.

20. Sandbags can be used to ensure joints lie flat to the substrate on undulating ground to prevent voids from forming underneath the CC Hydro™.

21. For complex areas and junctions the geomembrane can be jointed using a hand-held welder or using a PVC solvent. It is recommended to form 'boots' for pipe penetrations on site using a hand-held heat gun and slot nozzle.

22. Concrete grout can be used in tandem with thermal welding to aid with jointing around upstands or other infrastructure.

23. For detailed guidance on mechanical attachment of CC Hydro™ to penetrations and structures refer to ASTM D-6497.

24. On large projects, it is recommended to cover the last strip of unhydrated CC Hydro™ at the end of the day (eg with a plastic tarpaulin) to protect it from moisture or rainfall which may cause partial hardening and impinge on the next phase of welding work.



A Hand-held heat gun with 40mm slot nozzle & a 45mm seam roller



A trial weld should be conducted prior to commencement of a field weld

25. Personnel should not wear damaging shoes and trafficking of laid CC Hydro™ should be kept to a minimum to avoid staining of the surface, particularly with wet footwear.

26. Do not allow heavy vehicular traffic directly on CC Hydro™ unless the subgrade has been prepared with sufficient surface modulus to support vehicle traffic without causing rutting. In which case rubber-tired ATVs and trucks are acceptable on unset CC Hydro™ if wheel contact is less than 55 kPa.

27. A stiff brush can be used to clean the surface of CC Hydro™ prior to hydration in order to remove footprints, dust accumulation and prevent staining on the set material.

28. When powering down the automatic or manual thermal welders it is recommended to turn off the heating element whilst allowing the air to remain running in order to cool the element and avoid damage.

29. This guide is intended to provide an overview of thermal welding of CC Hydro™, however, it is not exhaustive and is intended for guidance purposes only. It is always recommended that installation is carried out by a fully trained and qualified thermal welding technician (eg a level 1 to EN 13067: CSWIP 7.4 and 7.5 or equivalent with a minimum of 2 years geomembrane welding experience).

Wear heavy gloves and a mask (A2P3 filter or equivalent) as the Geomembrane will be hot and will give off fumes. Only thermally weld CC Hydro™ in a well ventilated area.