INSTALLATION GUIDELINES

DuoGuard™ Hybrid Anode System

IMPORTANT: This installation methodology is an outline. Modifications may be required to reflect local site requirements.

Equipment Checklist

Drill, 30mm (1¼") drill bit, cover meter, multimeter, saw cutter, concrete breaker, rivet gun, wire strippers, water spray, paper roll/rag, tape measure, 12mm (½") ring spanner, sharp knife, caulking gun, hose extension and appropriate PPE.

Preliminaries

The structure should be assessed prior to installation of the DuoGuard Hybrid Anode system as follows:

Steel reinforcement size and location should be established using all available drawings and recorded information. Concrete cover to the steel reinforcement should be a minimum 20mm (⅞") for the installation of DuoGuard anode system. Depth of concrete to be treated should be a minimum 50mm (2") greater than the specified anode.

Confirm steel continuity in areas to be treated. Measure the electrical resistance between reinforcing bars in mutually remote locations across the structure and between reinforcing bars exposed during concrete repairs or other works.

This work should follow the method and acceptance criteria as specified in BS EN ISO 12696:2016, clause 7.1.

Installation

1. With reference to available drawings, undertake a reinforcing steel survey using a cover meter and mark out the surface to identify:

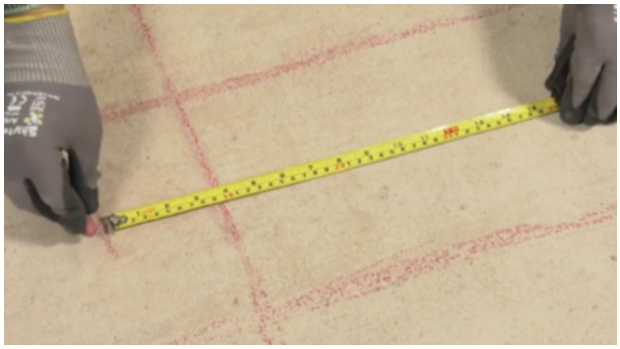
a) Steel reinforcement configuration

b) DuoGuard anode locations

c) The position of saw cuts

d) Reference electrode locations

e) Connection box locations



Identify locations for the temporary power supplies.

2. Drill 30mm (1¼") diameter holes of the required depth (see table) at the marked locations.

Product	Hole Diameter	Hole Length
DuoGuard 100	30mm (1¼")	62mm (2½")
DuoGuard 175	30mm (1¼")	72mm (2⅞")
DuoGuard 350	30mm (1¼")	110mm (4¼")
DuoGuard 500	30mm (1¼")	145mm (5¾")
DuoGuard 750	30mm (1¼")	200mm (8")
DuoGuard 1000	30mm (1¼")	255mm (10")

3. Cut 4mm (3/16") wide x 15mm (⅝") deep chases at marked locations between holes, for recessing of red titanium anode feeder wires and black titanium steel connection wires.

Ensure that no reinforcing steel is exposed within the holes and saw cuts as this has the potential to cause electrical shorts.

Holes and saw cuts shall be fully cleaned out prior to continuing with the installation.

4. Make electrical connections to the reinforcing steel.

Remove a small area of cover concrete before drilling a 4mm (3/16") hole into the exposed steel.

Use a stainless steel rivet to connect the XLPE insulated black copper titanium wire to the steel.

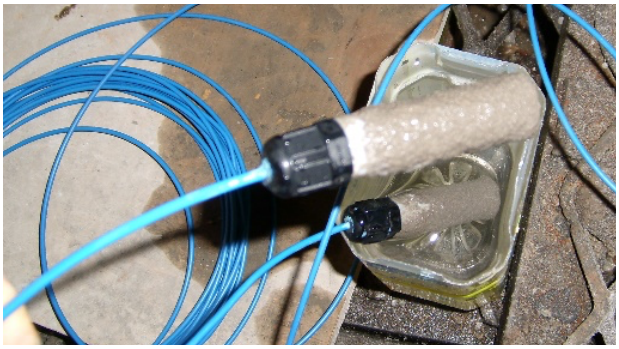
Clean excavations of all debris.

At least two steel connections shall be made per zone of anodes.

5. Position temporary power supplies in a protected location, preferably out of the way, where they will not be damaged.

6. Pre-soak CPT MN15 reference electrodes in saturated lime water and install at marked locations into typically 105mm (4⅛”) deep x 30mm (1¼”) diameter pre-soaked holes, using a suitable bedding mortar. Run the cabling back in 20mm (⅞”) deep x 7mm (¼”) wide saw cuts to the appropriate terminal within the connection box.

Note: refer to reference electrode datasheet and record the ID of the reference electrode prior to installation.

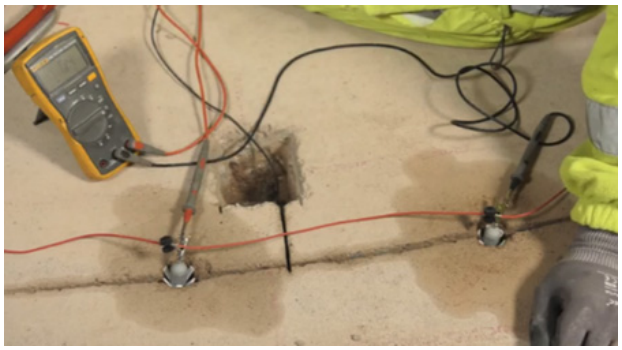


7. Remove dust and debris and then, using a spray bottle or other suitable method, wet out the anode holes for a **minimum of 15 minutes** ensuring that any excess water is removed prior to application of the SD mortar.

8. Using wire strippers, strip the coating from the red insulated titanium feeder wire at the locations where the anodes are to be fixed. With the DuoGuard Anodes positioned in the holes electrically connect the individual units to the titanium feeder wire using the plastic screw connectors.

Carefully tighten the connectors with a 12mm (½") multi-tooth ring spanner/socket. Twist the excess wire from the DuoGuard units around the titanium feeder wire (as shown) to ensure electrical continuity.

Check the connection between the DuoGuard anodes and the feeder wire by using a multi meter to ensure a resistivity of 0.5 ohm or less.



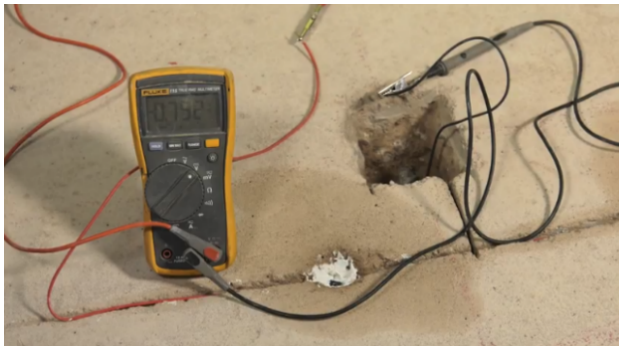
9. Remove the DuoGuard anodes from the holes. Using a caulking gun and a rubber hose extension apply DuoCrete SD mortar, ensuring that any trapped air is removed as you progress. Squeeze the caulking gun trigger a couple of times to expel any watery material before proceeding. Fill the pre-drilled holes approximately half way up with the mortar.

DuoCrete SD mortar should only be applied and cured at a temperature greater than 5°C and rising.

10. Insert the DuoGuard units into the mortar. The mortar should flow to ~20mm (⅞”) from the concrete surface. The plastic screw connector must be 20mm (⅞”) below the concrete surface.

Note: The DuoGuard anodes should be installed immediately after injection of the DuoCrete SD mortar.

11. Check the installation for electrical shorts by measuring the electrical potential between the reinforcing steel and the DuoGuard units using a high impedance voltmeter during installation. The potential difference should be greater than 300 mV and stable.



12. The remaining void at the top of the anode hole shall be filled with a low shrink repair mortar within **2 hours of installation**.

All wiring and cable chases, and excavations where steel connections have been made, should be cleaned, pre-soaked and filled with an appropriate low shrink concrete repair mortar.

13. Connect the red anode feeder wires, black steel connection wires and, where applicable, blue reference electrode cables to the appropriate terminals in the connection box.

Connect the positive and negative connections from the temporary power supply to the relevant terminals in the connection box, incorporating an appropriate resistor within the circuit. Rechargeable battery or rectified mains power can be used.

14. Activate the power supply within 2 hours of installation of the DuoGuard anode units.

Undertake a polarity check and record the data. The steel potential must shift more negative relative to the reference electrode. If the potential moves to a more positive potential relative to the reference electrode then the current should be disconnected immediately and professional advice sought. A method statement must be provided by the contractor.

Polarity check data will be recorded for all zones of DuoGuard application. Record number of tests undertaken and detail any areas which fail the test prior to rectification.

Note – A method of obtaining a polarity check is to place a surface reference electrode adjacent to a DuoGuard unit and observe the change in potential registered as the impressed current is applied. Ensure that the reference electrode is in the COM terminal for polarity checks.

15. Activate the power supply for a minimum of 1 week. If rechargeable batteries are used, exchange battery power units on a daily basis or as necessary to maintain charge capacity in excess of 50% (ensure that replacement batteries are kept fully charged). The voltage and current output for each zone shall be recorded on a daily basis as per the example below. A method statement must be provided by the contractor.

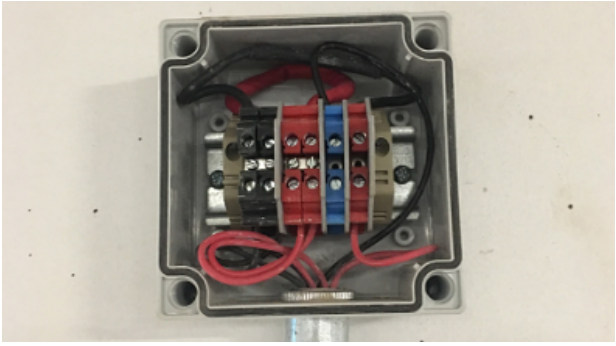
Zone	Date connected to power supply	Date disconnected to power supply		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
1	*04/03/17*	*14/03/17*	Voltage (V)	*12.1*	*12.1*	*12.0*	*12.0*	*12.0*	*12.0*	*11.9*	*11.9*	*12.0*	*11.9*
			Current (mA)	*600*	*512*	*488*	*423*	*411*	*388*	*374*	*358*	*350*	*348*

A copy of this data should be forwarded to the Engineer/Client and Concrete Preservation Technologies Ltd.

Note: To determine the voltage of the power supply, use a voltmeter to direct read from the terminals.

A typical method of measuring the current delivered from the power supply is to measure the voltage drop across a 0.1 Ω resistor placed in series with the circuit.

16. When sufficient charge has been passed, disconnect and remove the power supply and connect the DuoGuard anodes directly to the steel reinforcement across an appropriate resistor within the connection box.



17. The DuoGuard units are now operating in galvanic mode.

18. Clean the treatment area. The installation phase is now complete.

Additional Information

Any unusual site details should be discussed with the engineer/CPT prior to installation of the system.

Process Monitoring

Visual inspection

Before the DuoGuard hybrid anode system is connected to the power supply for the impressed current, the installation and all its component parts shall be subjected to a complete visual inspection to check they are installed correctly, labelled and protected from environmental, human and animal damage.

Routine inspection and maintenance

Routine inspection shall be carried out at least once a day. The following checks shall be carried out and the data recorded:

Phase 1 – Impressed current

1) Confirmation that the power supplies are functioning correctly and have sufficient charge capacity for the impressed current treatment.

2) Measurement of current delivery to each treatment zone.

3) Visual checks of cable insulation and anode connections to confirm their proper function.

Phase 2 – Galvanic protection current

Confirmation of galvanic activity after the 1st phase impressed current treatment may be undertaken by measuring current between the DuoGuard anodes and the reinforcing steel after a period of 24 hours after disconnection of the power supply. A protective current will be observed from the DuoGuard anodes.

Steel Corrosion Rate Measurement

This method uses the applied current density of a segment of the anode system and the steel potential shift achieved from application of the galvanic current to calculate the open circuit steel corrosion rate. The rest of the DuoGuard system should remain connected in sacrificial anode mode to act as a guard ring to the DuoGuard anode group to be tested.

Small or large perturbation techniques can be utilised in measuring steel corrosion rates, the former identified with the polarisation resistance method and the latter using larger potential perturbations as detailed elsewhere (G.K.Glass, A.C.Roberts and N.Davison, 'Criteria for novel electrochemical treatments of steel in concrete', Proceedings of the 7th International Conference on Concrete in Hot and Aggressive Environments, Volume 2, p.477-492, 13-15 October 2003).

Corrosion rates less than 1-2 mA/m2 (less than -2µm of steel section loss per year) are in general deemed to be negligible rates obtained on passive steel. (See Corrosion, Vol 55, 1999, Page 286).

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