DINCEL STRUCTURAL WALLING

STRAY CURRENT CORROSION PROTECTION

1. INTRODUCTION

IF YOUR BUILDING IS NEAR A RAILWAY LINE, READING THIS DOCUMENT WILL SAVE SIGNIFICANT COST AND TIME.

Undesirable stray current corrosion has been mainly associated with the following:

- Electrical rail transit systems (e.g. railways, street trams).
- Buried structures which are influenced by different Corrosion Protection Systems (CPS). While the CPS applied to a building structure or pipeline protects the structure from corrosion, it may however cause corrosion to a third party structure. This means that it can cause damage to other buildings or pipes nearby. This poses a significant risk to major assets. The main CPS types are:
  - Cathodic Protection Systems.
  - Drainage bonds (capturing and diverting stray current from railway lines).
  - Transformer Rectifier Assisted Drainage (TRAD – powered automatic drainage bond).
  - Cross bonds (draining stray current from one structure to another).

  For further information refer Reference No: 1
- Mining, manufacturing operations, direct current welding equipments, microelectronics, etc.

This document deals mainly with direct stray current corrosion issues associated with electrified rail transit systems. Stray current corrosion problems can arise in DC traction systems in which the rails act as the primary current return path.

For practical purposes, it is virtually impossible to insulate these rails completely from the ground. The ground surrounding the rails and any metallic structures buried in it represent a conductor that can carry stray current.

2. THE PROBLEM

2.1 BACKGROUND

Railways or trams in Australia use direct current to operate the traction system. The current is delivered by the overhead catenary cables and the return path to the sub station is via the track. The track is not insulated from earth, principally because of the difficulty of achieving insulation and secondly, for safety reasons. Whilst the steel track is large in cross section, some of the current leaks from the tracks find alternate paths back to the sub station.

All current obeys Ohms Law and if a low resistance metallic structure exists in the path of the "stray" current, this can pick up the stray current which then flows along the structure to a point close to the sub station, where it discharges back to earth, and ultimately returns to the sub station.

Where the "foreign" structure picks up the stray current a small measure of corrosion control or "cathodic protection" is achieved. However, where the current discharges from the foreign structure back to the soil, corrosion of the foreign structure occurs as shown on Figure 1.

[1] Review of New South Wales Corrosion Protection Regulation – July 2010:

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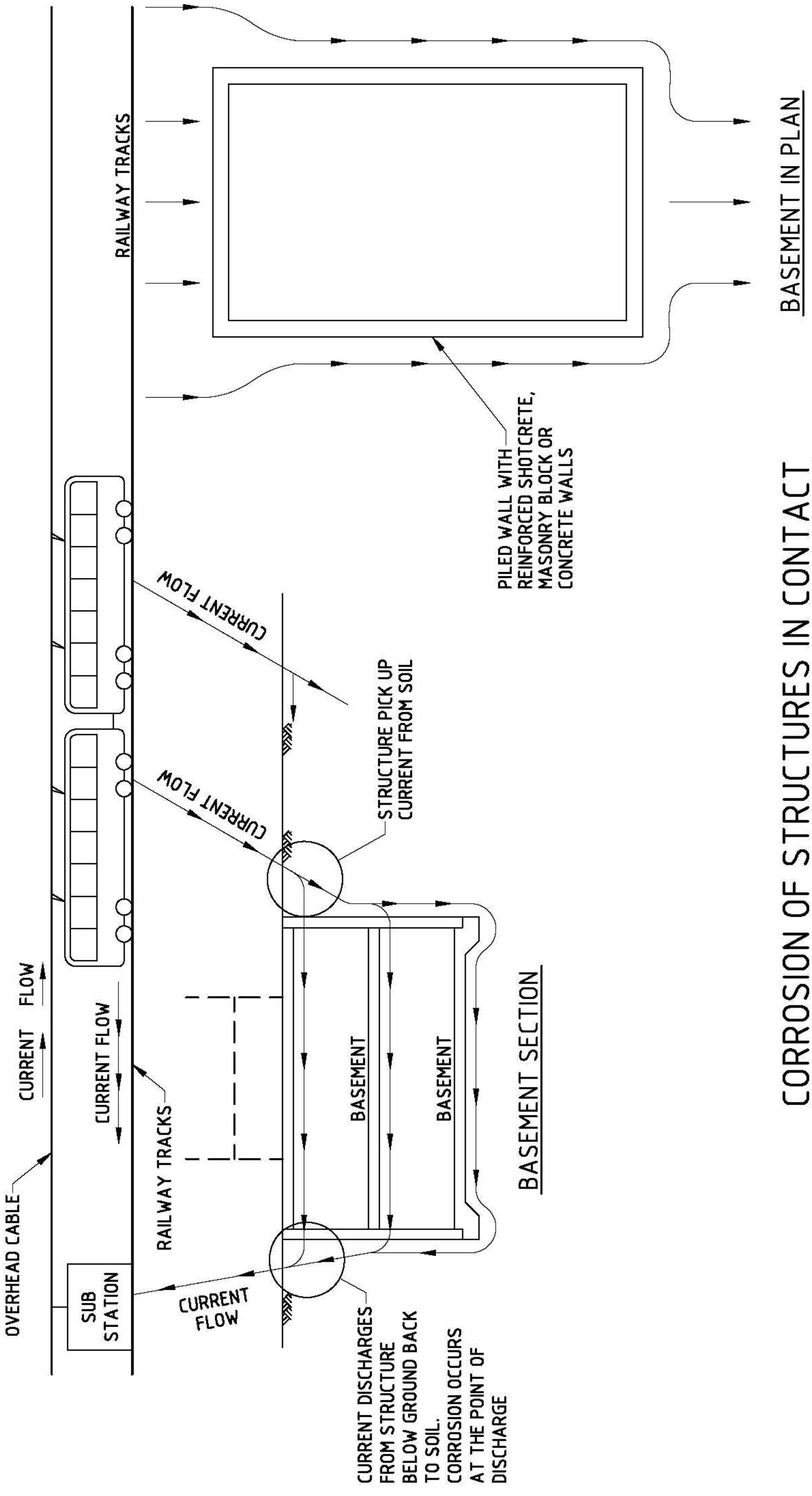

CORROSION OF STRUCTURES IN CONTACT WITH GROUND DUE TO STRAY TRACTION CURRENT

BASEMENT, STORAGE TANKS, PITS, DRAINS CULVERTS, PIPES, BUILDING FOUNDATIONS

FIGURE 1

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2.2 CORROSION HAZARD FROM STRAY TRACTION CURRENT

Direct current as used by the traction system can cause serious corrosion to underground metallic services and the steel reinforcement of concrete. Stray traction current flowing in the ground can be picked up by the steel reinforcement, one side of the development as shown on Figure 1, flow along the structure and discharge back to the soil on the opposite side of the building. At the discharge point of the current, corrosion of the reinforcement will occur with conventional construction systems if the basement walls are not insulated from the surrounding ground with a PVC based waterproof membrane systems.

For a building, the most common means of eliminating the corrosion hazard from stray traction current is to increase the electrical resistance of the concrete to the ground. This prevents the flow of stray traction current through the reinforcement.

Increasing the electrical resistance of the structure to ground for an on-ground slab is automatically achieved by the moisture barriers installed to prevent water entry into the structure. The moisture barrier is an electrically insulating membrane.

The same is achieved if DINCEL-WALLS are used in below ground walls. DINCEL-WALLS consist of PVC based polymer formwork and concrete infill. DINCEL-WALLS are similar to the vapour barrier of the slab-on-ground which insulate the reinforcement within the basement walls. The waterproof Dincel polymer encapsulation **(Download – Waterproof Walls)** achieves electrical insulation to the steel reinforcement in the basement perimeter walls. Therefore, Dincel-Walls allow total isolation of stray traction current from the surrounding soil.

Where the structure is supported on pad and/or piered footings, increasing the resistance of the structure to ground can be achieved by either:

(a) Applying moisture barrier to the excavation into which the pad footings or piers are poured.

(b) If installation of moisture barriers into the excavation is impractical, i.e. for piered footings, these can be insulated from the structure by the application of insulating sleeving to the starter bars where they tie into the building reinforcement.

(c) **(Download – Basement Construction)** for detailing of Dincel Construction System in below ground conditions.

3. MITIGATION OF STRAY CURRENT

There are a number of options to deal with the potential corrosion problems which can result from stray traction current. These include:

(a) Prevent or reduce exposure of the structure to stray traction current.

(b) Install a mitigation system to offset the problem.

In the case of the latter this is an expensive approach as it requires the establishment of infrastructure necessary for the mitigation of the problem.

3.1 ELIMINATE OR REDUCE EXPOSURE TO STRAY TRACTION CURRENT

The simplest approach is to avoid exposure of the structure to stray traction current. Two approaches, which can be adopted, are:

3.1.1 REDUCE LENGTH OF STRUCTURE IN ALIGNMENT WITH TRACTION CURRENT PATH

As noted in Section 2, the hazard from stray traction current is due to the current flowing onto and then off the metallic structure or steel reinforcement of the concrete structure. Corrosion occurs at the point of discharge of the current back to the soil.

The hazard from the stray traction current increases as the length of the conducting service increases. Stray traction corrosion is a problem because the metallic service presents a lower electrical resistance path to current flow than the alternative path through the earth.

Accordingly the shorter the length of the metallic structure the less likely it is to be affected by stray traction current.

This provision of reducing the length of the building's basement structure most often will not be possible due to the architectural or feasibility requirements of the development. However, the presence of DINCEL-WALLS eliminates the need for this provision.

3.1.2 ISOLATE THE STRUCTURE FROM STRAY TRACTION CURRENT

The effects of stray traction current can be avoided by increasing the resistance of the structure to the soils in which stray traction current is flowing. This can be achieved by use of moisture barriers such as DINCEL at the walls and polymer vapour barriers (e.g. fortecon membrane) under the slabs on ground which provides an electrically insulating membrane which prevents entry of stray traction current. Even if the membrane is damaged, it will still provide sufficient resistance to prevent entry of stray traction current. (Fortecon membrane thickness is about 0.15mm; DINCEL-WALL membrane thickness at each face is 2.5mm which cannot be easily damaged in comparison to the fortecon membrane).

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3.2 STRAY TRACTION CURRENT MITIGATION

Stray traction current mitigation is achieved by providing a low resistance path from the structure to allow discharge of any stray traction current directly back to the rail.

Provision of a mitigation system involves the following:

(a) The reinforcement of the concrete has to be made electrically continuous. This involves track welding all members of the reinforcement cages.

(b) Testing has to be undertaken to provide evidence to the Railway Authority that a stray traction current corrosion hazard exists.

(c) If the testing identifies a corrosion hazard to the steel reinforcement does exist, installation of a "railway drainage bond" can proceed.

It is known that installation of a mitigation system is a particularly time consuming and expensive option. As a result, this option is used in tunnels rather than in building structures due to testing requirements and the steel reinforcement quantity and complexity, hence related costs.

4. SOLUTIONS

4.1 CONVENTIONAL SOLUTIONS OFFERED AND THEIR INADEQUACIES

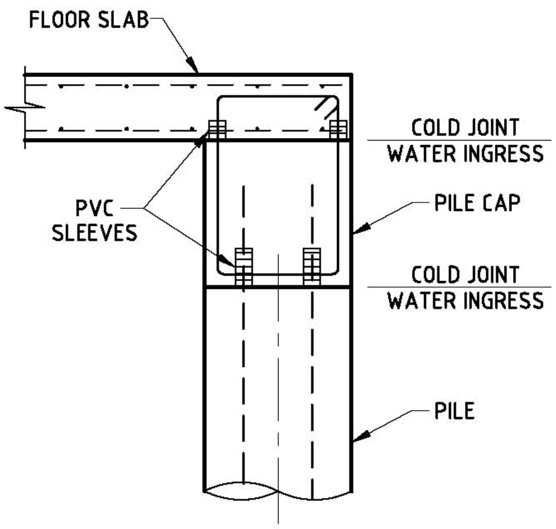
The conventional solutions may consist of the following.

The basement excavation may consist of the following solutions:

(i) Reinforced masonry block-walls or reinforced concrete walls at the basement periphery.

Stray current corrosion in these walls is unavoidable due to the presence of horizontal steel reinforcement. The solution is to have a rubber type (less susceptible to damages during construction) waterproof membrane to insulate the earth face of the subject walls. Refer Figure 4.

(ii) Discrete piles with shotcrete walls at the basement periphery.



SECTION AT PILE CAP OF FIGURES 2 & 3

• IT IS COMMON THAT FLOOR SLABS AND PILE CAPS ARE NOT POURED AT THE SAME TIME

• IT IS DIFFICULT TO PLACE TOP MOST PVC SLEEVES

- Water ingress is unavoidable at the cold joints of the pile cap; isolate steel reinforcement with PVC sleeves.
- The high strength concrete at the pile caps and piles (i.e. lesser porosity) would not work as a solution as:
  - ➤ The water ingress at the cold joints is unavoidable.
  - ➤ It will be unrealistic to assume that the concrete cover and steel/concrete placement in the piles will achieve the intended purpose in each instance.

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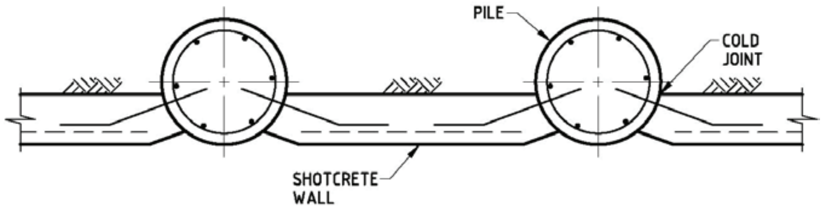


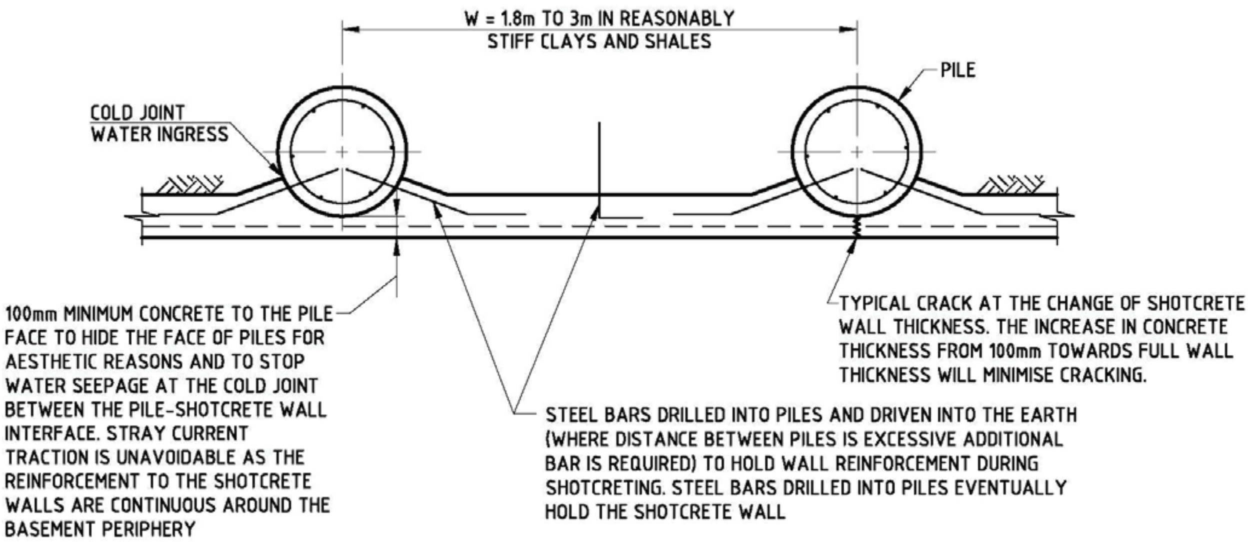
SHOTCRETE WALL IN BETWEEN PILES

FIGURE 2

Stray current will not be carried by the shotcrete wall of Figure 2 since the shotcrete wall reinforcement is not continuous.

The above detail of Figure 2 in construction is rarely adopted for the following reasons:

- Minimum 100mm concrete over the pile face is placed to hide the pile face (i.e. aesthetic reason) and minimise the water seepage through the cold joint between the pile-shotcrete wall interface.
- Figure 2 requires additional detailed excavation in between the piles. This results in time consuming and expensive construction.
- The placement of shotcrete walls will be impractical for piles spaced at close distances to each other. The contiguous and secant piles receive shotcrete on the face of the piles.
- Additional chamfering is required where the shotcrete wall joins the pile; otherwise fretting at the edge of the concrete will result in a very untidy look.



TYPICAL PILE-SHOTCRETE WALL
SHORING DETAIL IN CLAY/SHALE TYPE SOILS

FIGURE 3

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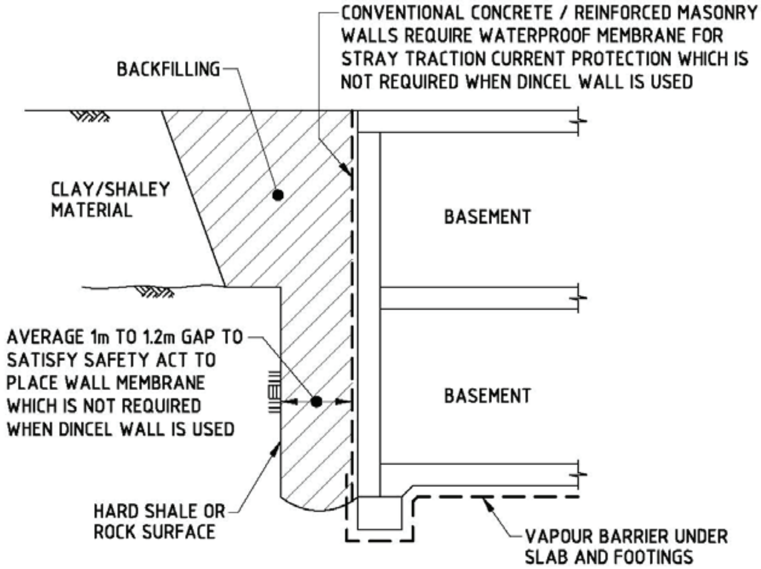
4.2 SOLUTION USING DINCEL-WALL

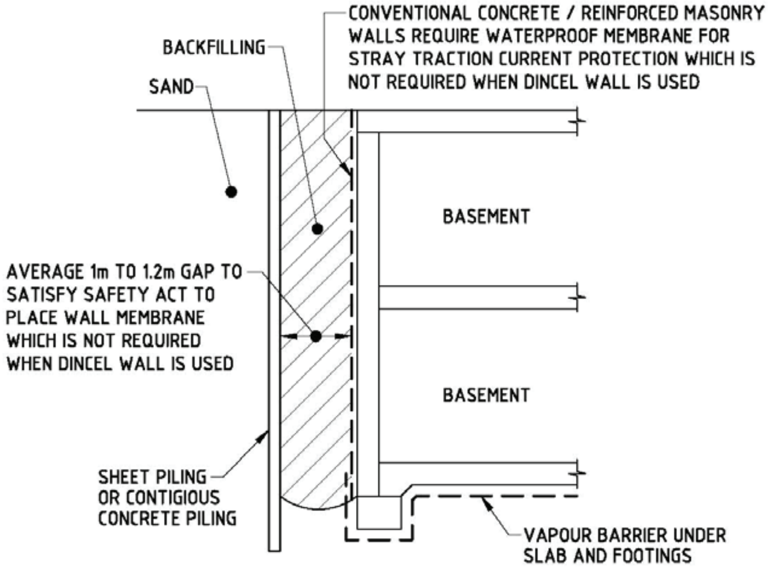
(i) Ground conditions may allow battering the excavations as shown in the figure below. This will allow the use of DINCEL-WALLS around the periphery of the building. **(Download – Basement Construction)**.



CONVENTIONAL BASEMENT
IN COHESIVE SOILS

FIGURE 4

(ii) Sandy ground conditions. The most cost effective excavation solution incorporates sacrificial or temporary sheet piling. The sheet piling technology has been significantly developed in recent years to allow hydraulic rams to push the sheet piling into the sand rather than hammering which may cause vibration and cracking in nearby structures. This type of shoring system incorporates the installation of DINCEL-WALLS after the erection of the shoring system.



CONVENTIONAL BASEMENT
IN NON-COHESIVE SOILS

FIGURE 5

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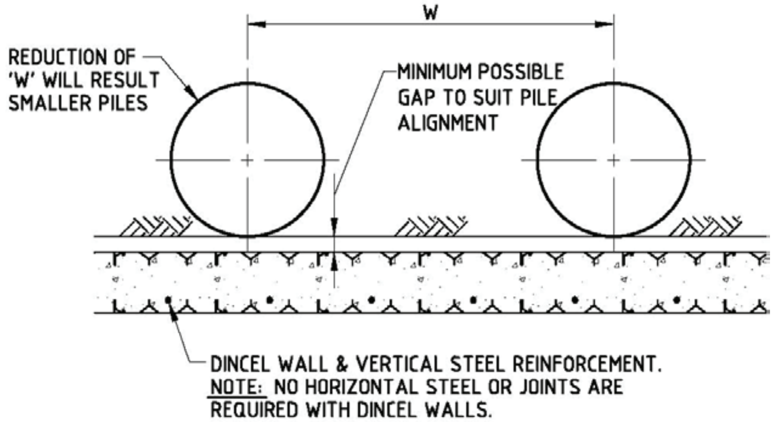
(iii) Clay-shale type of soils may consist of basement excavations either by ground battering or shoring system as shown in Figure 4.

The following may be incorporated as a solution to the problem identified.



ALTERNATIVE SHORING SYSTEM IN CLAY/SHALE TYPE SOILS

FIGURE 6

- Consult with the Geotechnical Engineer to reduce the **W** dimension shown in **Figure 6** to suit so that the ground can be excavated to its full excavation depth without the need of a shotcrete wall. If necessary, provide 50mm thick shotcreting in between the piles to prevent the moisture loss of exposed face of excavation.
- Alternatively, soil nailing at suitable soil conditions (refer geotechnical engineer) may be used in lieu of shoring with piles.

5. CONCLUSION

The isolation of the structure from stray current and its corrosive effects is clearly the most cost/time effective solution when structures below ground (buildings, tanks, pits) incorporate DINCEL-WALLS.

Dincel-Wall provides complete insulation against any direct electrical current.

DISCLAIMER

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