

TECHNICAL NOTE

TECHNICAL INFORMATION FROM THE CONCRETE PIPE ASSOCIATION OF AUSTRALASIA

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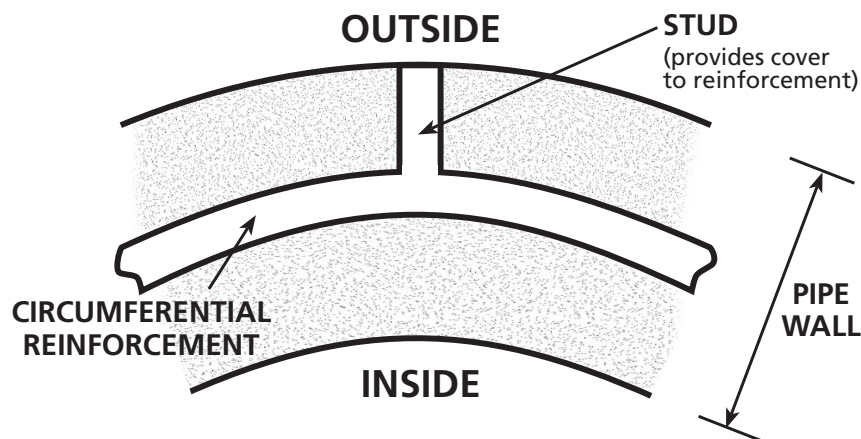
STEEL STUDS AND DURABILITY

In the manufacture of concrete pipes, cover to steel reinforcement is usually controlled by spacers, known as studs or nibs. These are attached to the reinforcement cage and extend to the outer surface of the pipe. They are either made from mild steel, or plastic. Studs extend at right angles to the cage and mould wall, ensuring the outermost portion of the cage never comes any closer to the concrete surface than the length of the studs.

The most widely used material for studs, in the production of concrete pipe, is the same mild steel as that for the steel reinforcement cage. These types of studs have been used for decades and have never been found to cause structural or durability issues that impact the service life of concrete pipe.

Diagram 1

Cross section of pipe showing position of the stud



FIELD EXPERIENCE

Field investigations of long serving concrete pipelines in a variety of soil environments show that when exposed to aggressive ground waters, the stud rusts at the tip. As the stud is slowly eaten away from the outer or exposed tip, corrosion products build up over the stud tip and expand out from it. The adherent, dense oxide build up stifles further corrosion and reduces future corrosion rates. It does not cause spalling as it is free to expand out of the stud location.

CORROSION MECHANISMS

Two mechanisms operate to encourage corrosion of the stud at the exposed tip only.

Steel in concrete, when connected to bare steel in the soil (i.e. the exposed stud tip in contact with the ground), sets up a galvanic couple and the resultant potential difference between the two causes the bare steel to become the anode and the steel in concrete the cathode.



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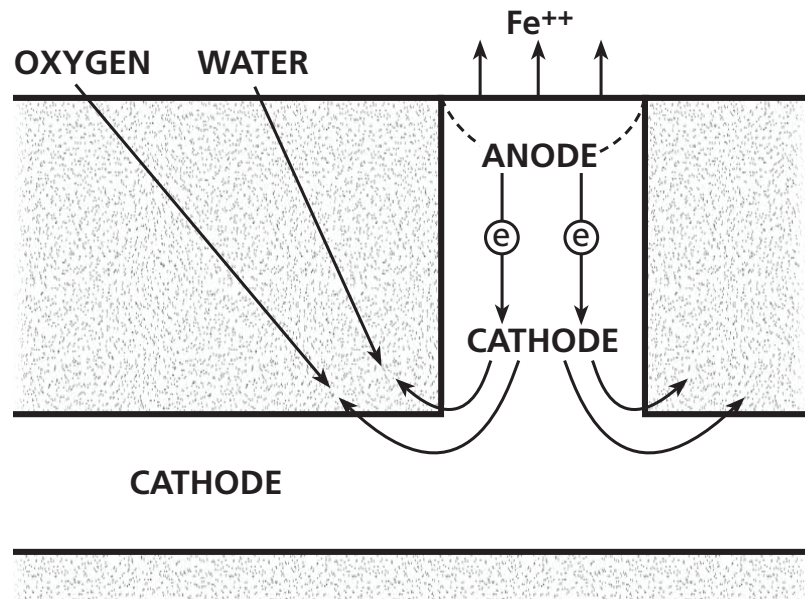
At the anode, steel corrosion occurs:



At the cathode, oxygen and water are converted to hydroxyl ion, increasing the pore water pH:



Diagram 2
Galvanic corrosion
mechanism



The cathode in this instance is the steel reinforcing cage and the body of studs combined, which results in a large surface area. The anode is the stud tip, which has a relatively small surface area. As such any corrosion which occurs at the stud tip can have an abnormally high rate. However, in the dense impermeable pipe concrete this rate is reduced considerably by the relatively high electrical resistivity of the covering concrete, because oxygen diffusion to the cathodic steel is greatly restricted. In practice the corrosion rate is controlled by the diffusion of oxygen through the concrete to the steel reinforcement. In submerged or deeply buried concrete, oxygen diffusion to the structure itself is greatly reduced.

In addition to this "induced" corrosion mechanism, micro-cell corrosion can occur on the exposed stud tip. When oxygen diffusion rates restrict the induced corrosion rate, this process becomes the dominant cause of tip corrosion. Here, general rusting occurs just on the exposed steel surface as micro corrosion cells form under water droplets.

STUD CAPS

In the past it has been required by some specifiers to have plastic or brass caps inserted over mild steel studs to protect them. Capping the spacers has proven to be of no value and in some conditions can be harmful. They can permit groundwater to penetrate down the concrete-cap interface and cause corrosion at the base of the stud, or in the crevice under the cap. Such corrosion deep within the body of the concrete has the potential to cause concrete cracking and spalling in this area. The use of brass caps would set up a galvanic couple with the mild steel that may accelerate corrosion.

CONCLUSIONS

Both field experience and corrosion theory support the use of mild steel studs in all but those cases where rust stains on the concrete surface are not acceptable for aesthetic reasons. Similarly pipes which are cut or broken in two to make junctions, bends or short lengths will have exposed steel, particularly longitudinal reinforcement. It is very rare for corrosion of such exposed steel to penetrate into sound concrete more than a few millimetres and no further corrosion should eventuate.

AS/NZS 4058 recognises the inert characteristics of studs on concrete pipe by stating that the concrete cover requirements do not apply to radial nibs, end spacers and longitudinal reinforcement ends.

