



Hot Dip Galvanized Case Study No. 13 Pressed steel plate water storage tanks

The Application

The concept of liquid storage tanks constructed using hot dip galvanized modular pressed steel plates bolted together on site was originally developed and patented in 1901 by “Braithwaite” in the United Kingdom, an organisation which continues in business to this day.

Two large water storage tanks mounted on structural supports and constructed of the “Braithwaite” design is the subject of this case study. There are many similar installations of this type of tank, but this particular example has been selected in order to examine the corrosion control performance of the hot dip galvanized coating after an estimated service life of more than 70 years.



**Two “Braithwaite” type
tank tanks located on the
rampart of the old
Johannesburg fort, now
the location of the new
Constitutional Court of
South Africa**



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Environmental Conditions

Johannesburg and the Reef have a wide range of atmospheric corrosive environments with pollution from coal fired power stations, industrial areas as well as many informal settlements.

In the early years of Johannesburg the atmospheric corrosive environment would have been classified as severe with possible zinc corrosion rates of 4 to 5 or even in excess 6µm per year.

As the mining town became a city, the atmospheric conditions of this specific site would have improved and can now be estimated at between 1 to 2µm per year.

It is in such a variable atmospheric conditions that our case study tanks have been exposed.

In terms of the variable corrosion rate of zinc over the life of the tank, one can only assume that the average corrosion rate to be in the order of 2 to 3µm per year.

The current corrosion rate would be less than 1µm per year.

The Site

The two case study "Braithwaite" water tanks are situated on the eastern rampart of the old Johannesburg Fort. The tanks comprise the same pressed steel panel plates that continue to be manufactured up until the present day.

In order to attempt to establish when the water tanks and support structures were installed, a short review of the fort is of interest.

Following the invasion of the ZAR in January 1896 by a troop of cavalry led by Dr Leander Jameson, the Executive Committee of the Republic resolved to build a fort on Hospital Hill overlooking the mining town of Johannesburg.

During the course of the Boer War the British captured Johannesburg and took possession of the fort in May 1900.

The fort then served as a prison until it was declared a National Monument, and in 1994 became the site for the Constitutional Court of South Africa.

There is a distinct possibility that the Braithwaite water tanks were ordered from the United Kingdom to provide water for the entire garrison including the new awaiting trial prisoner block (built in 1928), which suggests that the tanks may have been in existence from about 1930.

Should this be correct, then the hot dip galvanizing has performed considerably well for more than 70 years.

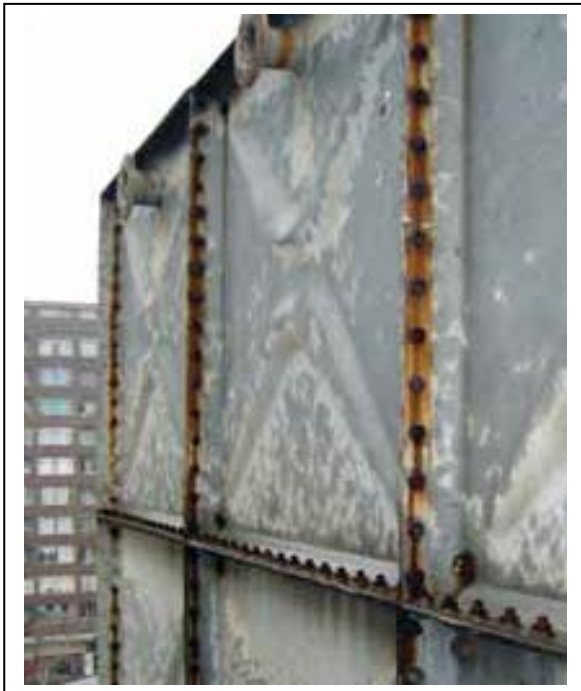
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Findings

The fasteners, assumed to have been hot dip galvanized, are in an advanced state of corrosion with red rust causing discolouration (rust staining) of the hot dip galvanized pressed steel panels. The fasteners remain structurally sound, but require maintenance by over coating or replacement.

Had the original fasteners been hot dip galvanized the zinc coating would have been in the order of 65 to 75 μ m. Assuming the average corrosion of say 2 μ m per year the bolts would have lost all their coating after approximately 30 to 40 years. It is therefore possible that the fasteners may not have been hot dip galvanized or the tank is not as old as first believed.

It is however most important that when fasteners are used to assembly hot dip galvanized steel components, the fasteners must be specified as hot dip galvanized in order to achieve a balanced design.



Photographs of the tanks taken in 2006

Fasteners have corroded to the point where no zinc remains, while the tank plates continue to provide an excellent service

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In 2006 the zinc coating on the pressed steel panels was measured and found to be in a range of 68µm to 91µm. In terms of the assumed service life of more than 70 years, the tanks would have had been originally supplied with a hot dip galvanized coating in the order of 200µm. At the time of supply from the UK this could well have been the norm.

These assumptions further illustrate the need to ensure a balanced corrosion control design between such plates and the fasteners.

Conclusion

Whatever the actual age of the tank and the supporting structure, based on only an external conditions, the service life has been impressive as the installation continues to serve the new Constitutional Court facility. It would be of interest to examine the internal surfaces of the tanks as this aspect remains unknown.

Should maintenance be undertaken, and with specific reference to the fasteners, the installation will continue to provide excellent service for years into the future.

The supporting structure to the water tanks is showing signs of corrosion, but could and should be considered for restoration. Should this process be undertaken, it would afford the authorities with an opportunity to re-galvanize the tank plates and replace all fasteners. Once such a process has been completed the installation would be returned to an “as new” condition.