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GALVANIZED STEEL ON THE COAST

BACK TO THE FUTURE

12 Apostles at Port Campbell National Park, VIC

Editorial
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Prepared by
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Galvanized Steel on the Coast: Back to the Future

Architects, engineers, specifiers and end users often ask for proof of past performance when they are considering materials for use in specific situations. This is a wise thing – the best indicator of future performance is past performance and the longer the material has been performing in a given environment, then all the better.

Everyone has a natural inclination to use the latest product available. In our everyday lives, the latest is marketed as the best. However, communities, asset owners and end users value reliability, ease of use and the minimisation of ongoing costs above all else. Economics, durability, reduced maintenance, the reduction of pressure on finite resources, sustainability and recyclability are all now part of the value chain when decisions on infrastructure and construction are made. In this environment, it is the material that is proven over a long period of time and over a wide variety of applications that is selected.

Hot dip galvanized steel is used in innumerable infrastructure and building applications in Australia. This is increasing due to galvanizing's robustness, relative lack of maintenance, sustainability and recyclability. It is worth reviewing some examples of the history and performance of galvanized steel in one of the most demanding environments – the Australian coast.

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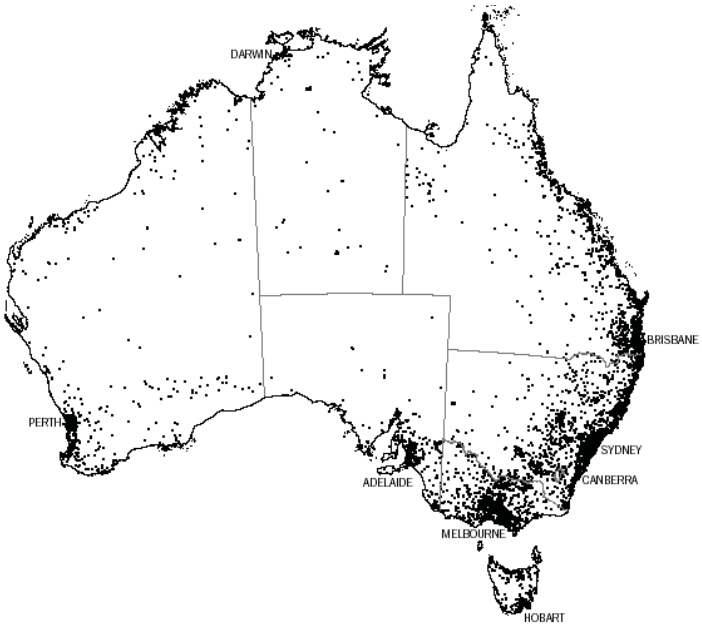
AUSTRALIANS AND THE COAST

Australians are tied to the sea and the coast. We live there, work there and play there.

Australia is a vast continent, however the arid nature of much of its landmass means that most of the population live in concentrated areas. The latest Australian Bureau of Statistics data shows that 84% of the population lives in 1% of the most densely populated area. Most of this area is situated on the coast.



Australian population distribution and density (ABS)

This situation is unlikely to change since people are migrating to the coast to live in increasing numbers, both as a lifestyle choice and as a broader demographic trend dictated by industry and employment. In fact, current predictions by demographers and local governments indicate that this trend will continue and, in all probability, increase.

The increase in the coastal population means that corresponding infrastructure and construction is increasing. Practical, economic and sustainability considerations mean that buildings and infrastructure must be durable and require a minimum of maintenance. The use of steel in this infrastructure means that appropriate corrosion protection systems must be adopted due to the increased corrosiveness of coastal environments.

Galvanized Steel and the Coast

Galvanized steel has long been the preferred material of choice in many harsh environments. It has a long history of use in coastal applications and in many instances it matches or exceeds the performance of more complex and newer systems. However, focusing on the continuing amount of new galvanized steel being utilised does not provide an adequate context in which its durability can be assessed. If one does indeed learn from the past, then the Galvanizers Association of Australia was determined to revisit the past and examine enduring examples of galvanized steel in a variety of coastal locations.

In mid-2007, the GAA initiated a study that involved surveying, examining and assessing the performance of a number of structures of varying age along the approximately 400km of coastline in south-west Victoria. This area fronts Bass Strait and is characterised by high winds and heavy surf, in many instances breaking on rocky coastline and generating significant quantities of chloride-laden spray. The general corrosivity of the area surveyed ranges from Category C: Medium to Category E-M: Very High Marine as per AS/NZS 2312 or ISO 9223. The survey looked to cover a large cross section of applications including iconic buildings, a water treatment plant (featured in galvanize! 65) and some more common structures such as bridge rails along the Great Ocean Road. To add relevance to all users of galvanized steel, some other case studies were also included here: the Carousel in Geelong on Port Phillip Bay in Victoria and the light towers at a wharf facility in the Port of Botany, NSW.

CASE STUDY 1: Portland Maritime Discovery Centre

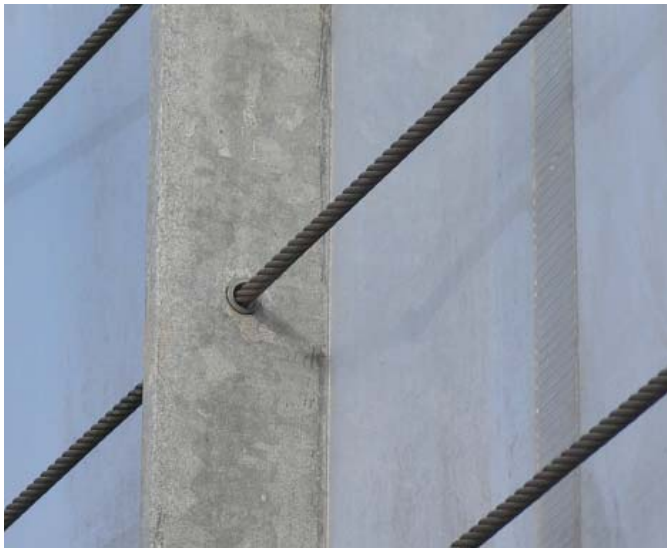
Portland Maritime Discovery Centre

This popular facility acts as both a museum and information centre for the coastal city of Portland – Victoria's oldest town. Portland is one of the deepest ports on the Australian coast. The Discovery Centre houses the oldest intact marine vessel in Australia, a lifeboat involved in the rescue of 19 people from a shipwreck in 1859. This section of the coast in south-west Victoria is notorious for the number of shipwrecks that occurred there. The coast is so wild that there are at least 18 known shipwrecks in the area and it is known as the "Shipwreck Coast". Visitors can also sit inside the ribcage of the skeleton of a sperm whale. The centre's frame structure is made up of universal beams and columns and much of this exposed to the ocean. All of the structural steel is hot dip galvanized and most of it is located about 10 to 15m from the shoreline and is confronted with prevailing winds directly off the ocean. In severe weather, waves of 2 to 3m are not uncommon and erosion of the shoreline is a significant problem.

The Centre is 9 years old and the galvanized steel has performed very well with no maintenance. Maintenance was a key criterion for the facility as the local authorities wanted to minimise the cost burden on the community. The design of all the steelwork took corrosion issues into consideration and this has also contributed to the performance of the galvanized steel. The corrosion protection integrity of the structure was maintained through the bolting of joints, welding prior to galvanizing and consideration of bimetallic corrosion.

CASE STUDIES

After 9 years, the average coating thickness of the structural steel is 2 to 3 times (160 – 220 µm) the required level of AS/NZS 4680.



Use of plastic inserts prevents dissimilar corrosion between stainless steel and galvanized steel in coastal environment

CASE STUDY 2: Geelong Carousel Pavilion

The Geelong Carousel Pavilion is located in the city of Geelong on the foreshore of Port Phillip Bay.

The Pavilion houses the oldest and most valuable carousel in Australia, hand carved in the United States in 1892. The carousel is powered by an 1888 steam engine and is accompanied by an 1898 Gavioli band organ.

All of the structural steel in the Pavilion is hot dip galvanized steel and most of it is exposed to the sea. An indication of the potential for significant chloride deposition is that one of the major structural design parameters for the building was the offshore wind loading. The design of the structure paid due consideration to corrosion through the use of bolting, the minimization of "corrosion hotspots" due to proper detailing and the expanded metal roofing that reduced the wind loading and allowed the washing effects of rain on external steelwork.

The carousel is a popular tourist attraction and during school holidays it is subject to considerable stress due to children's parties and general public traffic. It has been open for 6 years and has required no maintenance in that time. The steelwork is in excellent condition and all of the galvanizing is 2 to 3 times in excess of the levels required by AS/NZS 4680.

CASE STUDY 3: Great Ocean Road Bridge Rails

12 bridge rails were examined along the Great Ocean Road on the south-west of Victoria with the assistance of the local roads authority. All of the bridge rails were performing well and it is standard for them to be hot dip galvanized and either left bare or painted in instances where aesthetic requirements demanded. Of interest is the fact that even though many of the bridge rails were in the surf zone and approximately 10 – 30m from the breaking surf and over estuarine waters, they were in excellent condition. Conferral with the responsible engineers indicated that they were performing as expected and that a life of over 20 years with minimal maintenance was the expected performance.

Bridge rail at Smythes Creek on Great Ocean Road (10 years old)

Geelong Carousel Pavilion

Bridge rail at Grassy Creek on Great Ocean Road (24 years old)

CASE STUDIES

CASE STUDY 4:
Port of Botany Light Towers at DP World Terminal

Port of Botany light tower being examined (27 years old)

The DP World terminal is located in Botany Bay. Depending on wind levels, water agitation and other factors, then the corrosivity environment may be classed as either a C: Medium to AS/NZS 2312 (C3 ISO 9223) or D: High (C4 ISO 9223). During the time of the inspections, the wind was very strong coming off the bay and there was considerable spray indicating that for certain weather conditions there would be periods where the environment approaches that of an E-M Very High Marine (C5 ISO 9223).

The coating appeared to be in good condition considering its exposure environment and age of 27 years. All of the thickness measurements were above what would be required by Australian Standards for a new installation (AS/NZS 4680).

Based on the conventionally accepted corrosion rates for zinc and taking into account the lowest measured thicknesses for each tower, it was conservatively determined that the remaining life of the coating was approaching at least 20 to 25 years.

Conclusion

Galvanized steel has a long history of use on the Australian coastline. The requirements for the corrosion protection of steel will continue to increase due to the nature of the general "seachange" in society and the fact that most of Australia's population and industry is located in coastal environments. In the overwhelming amount of cases examined, galvanized steel has performed at least to or above expectations. Much of this can be attributed to the fact that the use of galvanized steel by experienced engineers and specifiers means that detailing and corrosion protection are taken into account in the design of structures. However, much historical "proof of performance" has been passed down by practitioners without any specific detailing of the reasons why it actually works and its use in many applications has become a "cultural" norm rather than a scientifically based process.

It would appear that, in some instances, standards may have underestimated the performance of galvanized steel in coastal environments. Case studies and documented evidence are required so that a scientific basis for the successful and economic use of materials such as galvanized steel can be presented to show that they are an option as a construction material in some of the harshest environments. This will require further work on both an exposition and recording of the condition of practical structures over their life cycle and also how this relates to theoretical performance.

The GAA is currently conducting the next stage of the study which will provide a closer examination of the galvanizing thicknesses and corrosion by-products. It is hoped this provides further insight in the performance of galvanized steel in such environments. Galvanize readers will be provided with the results.

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