Durability of Attachments to Glass-Fibre Reinforced Concrete Panels

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Introduction

Glass-fibre reinforce concrete (GRC) panels are a versatile and lightweight façade system. Various surface colours and textures are available, making GRC adaptable to numerous architectural applications. They can be designed with a face mix to achieve an appearance very similar to that of precast concrete panels.

GRC and other lightweight systems are beneficial because they are easy to erect and generally do not require heavy steel structural support in the primary building structure and also result in reduced foundation requirements. For these reasons GRC and other lightweight systems often result in more economical steel frames.

GRC panels comprise a barrier wall system for water management. As with all barrier wall systems made from panels, the joints are the key to successful moisture protection of the wall systems. The joint system should included watertight sealants and should be designed to handle the anticipated movement at the joints.

Façade attachments are usually difficult to inspect during the life of a building. To do so may require removal and/or replacement of the façade parts, or of the back-up wall, to visually inspect the attachments and their anchors. Furthermore, shortcomings in the façade design and/or construction may lead to water leaks that expose parts within the wall that were otherwise intended to dry. Since failure of an attachment could lead to falling hazards, due consideration should be given to durability as a design criterion. Clause B2 of the New Zealand Building Code requires 50 year durability of fixings for the GRC panel façade. This article provides guidance on atmospheric corrosivity, coatings selection and also gives an example of how 50 year durability is achieved using hot dipped galvanised coatings.

Figure 1: GRC Panels Results in Economical Steel Design (photo from www.unicast.co.nz)

Atmospheric Corrosivity Environment

Current design methods for GRC panels incorporate an air space between the panel skin and the insulation to mitigate moisture accumulation. Vapour barriers are often used as an additional protective measure. The attachment of the panel skin to the back-up frame can be achieved with flexible steel rod anchors.

The environment for covered steelwork within external wall linings depends on the following:

a) Whether the steel lies on the warm side or cold side of the dew point, and
b) Whether the external cladding is essentially weather tight, as is required by Clause E2 of the New Zealand Building Code

The dew point is important because it marks the point at which condensation on a surface occurs when warm, moist air passes over that surface. When a building or component has a temperature below the dew point, condensation will accumulate on that material.

A portion of the length of the flexible steel rod anchors will be located on the cold side of the dew point. This is a medium atmospheric corrosivity category and would be not less than the mid-range category C in terms of AS/NZS 2312.

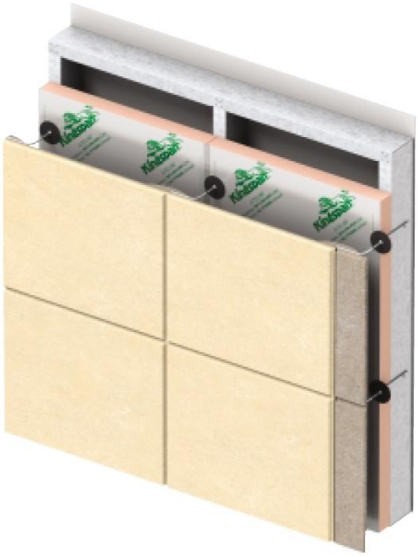

Figure 2: GRC Panel Makeup (graphic from www.kingspanfabrik.com)

Attachment and/or Coatings Selection

The American Institute of Steel Construction latest design guide *Façade Attachments to Steel Framed Buildings* recommends the use a hot-dip galvanized coating or a zinc rich paint to be applied to the GRC rod anchors to meet durability requirements. In the United Kingdom stainless steel is used by Kingspanfabrick for their attachments of GRC panels.

Zinc and cadmium electroplated coatings are relatively thin (5µm - 25µm) compared with conventional hot dipped galvanised coatings and are rarely appropriate for exterior service. These coatings will not meet durability requirements.

Corus has produced a number of useful corrosion protection guides. Corus defines the structure life as the period of reasonable freedom from severe corrosion of the steelwork that might lead to weakening of the structure. This period assumes no mechanical damage in service, that no maintenance is carried out and that up to 1mm of steel may be lost from the surface at the corrosion rate for each environment given in BS EN ISO 12944. AS/NZS 2312 gives equivalent environments.

Example of Achieving 50 year Durability of attachments by the use of Hot Dipped Galvanised Coating of Attachments

From above the GRC rod attachment is in atmospheric category C

Step 1 Determine the time to first maintenance of the galvanized system and time to loss of the galvanising

For a hot dipped galvanised coating of 85µm thickness and for atmospheric category C in terms of AS/NZS 2312 will give a time to first maintenance of 25 – 40 years. HERA Report R4-133 *New Zealand Steelwork Coatings Guide* states that the coating life may be taken as 1.2 x the time to first maintenance. Therefore the time to first maintenance is:

1.2 x 25 = 30 years

Step 2 Determine corrosion loss of parent material

Corrosion starts off at the highest rate, reduces and then reaches a steady state corrosion rate after about 10 years.

The *New Zealand Steelwork Coatings Guide* presents a table giving average corrosion rates for the first 10 years and also gives the steady state rate for after 10 years. For atmospheric categories C the corrosion rate for carbon steel is:

5 – 12 µm/year for the first 10 years
1.5 – 6 µm/year after 10 years for the steady state rate

Therefore loss of parent material after 50 years is:

10 years x 12µm/year + 10 years x 6µm/year = 180µm or 0.18mm

This is significantly less than 1mm of steel loss that form the basis of Corus corrosion protection guides. The attachment should be designed on the basis of loss of material

References

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