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Resistance to corrosion of QUICKJET throwaway cassion

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4 Corrosion resistance of the *Quick-Jet* throwaway cassion

The corrosion resistance of the *Quick-Jet* throwaway cassion is discussed for the following applications:

- foundation completely laid in soil
- foundation laid in soil
- internal concrete structure not directly exposed to atmosphere
- concrete structure not directly exposed to atmosphere

First of all it is important to state that the throwaway cassion hasn't any structural FUNZIONE, but it only has to contain the fresh concrete during casting operation: the foundation design as well as the column or beam dimensioning is not influenced by the presence of the Quick.-Jet cassion.

The throwaway cassion are is a 0.5 mm (40-60 cm wide and 250 cm long) carbon steel or galvanised steel sheet.

Taking into account the galvanised steel cassion, the zinc layer has to be estimated considering the aggressivity of the environment and the service life of the structure; the duration of the protection provided by the galvanisation increases as the zinc thickness increases. In alkaline condition, such as pristine concrete chlorides-free, the zinc, since it is an amphoteric metal, suffers an initial corrosion attack that lead to a dissolution of about 10 μm. The zinc dissolution is grater during the setting of concrete; after 24-48 h, the zinc tends to passivate (zinc oxide and hydroxide are formed) and once concrete is hardened the residual corrosion rate of zinc is reduced to 1 μm/year. The presence of chlorides exciding a threshold value (typically 1.2-1.5 % with respect cement weight) lead to zinc localised corrosion with high corrosion rate.

Due to that, the zinc layer thickness depends on the service life of the concrete structure: as an example, if the service life is 50 years, the minimum zinc thickness is 60 μm (being equal to 10 μm + 1 μm/anno × 50 years).

Metallic galvanic coupling between galvanised elements and carbon steel reinforcements in concrete leads to an higher corrosion rate of zinc during the concrete setting. The passivation of zinc is achieved at longer time. On the other side, the coupling allows the initiation of chlorides-induced corrosion on zinc at lower chlorides content, close to the values typical for carbon steel rebar (0,4% with respect cement weight).

Summarising, any metallic contact between carbon steel and galvanised steel element has to be avoided in concrete in the presence of chlorides (marine structure o concrete structures treated with de-icing salts).

In using the *Quick-Jet* throwaway cassion the main suggestion are as follow:

- carbon steel throwaway cassion may be used for foundation permanently and completely laid in soil
- for concrete structures that will suffer only corrosion induced by carbonation of concrete (sure absence of chlorides), the use of galvanised cassion is preferred: the thickness of zinc layer depends on the service life

- for concrete structures that will suffer chloride-induced corrosion, the use of galvanised throwaway cassion must be combined with the application of an external concrete cover. The concrete has to be of high quality (low W/C ratio, blended cement type, high cover) in order to reduce or avoid chlorides penetration. To design concrete mixture proportion, recommendations of International Standard has to be taken into account (EN 206 or Eurocode 2). For hot and tropical environment, higher concrete cover and lower W/C ratio has to be used.

4.1 Foundations

The use of carbon steel *Quick-Jet* throwaway cassion for foundations is possible only if the foundations will be permanently and completely laid in soil provided the concentration of chlorides is low.

A generalised corrosion will take place on the external side of the cassion (the one directly in contact with soil) with a corrosion rate close to 30-40 μm/year for the first years, and it reduces with time. To reduce corrosion, the application of an external coating (i.e. bituminous coating) is possible.

If the foundations are partially in soil, or if they are in the basement of a building (in which the relative humidity is very high), in the presence of capillary suction corrosion problem may arise if water is rich in chlorides. In such a condition galvanised steel cassion with coating are recommended.

Higher is the temperature, higher is the aggressivity of the environment.

4.2 Concrete structures exposed to the atmosphere

Two different conditions are discussed: concrete structure in internal rooms and concrete structure directly exposed to the external atmosphere.

4.2.1 Internal rooms

The use of carbon steel *Quick-Jet* throwaway cassion is suggested in the case of concrete structures working in internal rooms, without any risk of wetting and if the relative humidity (RH) is always lower the 70% (for tropical environment). A concrete cover (20-30 mm thick) may be applied on the external surface of the cassion, but it is not mandatory. The RH threshold is 80% in temperate environment.

If risk of carbonation of concrete could be a problem, and in the case of RH higher than 80%, the use of galvanised steel cassion is recommended. To reduce carbonation penetration a concrete cover has to be applied on the external surface of the cassion: W/C ration, type of cement and cover thickness has to be designed on the basis of environment aggressivity.

4.2.2 Concrete structures exposed to the external atmosphere

In the case of concrete structures exposed to the external atmosphere the use of galvanised steel cassion with an external concrete cover is mandatory. A low W/C ratio (< 0.45), the use of blended cement and proper cover are recommended for the concrete to be applied on the cassion.

If carbonation of concrete is the only cause of corrosion, the galvanised steel cassion does not suffer corrosion since zinc is stable at neutral pH.

Worst condition occur in the case of marine structures, in the presence of chlorides. The throwaway cassions can not be used if the structure is in direct contact with chlorides-rich water (sea water in general, splash zones, tidal zones), since chlorides penetration rate is very high, and zinc is not able to protect from corrosion. Only for concrete structure non directly in contact with seawater, the throwaway cassions may be used, in combination with a proper concrete cover.

When chlorides migrate into concrete and reach at the cassion level a concentration higher than 1.2% with respect the cement weight, cession may initiate. Chloride threshold reduces to 1% if concrete is carbonated. In the presence of metallic coupling between the galvanised cassion and the carbon steel rebars the threshold is further more reduced to 0.4-0.6 %.

Corrosion lead to the formation of voluminous products that cause the cracking and spalling of the concrete cover over the cassion. Critical condition must be avoided or delayed with the use of an adequate concrete mixture proportion and thickness.