

## Limited stress resistance with stainless steel suspension constructions

### *Application of stainless steel 300 grade in swimming pools can lead to serious problems*

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#### Introduction

In 1985, a concrete roof collapsed in Uster, Switzerland. The roof was fitted with stainless steel parts. 12 People were killed and 17 severely wounded. In the Netherlands a similar situation occurred. In 2001 a heavy wooden ceiling in Steenwijk collapsed. Because this happened during closing hours, there were no casualties. On July 8, 2002, a heavy duct fell in the swimming pool in Deventer, due to stress corrosion in the stainless steel construction. After this, several other suspension constructions of ceilings and light fixtures failed. It was remarkable that the collapse was not preceded by any "warning signs" such as obvious deterioration or corrosion of the material. In all cases there was a sudden partial or complete collapse of the constructions. Thanks to a.o. Cobra Consultancy, said incidents have drastically reduced.

#### Stress corrosion

In all cases the stainless steel suspension constructions were found to be involved. These constructions collapsed as a result of Chloride Stress Corrosion, also called SCC (Stress Corrosion Cracking). This form of corrosion is hard to detect and cannot be found by visual inspection. SCC occurs in the event of:

- a combination of (high) ambient temperature
- an internal environment with chlorine vapour
- permanent strain on the construction

As far back as 2002, TNO advised the Provinces and the Ministry of Housing, Spatial Planning and the Environment to ensure that swimming pool managers in the Netherlands check whether load-bearing stainless steel constructions in swimming pools show signs of corrosion and to examine for chloride stress corrosion. The water and air temperatures in indoor swimming pools are significantly higher than they used to be. Play apparatus, wild water courses, water curtains and whirlpools increase the contact of water with air, thereby increasing the humidity. Visitor numbers and duration of stay have increased, necessitating a greater use of chlorine. More chlorine in combination with higher water and air temperatures and an increase in humidity cause an increase in the chlorine concentration in the air. The extent to which ventilation air is re-circulated (energy saving) has a negative effect on the chlorine concentration present in the internal environment.



#### Stainless steel 304 and 316 not under stress

Stainless steel is an alloy of iron that contains at least 11-12 % chrome and thereby forms a chromium oxide film when it comes into contact with oxygen, making the material impervious to corrosion if the surface remains intact. The most well-known types of stainless steel are: AISI 304 (A2) and AISI 316 (A4). AISI 316 is more pit corrosion resistant because of the 2-2,5 % molybdenum in this alloy. Specifically these types of stainless steel are particularly vulnerable to SCC and have been deemed unsuitable for use in load-bearing constructions in indoor swimming pools.



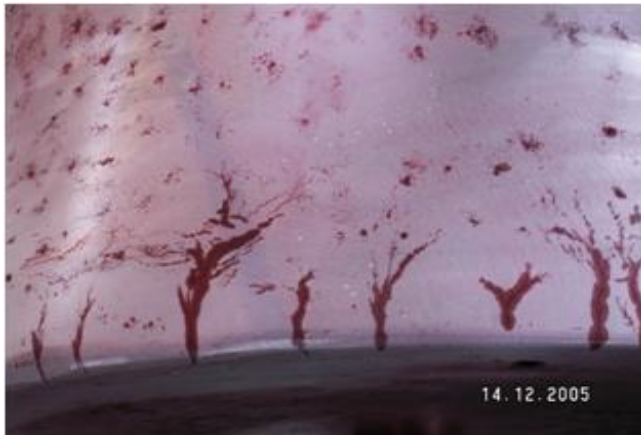
Heavily corroding stainless steel parts



Cleaning with steel wool causes an opposite reaction, namely infection of the stainless steel

### How to show?

It is possible to check stainless steel for stress corrosion yourself. This can be done by Non Destructive Testing with a "contrast spray" (see also [TB 2011-05](#)). After 3 simple steps (pre-cleaning, penetrating, contrasting) even the smallest hairline cracks will become visible. A Chemetall testset to trace this type of corrosion is available from Vecom. The photo below shows numerous cracks which became visible in stainless steel after using this spray.



### Recommendations applied material

For critical applications of, among others, stainless steel 304 and 316, replacement by AISI 926 (20% Cr, 25% Ni and 6.5% Mo) an austenitic stainless steel which seems to be insensitive to stress corrosion in swimming pool environments. Constant attention to proper management of the quality of the swimming pool water and the internal environment (air quality) prevents unnecessary chlorine concentrations in the air. Maintenance and inspection remain important, particularly in situations where collapse of load-bearing constructions could endanger people's lives.

### Regular maintenance of stainless steel (and steel) in swimming pools

Stainless steel attributes such as stairs and railings are sometimes cleaned using steel wool. This infects the stainless steel with iron particles, which in the aggressive, chlorine-rich swimming pool environment will corrode heavily. In order to prevent this corrosion, the stainless steel should then be treated with **Vecinox Stainless Steel Gel**, a cleaning compound designed specifically for this type of maintenance activity by Vecom. It removes mild corrosion on the stainless steel and gives back the original shine to the stainless steel. For carbon steel, applied with f.i. slide pillars etc., Vecom has a rust converter **Rust Converter Super**. Before applying this product, it is sufficient to brush off loose rust. Then the product can be applied, even on a wet surface. Within 2 hours a passive purple/black layer will form through a chemical reaction which can be finished with a lacquer.