Why do Parking structures need protection?

Modern day multi-storey residential and commercial buildings boast of muti-level parking lots in cities like Mumbai, Delhi & Bangalore. It is important to analyze the protection mechanisms required to prevent failures due to carbonation, chloride attacks etc. and this article aims to do just that.

Incidents reported in Internet (gleaned with thanks)

Collapse at Windsor Parking Structure One Person Hurt

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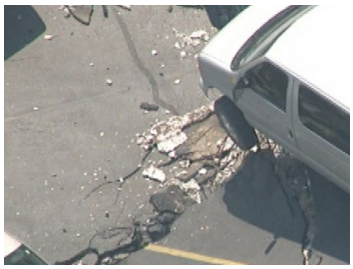
By AMY LANGE myFOXDetroit.com

WINDSOR, Ont. - A parking structure comes crashing down in Windsor. One person was pulled from the crumpled concrete.

From the air, it looks like a sinkhole -- a surface parking lot collapsed into the underground garage behind an office building in Windsor.



(a) **(b)**

Figure 1: Steel reinforcement corrosion at column (a) of collapse (b) of Pipers Row Parking Garage (Wood)

One example of structural failure due to carbonation is the 1997 collapse of the Pipers Row Parking Garage in Wolverhampton, England as shown in Figure 1. The top level of this multistory concrete parking garage failed due to progressive collapse caused by punching shear failure at one column. This was caused by reinforcement corrosion in the slab of the top level. Forensic analysis of the failure found that reinforcement was initiated by carbonation, which later induced microcracks in the concrete as well (Wood). (a) (b) Figure 1: Steel reinforcement corrosion at column (a) of collapse (b) of Pipers Row Parking Garage (Wood)

The above are only a few examples of failures of Parking Deck structures around the world. It raises an important question as to the specific nature of failures, their root cause analysis and ways of overcoming such calamities. We will take a look at one of the important issues relating to the durability of structures. **CARBONATION**

Some of the facts about carbonation:

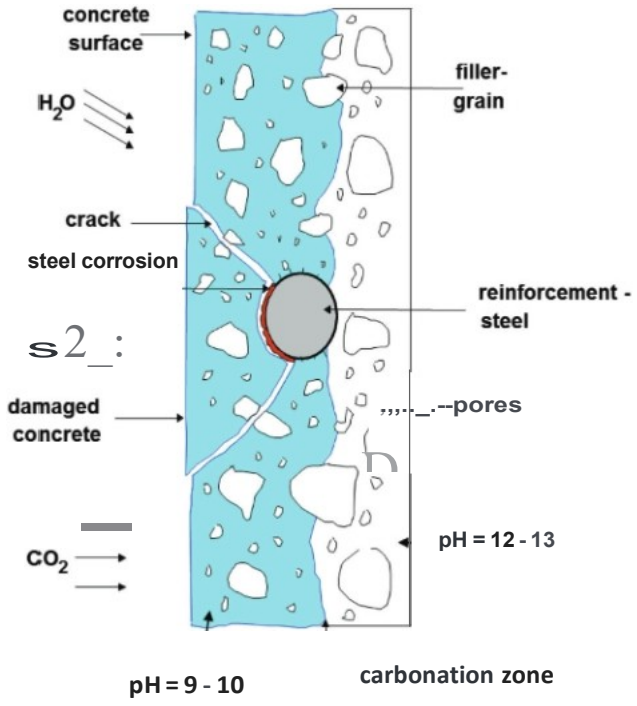
In construction industry, carbonation is referred to "the process of chemical weathering by which minerals containing soda, lime, potash and other basic oxides are changed to carbonates by the action of carbon dioxide and water".

The process is represented by the reaction below,

co2 + H_2O------> H2C03

H2C03+Cao------>CaC03+Hp

As represented by the above chemical reaction, carbon dioxide with water forms carbonic acid. This carbonic acid subsequently reacts with alkaline material such as lime to form calcium carbonate.



In addition to carbonation, chloride ions in the atmosphere (sea-side structures) will also substantially affect concrete durability.

The above factors clearly indicate that the protection of concrete and reinforcement from the ingress of water, CO2, chloride and other harmful gases (if any) is imperative to prolong the life of the structure (especially the parking decks) by means of flexible PU coatings (rather than rigid epoxy coatings)

While PU deck coatings take care of carbonation on the floor concrete, it is important to consider the other areas exposed to concrete such as beams, columns, soffit of slab and restraining RCC walls. A simple paint is not sufficient to protect these structures from carbonation or chloride attacks and it is imperative that these are to be coated with anti-carbonation coatings.

What are the characteristics of these anti-carbonation coatings?

1. The thickness of coating shall be atleast 200 microns (anti- carbonation properties at around thickness of above 200 micron DFT i.e Sd value obtained anything above 50 m is sufficient to give necessary anti-carbonation properties.)

	Unit	Film 1	Film 2	Film 3
Ory film Thickness	μ	270	600	1300
co2 permeability	g/m2xd	2	1	0.5
Sd	m	125	250	495

2. The coating is extremely durable (The durability of the coatings depends upon its stability against the harsh environment)

3. It is capable of allowing moisture inside the concrete to breath-out (Generally, water based coatings is more permeable to gases and water vapour. These coatings are formulated by using polymer dispersions. Water vapour permeability is a desirable property to allow water vapour to escape from the substrate. But if the permeability is too high, carbon dioxide can diffuse from atmosphere into the substrate easily. Hence there is a need for coatings with moderate gas permeability which can prevent Carbon dioxide from diffusing into the substrate while allowing moisture to escape.)

4. It is flexible enough to take care of minor cracks in concrete (Obviously, cracked areas will allow CO2 to permeate into the concrete and cause the failure)

Neotuffcoat PUW

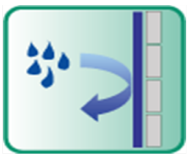
Neotuffcoat PUW is an water-based, aliphatic polyurethane/acrylic hybrid single component, concrete coating designed for the long term protection of interior wall surfaces in pharmaceuticals, hospitals, food processing plants, beverage plants, bio-tech plants, parking decks, podiums, interior walls of any concrete structures etc. PUW is uniquely formulated to provide bacterial and chemical resistance with exceptional scrub resistance, anti-carbonation and chloride protection.. Its easy cleanability and maintenance-free durability makes **Neotuffcoat PUW** one of the best in the industry.

Neotuffcoat PUW has the following special characteristics:

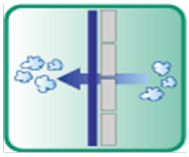
- Excellent bond to concrete
- Very good resistance to chemicals including acids and alkalies.
- Excellent scrub resistance to ant-septic cleaning fluids
- Anti-fungal, anti-bacterial
- Extremely durable.
- Protects concrete against carbonation and chloride attacks

- Easy to clean and maintain.
- Available in attractive pastel shades
- V.O.C compliant
- Easy application

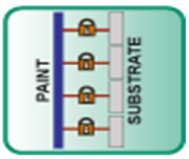
Characteristics of Neotuffcoat PUW



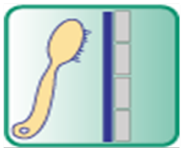
Water Repellency



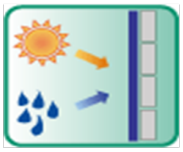
Vapour Permeability



Substrate Adhesion



Scrub & dirt pick–up Resistance



UV & Weather Resistance

Decorative

Property	Results
Elongation at break %)	270
Tensile strength N/mm2	3.5
Dirt Pickupresistance•	8
Wet scrub cycles·ASTM02486-06)	1650 cycles
ICIViscosity (ASTM04287)	2.2Poise
StormerViscosity (ASTM0562)	115 KU
TVOC grams/liter (ISO 11890-2)	25
Alkali resistance (internal STD)	passes
Water resistance (STM 870-09)	passes
QUVexposure 2000hrs. (ASTM4587) inDeltaE	1.6
Natural Exposure for 2 years (ASTM 3274-09e1) Delta E	4.5

It should be noted that there are numerous ways to mitigate the effects of carbonation deterioration, including thicker concrete covers, lower w/c ratios, treated reinforcement bars, anti-carbonation coatings or a combination of all. These measures are especially pertinent to consider when designing for concrete structures in dense urban areas, which are subject to high levels of atmospheric carbon dioxide, humidity, and temperatures. Carbonation will only become more of a concern in the future as carbon dioxide increases in conjunction with urbanization, and the number of structural failures related will escalate.

The author is B M Nagarajan, director of Neocrete Technologies Pvt Ltd which provides innovative solutions to most of flooring related problems. He is well-known in the industry, having served over 23 years in the field of construction chemicals