*coatings*

*Editorial*

# Effective Coating System Should Be Applied to Concrete with Recycled Waste Materials

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With global concerns over increasing $CO_2$ emissions, many countries have set up different strategies to achieve net zero $CO_2$ emissions. One important way to reduce $CO_2$ emissions is to use recycled waste materials, such as recycled aggregate concrete [1–14], recycled cement [15–17], and other recycled materials [18–24]. However, the physical properties of recycled materials might not be as good as the original ones [1–5]. For example, the recycled aggregates from demolished construction waste usually contain a lot of adhered mortar with a high porosity and micro cracks, which inevitably decrease the physical properties of concrete comprising 100% recycled aggregates, resulting in it being less durable under different environmental conditions (such as salt attack and carbonation). Thus, concrete that is primarily composed of recycled waste materials (e.g., >60%) is currently not allowed to be used in structural elements and can only be used in unimportant and non-structural elements.

As we know, concrete is one of the mostly widely used construction materials. Demands for raw materials such as natural stones, river sand, and limestone have been increasing due to needs for increased concrete production [16,19,22]. In local areas raw materials may be consumed at a rapid pace when there is a limited local supply. This represents an application for concrete that is primarily composed of recycled waste materials from demolition as well as other types of waste.

Steel-reinforced concrete elements may suffer steel corrosion during their service life. This corrosion is caused by the depassivation of steel by chloride ions in exposed environments [25–30] and concrete carbonation by the $CO_2$ in the atmosphere [31–33]. Other types of concrete deterioration include sulfate attack by the sulfate ions in water [34] and erosion caused by water. Additionally, the presence of micro cracks could accelerate the penetration of these harmful substances into concrete elements and could thereby accelerate the deterioration of concrete elements and decrease the service life of concrete structures [27,30,35]. When the composition of concrete most comprises recycled waste materials, concrete structures may have an even shorter service life, representing the main concern over using concrete with recycled waste materials.

Given that the mechanical properties have been fulfilled and the coating system can provide a long life and sustained lasting effects, in the author's opinion, through applying an effective coating system on the surface of concrete that is mostly composed of recycled waste materials, the deteriorated durability property of the concrete caused by recycled waste materials can be rectified.

An effective coating system [36–38] could provide protection to concrete made from recycled waste materials. Effective coating systems include protective coatings on concrete surfaces and steel surfaces and protection materials that can penetrate into the concrete. Coating materials include silane, corrosion inhibitors, epoxy, or other waterproof materials. Other types of innovative coatings are also encouraged. When silane is brushed or sprayed on a concrete surface, it gradually penetrates into the concrete inside and reacts with the water inside the concrete in an alkaline environment, resulting in highly reactive hydroxylases being formed that will react with the hydroxyl groups, forming a water-repellent molecular layer [39–41]. For example, Basheer et al. [42] showed that silane impregnation could extend the service life of concrete under freeze–thawing cycles by more than 100%.

However, there is still limited understanding on the long-term degradation of coating materials and the long-term interaction mechanisms between these materials and waste-based concrete, especially the long-term degradation mechanisms [43,44] of these materials on the surface and inside waste-based concrete. In addition, de-bonding between coating materials and concrete or steel surfaces could happen during the expected service life of waste-based concrete.

Future research on the following subjects is encouraged:

- Long-life performance and deterioration mechanisms of coating systems on the surfaces of waste-based concrete in different exposure environments;
- Long-term adhesion and compatibility between coating systems and waste-based concrete;
- Multiple coating systems and their interactions with waste-based concrete.

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