Chapter 10
Self-Healing Mortar

ABSTRACT

The cost of repairing cracked concrete is expensive as it requires special repair materials and skilled labour. Thus, the developments of new materials, like self-healing materials, are highly needed to repair cracks automatically and to restore or even increase concretes’ strength to prolong its service life. The aim of this chapter was to investigate the performance of epoxy resin without hardener as a self-healing agent in mortar. A detailed introduction of self-healing mortar is given followed by a problem statement. The epoxy resin as a self-healing material is also explained briefly. Self-healing concept is also discussed in detail followed by the experimental program. Results revealed that the epoxy resin without hardener as a healing agent performed effectively as the compressive strength and ultrasonic pulse velocity of 365 days old cracked mortar samples regained the initial reading with prolonged curing time.

INTRODUCTION

Concrete is a strong, relatively cheap construction material and is presently the most widely used material in the construction industry. The main constituent that contributes to concrete strength is Portland cement. It is estimated that cement (Portland clinker) production alone contributes about 7% of the global carbon dioxide emissions due to the burning of limestone and clay at a temperature of ~1500°C as well as fossil fuel. During this process, calcium
carbonate (CaCO₃) is converted to calcium oxide (CaO) and carbon dioxide is released (Worrell et al., 2001). From an environmental standpoint, concrete does not appear to be a sustainable material (Gerilla et al., 2007). Moreover, improperly manufactured concrete may experience a shorter service life as it can easily develop cracks due to excessive loading applications and other environmental causes. Hence, a good quality of concrete is needed which not only prolongs its service life but would also reduce the production of cement.

The major problem faced by concrete structures is cracking. It can cause severe damage such as corrosion of steel reinforcement that can lead to the deterioration of structures. A number of cracks with different morphology and size could appear during construction and the design life of structure (Zhang et al., 2011). Small cracks or micro-cracks need to be repaired before they become a major or macro-crack. There are many types of repair materials and methods that can be selected and used to repair these micro-cracks. However, in certain cases, micro-cracks will still exist in the concrete structure and if they cannot be repaired effectively, the performance of the structure is compromised and its service life will be shortened. The cost of repairing concrete is expensive as it requires raw materials such as cement and skilled labours.

In many concrete structures, tensile forces can cause cracks and these can occur relatively soon after the structure is built. Repairing cracks in conventional concrete structures usually involves applying mortar which is bonded to the damaged surface. Sometimes, the mortar needs to be installed into the existing structure to ensure it does not fall off. The bonding property between host concrete and new repair materials needs to be carefully verified to avoid another problem leading to extra repair cost. Repairs can be particularly time consuming and expensive; often it is very difficult to gain access to the structure to make repairs, especially if they are underground or at a great height. Therefore, the development of new technologies and materials is essentially needed that can automatically repair cracks by giving longevity to the structures. Such materials will eventually reduce maintenance costs and fulfil the need of sustainability.

The self-healing concrete had been investigated since 1996 by Stefan Jacobsen and Erik J. Sellevold from Norway. In their research paper, they investigated the deterioration of self-healing concretes caused by internal cracking. Besides, Nynke ter Heide (2005) from Delft University of Technology had discussed self-healing process of concrete in detail. This led to more investigations conducted by other researchers in the area of self-healing.
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