



Half day Seminar on “The Deterioration of Concrete and Its Repair and Protection According to EN1504”

by Ir. Lo Seng Ling

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The half day seminar on “The Deterioration of Concrete and Its Repair and Protection According to EN1504” was organised by the Civil and Structural Engineering Technical Division (CSETD) of IEM in collaboration with MAPEI Malaysia Sdn Bhd on 16th February 2017. Total of 118 participants attended the half day seminar.

The talk was presented by Mr. Lim Kean Meng, Technical Service & Training Manager as well as Product Manager (Industrial Floor) from Mapei Malaysia Sdn Bhd. His area of expertise include industrial flooring, waterproofing, joint sealing, concrete repair and protection and structural strengthening.

From newly cast concrete structures with honeycombs due to poor concreting to concrete structures which have suffered degradation from exposure to aggressive environment, concrete structures required repair and maintenance throughout their service-life span. To repair deteriorated concrete structures are not as simple as removing the deteriorated parts and replacing new concrete. In order to help the engineers to make the right decisions in the complex situation, the European Committee of Standardization has published the EN 1504 “Product and Systems for Protection and Repair of Concrete Structures” in 2004, which has covered the whole process of concrete repair and maintenance including repair strategies, repair principles and repair method and product. Subsequently, EN 1504 Standard has fully implemented since January 2009.

EN 1504 comprising 10 parts and Part 9 defined the principles and methods for protecting and repair concrete structures which may or have suffered damage or deterioration. According EN 1504, the common causes of concrete defects are mechanical, chemical and physical. While the common causes for the concrete corrosion are due to carbonation, stray currents, corrosive contaminants during mixing or from external environment.

During the seminar, Mr. Lim presented the process of Alkali-Aggregates Reactions (AAR), sulphate attacks concrete carbonation and chloride attacks which will damage and deteriorated the concrete in details. AAR happened in the concrete structures when the reactive forms of silica reacted with potassium, sodium and calcium hydroxide, $\text{Ca}(\text{OH})_2$ from the cement and formed a gel around the reactive aggregates. The gel around the aggregates expanded and created force that caused tension cracks around the aggregates when it contacted with moisture.

Soluble sulphate can be found in mining operations, in the soils or paper milling industrial process. The sulphate ions reacted with calcium hydroxide, $\text{Ca}(\text{OH})_2$ from the cement to form gypsum (first stage Ettringite). Then the gypsum reacted with the hydrated calcium aluminates (C-A-H) to form second stage Ettringite, which will cause delamination, swelling, cracking and detachment of the concrete.

Concrete carbonation happened when carbon dioxide (CO₂) or carbon monoxide (CO) reacted with the product of cement hydration, calcium hydroxide, Ca(OH)₂ and formed calcium carbonate (CaCO₃). CaCO₃ will caused the concrete become acidic and the reinforcement corrosion will occurred. The major factors caused carbonation are environment and humidity, concrete curing and the thickness of the concrete cover. To check the concrete deterioration due to carbonation, phenolphthalein solution in ethanol was used. The concrete will turn to pink colour is not carbonated and no change in colour is carbonated.

When the chlorides from sea water and de-icing salt penetrated into the concrete and with the presence of the oxygen and moisture, corrosion of the reinforcement occurred. Tensile force (ferum oxide) generated due to the reinforcement corrosion will forced concrete to crack and delaminate.

Then, Mr. Lim proceed his presentation with the concrete repair requirements according to EN 1504. During the concrete repair, all the damage and deteriorated concrete shall be totally removed. The concrete surface shall be clean from the dust, loose material, oil, greese and etc, and roughen to provide good base for mechanical bonding of the repair materials. the reinforcement shall be cleaned (from the rust) and coated. Mr Lim also presented the requirements in EN 1504 for reinforcement anchoring, motar bonding, curing and etc.

At the end of the presentation, Mr. Lim presented three completed rehabilitation project by using Mapei's product in Malaysia. The three rehabilitation projects are "Projek Baik Pulih Kerosakan Bangunan Dan Kerja-kerja Berkaitan di Sekolah Menengah Sains Miri, Sarawak.", "Repair and Strengthening work for Jambatan Batu Kawa, Kuching, Sarawak." and "Godown Rehabilitation and Conversion at Penang."

A simple products application demonstration and Q&A session was carried out at the end of the seminar. Then, Dr Ng Soon Ching from CSETD presented a memento and certificate of appreciation to Mr Lim Kean Meng.