Report on Non-structural crack in concrete: What codes of practice don't (can't) tell you

By Ir. Low Kai Wah

Ir. Low Kai Wah is currently the Deputy Chairman in the Civil and Structural Engineering Technical Division (CSETD).

The Civil and Structural Engineering Technical Division (CSETD) had successfully organized an evening talk on 7th August 2018 titled "Non-structural cracking in concrete: What codes of practice don't (cannot) tell you". The talk was held at Auditorium of Tan Sri Prof Ching Fung Kee, Wisma IEM and the invited distinguished speaker was Prof. Steve Garrity, who has over 41 years of experience in public and private sector. He was last attached as academician with University of Leeds.

The talk was chaired by Ir. Dr. Ng Soon Chin and was attended by 101 participants. The participants consist a pool of professionals from different industries background ranging from practising consultants, contracting firm, Authorities, academician and students.

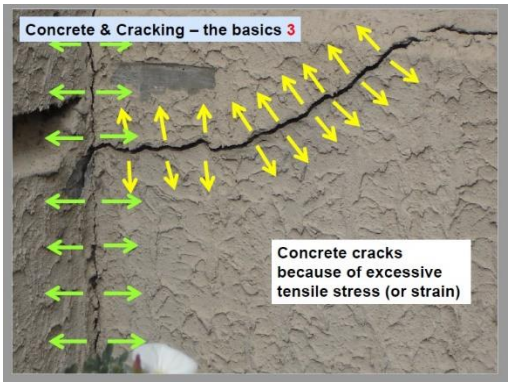
Prof. Steve outlined four (4) main topics in his presentation mainly:-

1) Setting the sene.
2) Non-structural cracking.
3) Action (before, during and after construction.)
4) Summary & Lessons.

Prof. Steve stressed that everyone has a role to play in controlling crack. Concrete relatively has good compressive strength but lack of tensile strength. It is brittle material with very little ductility.

Prof. Steve delivering his note

The speaker remind that tensile strength of concrete is very low during the first few hours/days so it is very susceptible to crack within this critical period. In order to minimise the crack we can either: 1) reduce or avoid tensile stress that will occur on concrete or 2) increase the tensile strength of concrete by increasing the concrete resistance to cracking.

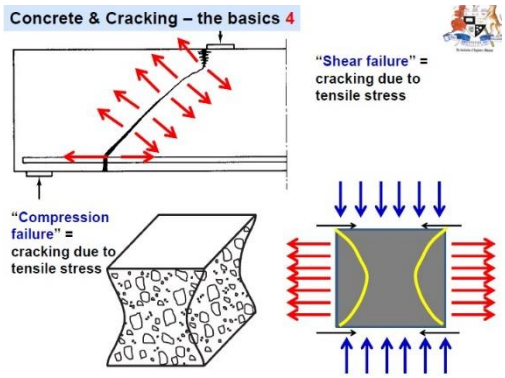


Simple illustration of tensile stress yielding concrete crack.

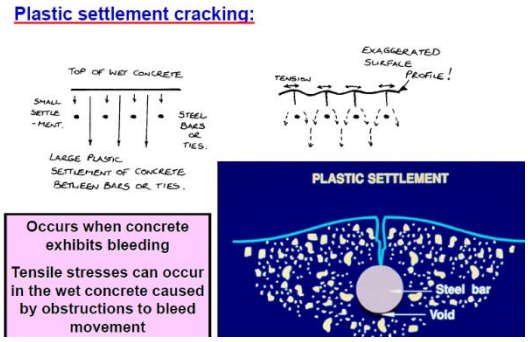
Prof. Steve highlighted to the audience that EC2 had acknowledged cracking is normal in concrete structures as it is subjected to bending, shear, torsion, and tension resulted from either direct loading or imposed deformations. The speaker further explained that direct loading usually will yield structural cracks whereas cracks caused by imposed deformations normally will be non-structural crack. The speaker highlighted that BS EN 1992-1-1 : 2004 does not provide sufficient guidance on calculating crack width due to restrained imposed deformation but is fully

covered with CIRIA C660. However, the design data used in CIRIA C660 is based on UK ambient conditions, cementitious material and data from a wide range of UK aggregates.

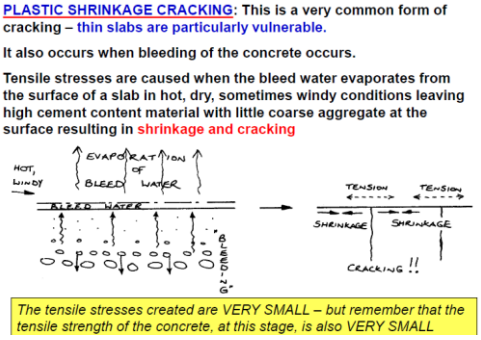
Prof. Steve than further exhibits some common form of non-structural cracks that are not caused by applied loading. He explained that plastic cracking is the most common cracks that consist of plastic settlement cracks than usually occurs during concrete bleeding because tensile stresses tends to develop in wet concrete caused by obstructions to bleed movement. Another form of plastic cracking is plastic shrinkage crack that are vulnerable to thin slabs.



Simple illustration type of failure that creates crack



Simple illustration of plastic settlement crack



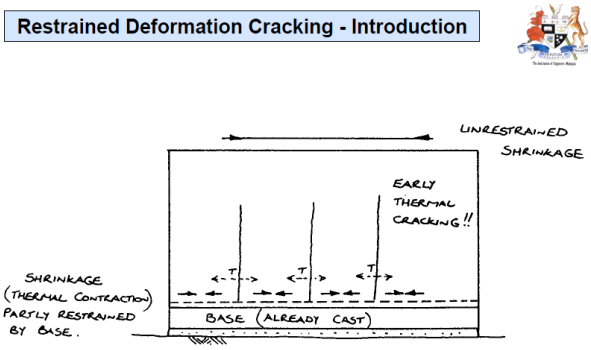
Simple illustration of plastic shrinkage crack

Further on cracks may develop due to expansive chemical reactions such as sulphate attack and alkali-silica reaction (ASR). Non-structural cracks may also develop due to restraint deformation as the concrete contracts/shrinks and is restrained from doing so.

Prof. Steve presented that to minimise plastic cracks, the designer can adopt cohesive mix design whereby the mixes will tend to have low bleed. Site engineer need to have adequate experience so that he/she is aware of plastic cracks possibility and conduct visual inspection on poured concrete regularly for sign of plastic cracking and possibly re-vibrate or re-float the concrete surface or use cement rich slurry into the hardening concrete.

Good engineering practice is required to control cracks due to expansive reaction in hardened concrete. Aggregate sources need to be verify to minimise the risk of ASR. Chemical analysis of soil and underground water need to be perform to identify the severity of exposure will be beneficial.

As for control cracking due to restrained deformation, it is common to provide extra steel reinforcement to counter the tensile stresses and to distribute the tensile strains. Alternatively, introducing movement joint will reduce the



Simple illustration of restrained deformation cracks

degree of restraints thus will result the need of smaller area of steel. Nevertheless, using low heat of hydration cement and control thermal gradient within the concrete will also help.

Prof Steve remind the audience that it is important to be proactive to minimise or control the crack rather than being reactive at later stage as the repair and strengthening work will be costly and timely.

At the end of the session, the Q&A session was lively as enthusiastic audience poured questionnaires to the speaker and were answered by speaker diligently. The talk ended with CSETD Chairman presented a token of appreciation to Prof. Steve.

CSETD Chairman, Ir. Chong presenting memento to Prof. Steve