

POROUS NETWORK CONCRETE: A NEW APPROACH TO MAKE CONCRETE STRUCTURES SELF-HEALING USING PREFABRICATED POROUS LAYER

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ABSTRACT

In order to optimize concrete durability which undergoes changes during its lifetime effectively, healing intervention at the right time and location is needed. Inspired by nature researchers develop several concepts and techniques such as capsule based, vascular, and intrinsic self healing system which have been used for different materials ranging from polymer to ceramic [1], including concrete. The author proposed idea to mimic nature that makes novel vascular system in concrete similar as spongy part of the bones. Imitating bone structures, we created hierarchical composite cementitious material using prefabricated thin porous network concrete layers which are placed internally (or at the surface) in the concrete structure. Although this research is still on going in the beginning phase, demonstration that the concept and idea proposed is feasible was performed with simple experiment.



Figure 1. (a) Outer compact bone and inner cancellous (spongy) bone, (b) A new vascular concrete with porous network concrete inside apparently solid outer concrete cylinder, and (c) 3D reconstruction after x-Ray μ CT scans.

Producing porous concrete cylinder of $\varnothing 35$ mm has been tried successfully based on mix design proposed by other researchers [2-3]. Then the specimens which has been covered with PVA film was put in the middle of mould of $\varnothing 56$ mm whereas outer solid concrete cylinder made with self compacting concrete was casted around this porous core. Figure 1b shows a new vascular or porous network concrete have been developed in which pore connection can be used as media for healing agents to be injected to fill and repair cracks and to make it dense.

In general the proposed self healing mechanism which makes use of this porous network concrete will be carried out using intelligent structures technology concepts which have capabilities of sensing, processing/controlling, and actuating with minimum human intervention. Figure 2 show the flow of information in this proposed self healing concrete.

Deformation controlled tensile stress was applied to create crack close to notch in the middle of sample height up to displacement about $200 \mu\text{m}$ (fig 3a). After crack developed and can be detected visually tensile load is removed. Then, sample is put in vacuum chamber and depressurized for ten minutes. Healing agents was flown through pore upper area until its impregnate all pores and crack spaces. Epoxy based was chosen for healing agents explicitly to seal the crack [4].

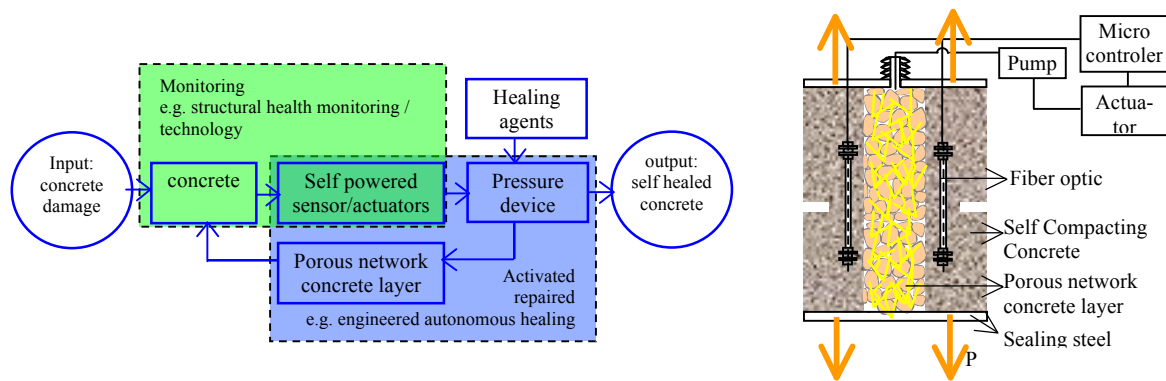


Figure 2. General concept proposed for self healing process which makes use of porous network concrete

Figure 3b shows longitudinal section of the samples which is portrayed under UV light to show different material phase. Bright green epoxy polymer can be seen fill up all space including seal crack in the middle of the sample. Boundary line between solid phase and porous concrete is visible and filled with epoxy which can be concluded that PVA film was dissolved during casting self compacting concrete. This phenomenon ensures that porous concrete can be keep porous in the interior concrete structure.

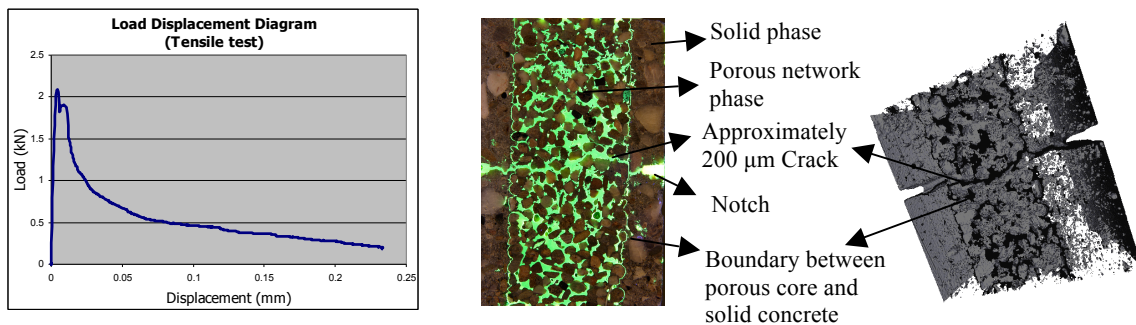


Figure 3. (a) Visible crack, (b) longitudinal cross section showing the crack which have been sealed by epoxy and (c) 3D reconstruction of the vascular concrete after crack propagation.

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