Civil Engineering Research Journal
ISSN: 2575-8950

Juniper Publishers
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Opinion
Volume 10 Issue 1 - March 2020
DOI: 10.19080/CERJ.2020.10.555778

Civil Eng Res J

Self-Sensing Concrete for Smart Infrastructure

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Submission: December 14, 2019; **Published:** March 06, 2020

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Opinion

Along with the research advancement in the field of nanotechnology, the sensor used in construction industry has also become smart which are designated as self-sensing materials. For the smart cities to be smarter, these self-sensing materials are proving more helpful, as they monitor structural health of the civil engineering infrastructures. These smart materials include smart concrete, which imparts any concrete structure the abilities of self-sensing. This self-sensing concrete establishes the relationship between changes in internal strain and changes in corresponding material properties like electrical resistance or temperature. These sensors are having more advantages of cost and sensing size, over the conventional structural health monitoring sensors available in the market as it provides more durability combined with uniformly distributed measurements. This article takes a review of the recent advancements in sensors made up of cementitious matrix used along with using Carbon Nanotubes (CNT's). Within the last few decades the researchers working on structural health monitoring conducted lot of research on self-sensing properties of cementitious material with conductive particles. From the literature of the research work in this domain it is observed that lot of efforts are taken to develop the material and sensors but it is not widely used due to its exorbitant cost and functional difficulty of dispersing nanoscale material like Carbon Nanotubes (CNT's) within the cementitious matrix.

Basically, Cement based sensors are developed to sense strain in the concrete structure. Normally these sensors are embedded in the structure where the deformation is expected to occur. Apparently, it means that structure is subjected to dynamic applied load, thus Cement based sensors must have sensitivity for small changes in strain and high repeatability. For measuring variation in strain piezoresistive effect is used. It means deformation and electric potential is applied t the sensor and changes in conductive networks are measured. But electrical conductivity of concrete is very low and that is the hurdle in practical execution. It can be overcome by adding additional conducive phase. Conductive phase can be carbon fibers, steel particles or carbon nanotubes. Large number of cycles of reversal of load (increasing and decreasing) is applied for long term durability of cement-based sensors. In recent time a new approach of creating a self-sensing and conductive concrete containing latex-CNTs thin film-coated aggregates has been developed. By using spray-painting the coating on course and fine aggregates is done in this method, that enables a economical and easier dispersion of Carbon Nanotubes (CNT's) within the cementitious matrix. The piezoresistive behavior of cement-based sensors containing carbon fibers or particulates changes with the time of curing. It may be observed that the electrical conductivity changes with the advancement of the hydration process. Apart from strain sensing, cement-based sensors are also developed for monitoring condition of concrete structure due to environmental effects such as crack propagation, damages due to humidity and variation in temperature. As cement-based sensors are made up of structural material itself, it offers longer service duration, easy installation and maintenance. This makes cement-based sensors as the better choice over other sensors. These sensors have transformed concrete into self-sensing concrete which makes civil infrastructure smarter..

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How to cite this article: Ankur Kulkarni A. Self-Sensing Concrete for Smart Infrastructure. Civil Eng Res J. 2020; 10(1): 555778.
DOI: 10.19080/CERJ.2020.10.555778.