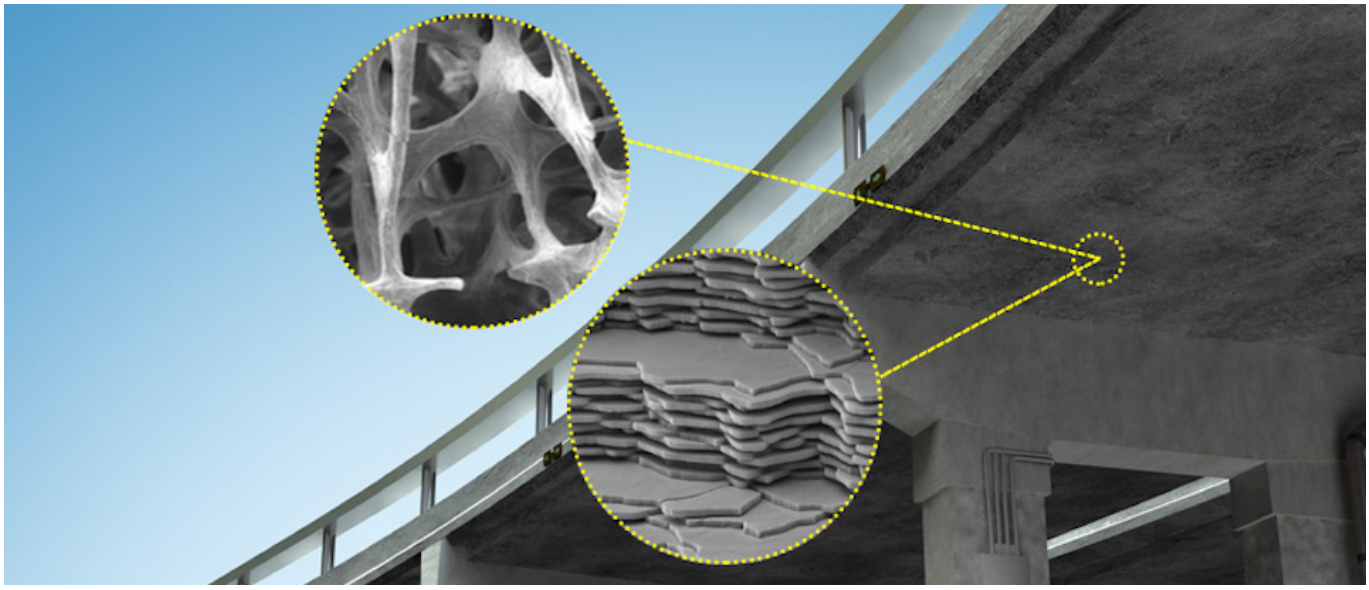

By observing nature's blueprints researchers at MIT are seeking to redesign concrete.

In the journal Construction and Building Materials, a paper was published contrasting cement paste with the structure and properties of natural materials such as bones, shells, and deep-sea sponges. Researchers noticed that the biological compounds are durable and strong due to the fact that they are structured with multiple length scales visible level.

Oral Buyukozturk, a professor in MIT's Department of Civil and Environmental Engineering (CEE), proposed a new bioinspired, "bottom-up" approach for designing cement paste.

"These materials are assembled in a fascinating fashion, with simple constituents arranging in complex geometric configurations that are beautiful to observe," Buyukozturk says. *"We want to see what kinds of micromechanisms exist within them that provide such superior properties, and how we can adopt a similar building-block-based approach for concrete."*

The requirement of a large amount of energy to manufacture Portland cement, the research team hopes to identify materials in nature that may be used as sustainable and longer-lasting alternative.
"If we can replace cement, partially or totally, with some other materials that may be readily and amply available in nature, we can meet our objectives for sustainability," Buyukozturk says.

From molecules to bridges

The current concrete that is being used is a random collection of crushed rocks and stones,

mixed together with cement paste. Concrete's strength and durability depends on its internal structure and configuration of pores. For example, the more porous the material, the more vulnerable it is to cracking. However, there are no techniques available to precisely control concrete's internal structure and overall properties.
"It's mostly guesswork," Buyukozturk says. *"We want to change the culture and start controlling the material at the* ***mesoscale****."*

Building from the bottom, up

To start to understand this connection, he and his colleagues looked to biological materials such as bone, deep sea sponges, and nacre (an inner shell layer of mollusks), which have all been studied extensively for their mechanical and microscopic properties. They looked through the scientific literature for information on each biomaterial, and compared their structures and behavior, at the nano-, micro-, and macroscales, with that of cement paste.

"In this context, there is a wide range of multiscale characterization and computational modeling techniques that are well established for studying the complexities of biological and biomimetic materials, which can be easily translated into the cement community," says Masic.

Applying the information they discovered from researching biological materials, as well as knowledge they gathered on existing cement paste design tools, the team developed a general, methodology, for engineers to design cement, "from the bottom up."

Ultimately, the researchers hope the framework will help engineers identify ingredients that are structured and evolve in a way, similar to biomaterials, that may improve concrete's performance and longevity.

Source:

http://news.mit.edu/2016/finding-new-formula-for-concrete-0526