Green concrete proves more durable to fire

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"When we talk about beams or columns or walls, they always have some reinforced steel," Dr Sarker says. Credit: Concrete Forms

Concrete made using an industrial by-product has shown better fire endurance than traditional concrete when exposed to fires of nearly 1000 degrees Celsius.

Selecting materials with high fire endurance is particularly important when constructing tunnels and high-rise buildings, and when storing hazardous materials, Curtin University researcher Dr Prabir Sarker says.

"In a fire, we don't want the structure to totally collapse," he says.

"If you're storing hazardous material, total collapse would pollute the whole environment. If it's a high-rise building, a lot of people are using the building."

Dr Sarker's research focuses on creating a type of concrete—called geopolymer concrete—made using recycled fly ash, a by-product of coal-fired power plants.

"This makes the concrete greener, it reduces the carbon footprint of manufacturing concrete…that's the most important factor driving this work," Dr Sarker says.

Producing one tonne of traditional cement currently releases about one tonne of carbon dioxide into the atmosphere.

Test subjects closer to industry materials

While previous research focused on the fire resistance of small cubes or cylinders of concrete, Dr Sarker's research examines fire's effect on reinforced concrete panels.

"When we talk about beams or columns or walls, they always have some reinforced steel," he says.

"This is more realistic to the concrete members in a real structure."

Dr Sarker used 125–175mm thick, steel mesh-reinforced panels of

geopolymer or traditional concrete, exposing one side of each panel to a gas furnace fire of up to 960 degrees Celsius for two hours.

He found the geopolymer concrete transferred heat faster than ordinary concrete, resulting in less cracking and flaking.

Dr Sarker then loaded each post-fire panel to failure, determining the residual load capacity of the geopolymer concrete to be 61–71 per cent, but just 50–53 per cent for traditional concrete panels.

"Fly ash geopolymer concrete has better fire endurance as compared to traditional concrete of similar strength, so it'll be more suitable for infrastructure in case of accidental fire," he says.

Using geopolymer concrete in an industrial setting is still in its infancy, with some structures using it in Queensland and ongoing research at Curtin and around the world.

"Previous results have shown geopolymer concrete is also very good in aggressive environments, such as exposure to sulphate during industrial processes," Dr Sarker says.

"There is a lot of interest in Australia and other countries where these by-product materials are readily available."

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