New fire-resistant coating to prevent failure in steel building fires

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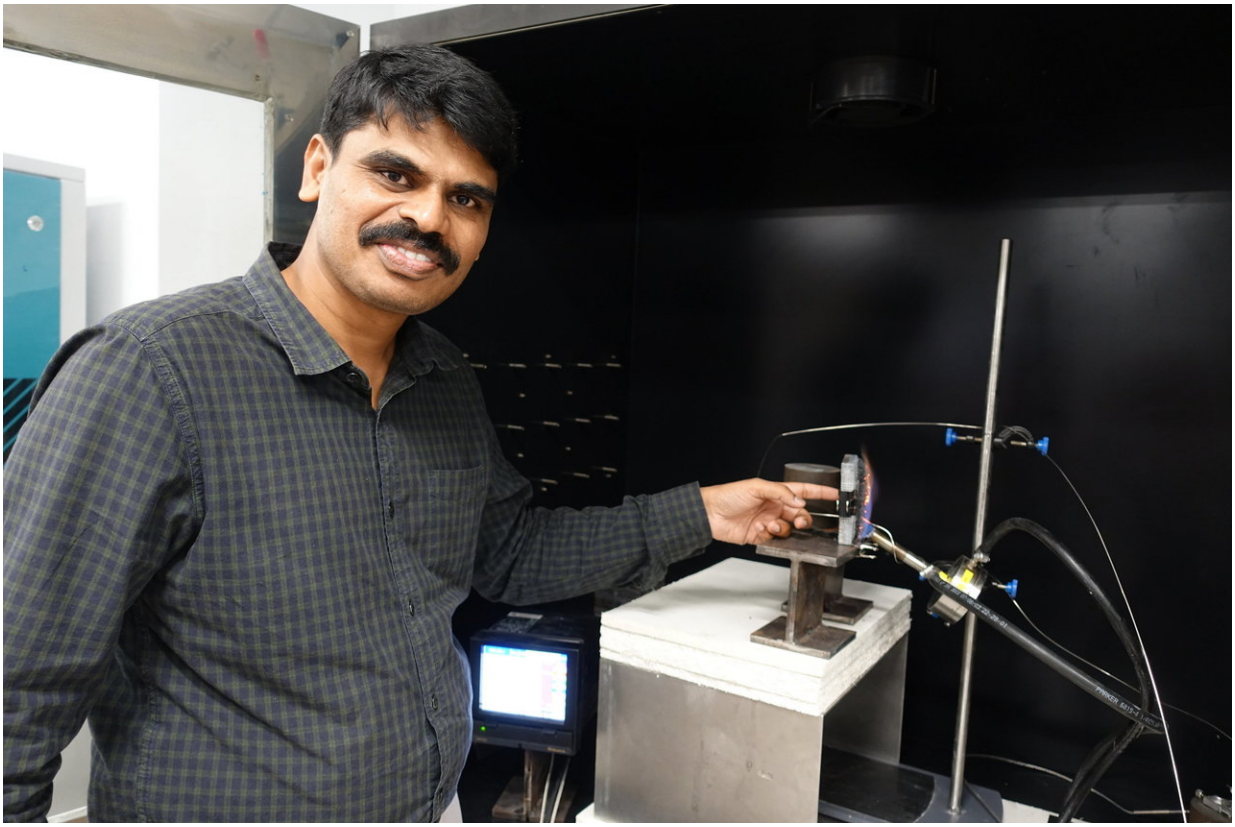


NTU Assistant Professor Aravind Dasari putting his finger on a piece of plastic that is cool enough to touch, which was placed behind a steel plate coated with FiroShield and exposed to a flame over 900 degrees Celsius. Credit: Nanyang Technological University

A few extra coats of 'paint' could be all that the steel in a building needs

to prevent itself from buckling and failing in a fire.

Scientists from Nanyang Technological University, Singapore (NTU Singapore) and Singapore's industrial developer JTC have developed an affordable 3-in-1 coating that offers enhanced fire and corrosion protection.

Existing steel structures in buildings are usually coated with a fire-retardant layer to shield the bare metal from damage by fire and meet the fire protection standard of two hours – aimed at giving occupants enough time to evacuate the building. Today's conventional intumescent coatings are thick, more expensive and laborious to apply.

In contrast, this made-in-Singapore coating can be applied to bare steel without the need for sandblasting to prepare the surface, reducing coating time by half, and will protect the material against fire for two hours without falling off.

Named FiroShield, the new coating is cheaper and less laborious to apply, and can function aesthetically like normal paint.

FiroShield has also been tested on other construction materials, such as reinforced concrete and laminated timber, and has the same excellent performance.

Leading the research team is Assistant Professor Aravind Dasari from the School of Materials Science and Engineering and Professor Tan Kang Hai from the School of Civil and Environmental Engineering.

The team leaders said the knowledge that they have obtained over the years of research on the different aspects of polymers and combustion, combined with civil and structural engineering experience, helped to streamline their approach.

The strength of their coating comes from a balanced mix of additives, which work well together to give off simultaneous chemical reactions when faced with extremely high temperatures. They knew that they had found the right formula when they were able to coat steel samples evenly with a spray gun.

"In a fire, our coating forms a compact charred layer that acts as a protective barrier against the heat," added Prof Dasari, who is also a Principal Investigator at the NTU-JTC Industrial Infrastructure Innovation Centre (I3 Centre).

"While typical fire coatings will also form a charred layer, those are thick and foam-like, which can fall off easily and leave the steel exposed to the fire. What we aimed at was an innovative coat that works differently from conventional intumescent coatings and can stick to the steel surface for as long as possible under high temperatures, and yet has durability and weather resistance under normal conditions without a need for a top coat of paint."

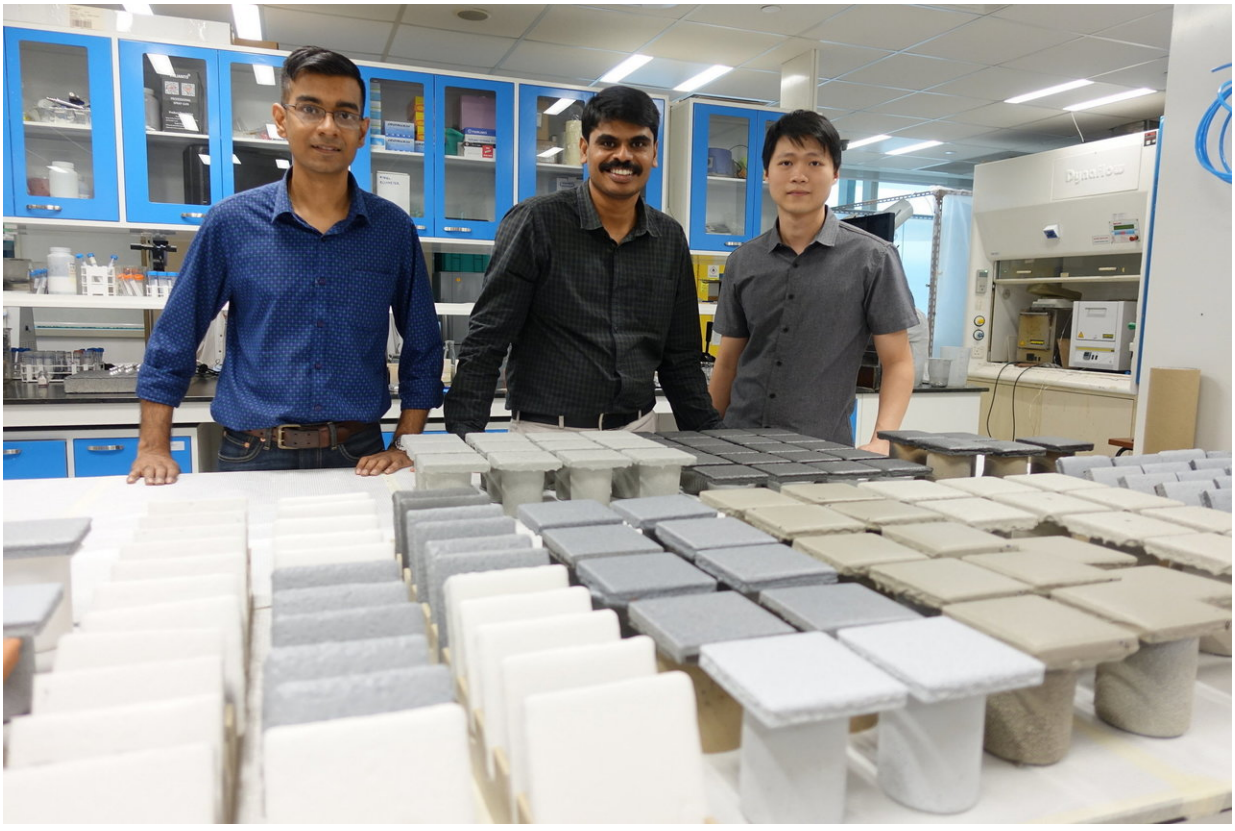
Mr Koh Chwee, Director, Technical Services Division of JTC and Co-Director of the I3 Centre, said that through collaboration with academic institutions like NTU, JTC aims to develop new and innovative solutions to enhance safety and construction productivity for its industrial infrastructure projects.

"The ease of application of this new fire and corrosion resistant coating on steel structures will help reduce labour-intensive work, thus improving productivity and enabling faster coating of prefabricated steel components. More importantly, the new coating's ability to maintain superior adhesion under high temperatures leads to increased building safety for occupants. We are confident that the new coating will be able to reduce both paint material and labour costs, and become a new alternative to other fire protection products," said Mr Koh.

Combination of materials used for coating

The base material of the new coating is made of synthetic resins, which are polymers commonly used to make paints. To give it fire and corrosion-resistant properties, Prof Dasari's team added a combination of common chemicals, including one that is endothermic – absorbing heat to start a chemical reaction that causes the coating to adhere firmly to the steel.

The team went further to develop a coating that is able to have assorted colours; pigments can be added to the mixture so it achieves the aesthetic function of normal paint. Paint manufacturers looking to add the benefits of FiroShield to their products should find that commercialisation is straightforward, as the innovation relies simply on the addition of key chemicals into their paint manufacturing process.



(From left) NTU research fellow Dr Indraneel S Zope; NTU Assistant Professor Aravind Dasari; and NTU PhD student Mr Ng Yan Hao; standing behind the rows of FiroShield-coated steel plates used in their research and development.

To achieve a two-hour fire rating, FiroShield requires just five layers of coating, compared to conventional coatings, which requires up to 15 layers or more. It is thus two times faster to apply and is cheaper by about 50 percent due to its lower materials cost and manpower requirements.

In addition to its fire-resistant properties and easy application, FiroShield can also protect the steel surface from corrosion, which no other fire coatings in the market can do at the moment. FiroShield is expected to last longer when exposed to weathering elements such as moisture and UV rays. Its performance barely dipped by two percent, as compared to the drop of up to 75 percent for conventional coatings when subjected to weathering tests in the lab. This will reduce the maintenance cost and frequency of inspections over the lifespan of a building.

For the next phase of development, FiroShield will be sent to the UK for an industry certification, which includes a load-bearing fire test that no facilities in Singapore can do currently.

Its proprietary formulation has been filed with NTU's innovation and enterprise arm, NTUitive, and upon the completion of the certification, NTUitive will work with JTC to explore commercialisation options.

After the certification, which is expected to be completed by April 2018, the new coating will be applied on steel structures within the upcoming

JTC Logistics Hub. The joint research team will also work with the relevant agencies to roll out this technology on a larger scale.

Building on this technology, Asst Prof Dasari will also work with JTC at the I3 Centre to develop another type of innovative coating for the construction and building industry, which addresses more properties beyond fire and corrosion resistance.

Provided by Nanyang Technological University