SPECIAL FEATURE
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William Conway, Progress Photography
CONCRETE & MASONRY

Awards in the Architectural Merit-Cast-in-Place category for the challenging than residential, generally, he says. “But this was a real challenge. Still, it was an honour for us to get the contract to ensure that the pieces would fit together seamlessly and still accommodate the required rebar, he says. General contractor Walsh Canada was working with engineering, we used guillotine valves and poured from the bottom which turned out to be the best method. The fiberglas actually released really well and we got a good finish.” The saddle was another challenge, he says. It’s a mass concrete curved ceiling spanning between both station entrances under Steeles Avenue West, some eight metres below grade. It took 4:4 concrete p{	extdegree}s of 700 to 1,100 cubic metres to accomplish using traditional wood forms and some loose filler. “It runs about 150 metres by 90 metres with 2,800 square metres of exposed surface,” Soleimani says noting the height varies from 9 metres at the peak to 6 metres at about two metres thick. “The trick there was to ensure the rebars didn’t sink into the concrete and stayed in place,” he says. “The third concrete challenge was the rock-wall, which runs at the station’s south concourse and required some special Styrofoam forms to get some 350 points of intersection accurately laid out using GPS to line them up. Styrofoam was the only material which would give the unique geometrical shapes required for the angle of intersection, Soleimani says. Again the forms were designed using 3D CAD (computer-aided design) software and put in place before an architectural mix of 10 mm (pea gravel) aggregate with a 750 mm spread rating was poured, again using a guillotine valve. “Of course with the Styrofoam, we couldn’t vibrate the forms during the pour because we would damage them,” he says noting the mix was also quick-set so once they started pumping they couldn’t stop because the goal was a smooth, seamless finish with no visible lines. General contractor Walsh had to manage a ballet of trucks in and out to keep the concrete flowing with two pumps simultaneously and back up on standby. Releasing the Styrofoam once the pour was completed became the next challenge and the organic solution, using vegetable oil as a barrier, wasn’t overly effective. “We couldn’t use chemicals because that would cause problems with the Styrofoam,” Soleimani says. To resolve the residue left by the vegetable oil crews sanded the surface to create a smooth, consistent finish. The rock-wall is a very interesting architectural feature but it’s the one we had the most difficulty with in terms of a forming system,” he says noting rings were buried into intersection corners to keep everything seamless. “We had the Styrofoam forms made with a CNC (computer numerical control) machine based on 3D plans. The wall is 50 metres long and four metres high and we needed to have no seams.” There were a few sleepless nights because of the challenges but ultimately the concrete was poured and all stakeholders were happy, and that, says Soleimani, is what matters.
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Researchers test bendable Engineered Cementitious Composite

Concrete is often the building material of choice for construction projects because of its toughness, durability, and the fact it can bear heavy loads. However, the cementitious mixture has an Achilles Heel in the form of lower tensile strength which can lead to cracking under excessive bending. A team of researchers at Louisiana State University (LSU) in the U.S. has been tackling the problem for the better part of two years and is now testing a new, cost-effective, bendable concrete blend for mass market that uses readily available ingredients and has more flexural strength.

The researchers, led by Gabriel Arce, senior research associate in the university’s department of construction management, have come up with a new Engineered Cementitious Composite, or ECC, material, that can withstand the kind of deformation stress that would crack regular concrete.

“Compared to typical concrete our cost-effective ECC material has about 300 times more deformation capacity, more than two times the flexural strength and a higher compressive strength,” said Arce.

“The cost of our material is approximately 3.5 times that of regular concrete. However, when you factor in the possibility of building pavements at half the thickness and the enhanced construction productivity due to the ability to construct pavements without joints, the cost of pavements with our ECC material could be comparable to that of traditional concrete pavements!”

Conventional concrete is made by mixing sand, cement and aggregates and activating it with locally available fly ash. The PVA does not possess the oil-coating that is typically used in PVA fibers for ECC application, which complicates the ability to endow the concrete with a ductile behaviour and makes the design of the material more challenging, but it substantially reduces the cost and increases practicability.

The final LSU mix uses fine sand from the Mississippi River, rather than expensive and hard-to-obtain micro silica, and a polyvinyl alcohol (PVA) fiber that is readily available in the U.S. market. Much of the conventional cement used in the ECC has been replaced with locally available fly ash. The PVA does not possess the oil-coating that is typically used in PVA fibers for ECC application, which complicates the ability to endow the concrete with a ductile behaviour and makes the design of the material more challenging, but it substantially reduces the cost and increases practicability.

After this process, we were able to manufacture ECC materials with locally available ingredients that produced excellent mechanical properties and were economical,” said Arce. Up to 75 per cent of cement in the bendable mix was replaced with fly ash, making it less expensive.

While the material does not exhibit better mechanical properties than typical ECC, Arce said it is more practical because it uses readily available, locally-sourced ingredients at a fraction of the price.

Admittedly, said Arce, the mix is much more expensive than regular concrete, which might not sound economically feasible at first, but only half as much material is needed to perform the same function.

Therefore, the material can reduce the cost because it has the potential to provide more durable and reliable concrete pavements that can mitigate the necessity of recurring repair, saving time and money.

Arce said the research is important because ECCs are promising for repair and construction of transportation infrastructure, along with pavements and overlays.

For instance, he said, ECCs exceptional ductility has the potential to eliminate the need for joints, reducing construction and repair costs, and prevent fracture of concrete pavements. Further, ECC pavements could potentially be constructed at half the thickness of typical concrete pavements.

The material has been used to repair two sidewalks on the LSU campus, mainly to prove that the material is easy to place and finish and can have superior durability to typical concrete at half the thickness. Arce says the sidewalks are regularly inspected and no signs of deterioration have been observed.

A large-scale test of the new material is now underway at the Department of Transportation and Development’s Pavement Research Facility in Baton Rouge. A 120-foot-long section of ECC and a 60-foot-long section of regular concrete have been laid and an Accelerated Transportation Loading System, or ATLAS 30, equipment capable of compressing many years of road wear into a few months, is being used to test the two lengths to obtain data on the overlays.

An analysis of the results is scheduled for later this year. Arce has high hopes of bringing the material to market — not this year, but down the road.

He and his team are still working on improving the cost-effectiveness and performance of the ECC material.

Currently, the team is experimenting with adding waste products from the local sugar industry in the ECC composition.

“Today, results are promising,” he said. “If the successful development of this material continues it will hopefully be able to hit the market in the coming years.”

Research shows that though Engineered Cementitious Composite mix is more expensive than regular concrete it can provide more reliable and durable pavements.
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A group of University of Toronto graduates who were internationally recognized for a proposal to create more environmentally friendly concrete for developing nations is taking its research to the next level.

The research will explore using brine water — a byproduct of desalination that is usually dumped — along with specific microbes to create self-healing concrete, while not tapping into precious drinking water supplies.

David Aceituno-Caicedo, a graduate of U of T Scarborough’s Master of Environmental Science program is going on to his PhD program based on the concept first formulated by his colleagues, Kimberly Asemota and Blandine Barthod, also Master of Environmental Science students at UTSC. Barthod was doing a one-year exchange program from the University of Geneva.

All three will continue to collaborate on the project as it develops, he says.

They entered their idea into the Geneva Challenge, a competition for masters’ students globally. They made it to the top 15 global semi-finalists and walked away with the UN Sustainable Development Solutions Network (SDSN) Youth Special Prize which was presented at awards ceremony in Geneva last January.

While the basic idea of using microbes in concrete to create self-healing concrete isn’t new and nor is using brine — the Romans used seawater to create concrete structures that have survived today — the idea of combining the two and using a waste product to divert it away from potentially harming the environment takes it to the next level.

There’s a lot of work yet, says Aceituno-Caicedo. “We’re going to try to apply this in a laboratory setting to develop what kind of bacteria can appropriately be used.”

They’re also going to be combing through the existing research to push them ahead.

“We’re going to be going through the research to get more of a concrete idea going forward, more of a foundation,” says Asemota. “And that’s going to include concrete mixes and other options. Specifically, we want to look at brine and bacteria too.”

The key for them is to help fight climate change and preserve environmental resources while promoting a closed circuit environment.

Funding for the project will come through the PhD program at the University of Toronto but sponsorship is high on the group’s wish list.

The group is at the beginning of the process. It wants to get something more tangible before accelerating the work, says Barthod. “That’s why David is doing the PhD to get there.”

It all started when Aceituno-Caicedo and Asemota took a geo-chemistry micro biology course and were delving into microbes and how they can be used to extract minerals. That led to a module and self-healing concrete which uses microbes.

From there the discussion widened. Maria Dittrich, an associate professor in the department of physical and environmental sciences connected them with Barthod. The trio then cooked up the idea of using brine laced with microbes to make more sustainable concrete.

“We’re working with that same professor now on my PhD which is cool,” says Aceituno-Caicedo.

Once they determine the right microbes, there will be logistical challenges on how to breed, package and transport them to locations for use in concrete-making. There is also the question of ascertaining how much fly ash or granulated blast furnace slag is optimum and what other waste products can be added to the mix to divert them from landfill but still produce strong concrete.
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Two Queen Street’s work rebuilds its heritage aspects

DAN O’REILLY
CORRESPONDENT

A single 1897 photograph from the Toronto Public Library Archives and an original hand drawing are the only reference materials in the now well-underway restoration of a prominent downtown Toronto retail building which has suffered some unsympathetic treatments during its almost 125-year existence.

Designed by Zeidler Architecture Inc. in collaboration with heritage consultant ERA Architects Inc., the project is intend- ed to carefully rebuild the Philip Jamieson Building while con- serving its cultural heritage attributes. Overseen by construction manager PCL Constructors Can- ada Inc., the far-reaching project encompasses an extensive and painstaking recreation of its façade which was constructed with buff brick and terra cotta and limestone decorative elements.

Clifford Restoration is the heritage contractor which will be installing more than 4,000 replica bricks, stone and terra cotta pieces that will be created by three different suppliers through a combination of 3-D modelling, digital cuts, and hand finishing. The Toronto-based contractor will also be stabilizing and preserving the building’s sandstone signage band which is the only original exterior feature left intact. It will also be restor- ing the first three floors of the back-up wall and rebuilding its fourth and fifth floors.

Now known as Two Queen Street, the Cadillac Fairview- owned and heritage-designated five-storey building at the cor- ner of Queen and Yonge streets adjacent to the Eaton Centre shopping mall will also receive a three-storey glass addition and a 659-square-metre (7,100-square-foot) green roof.

“It’s a building that’s been fighting against itself almost from the time it was built,” says ERA project manager Annabel Vaughan, in tracing the rather convoluted history of the Philip Jamieson Building and the daunting task of restoring it.

“Poorly fabricated terra cotta was used during the construc- tion and then an extra floor, which had been planned for, was added. Then, in 1915, new owners built a wrap-around section on Yonge Street. That was the first in a series of changing own- erships and subsequent renovations. “Each renovation contributed to the building’s decline,” says Vaughan, explaining how key features were lost, compromised, or disfigured during those phases such as the chipping away of the cornices and removing arches.

In the late 1960s the entire building was encased in a white screen in what she describes as “the worst” of those renova- tions/alternations. The screen was removed and partially replaced with aluminum panels in the 1980s as part of a resto- ration effort which was only partially successful, she says.

ERA, the heritage consultant on the project, was first hired in 2012 to conduct a heritage impact assessment study and pre- pare a conservation plan detailing how the restoration was to be conducted.

The following year Cadillac Fairview proposed a redevelop- ment which would have included a tower, but the tower was rejected by the city. In 2016 the current development proposal was submitted, necessitating the writing of a revised heritage impact assessment plan.

Initially, the hope had been that a considerable amount of the original façade could be preserved. But a scaffold inspec- tion earlier this year by ERA and Clifford revealed the various pieces had deteriorated to the point it couldn’t be saved, says Vaughan. As a result, the recommendation was to restore the façade with the replica pieces, and to reimagine historic details, windows and storefronts, she says.

ERA spent “quite a bit of time” designing the building using the 1897 photo, modern-day photography, plus extensive on- site surveys and measurements, cast iron storefront catalogues, and the 1986 restoration drawing package, says Vaughan.

One of the unique aspects of the project is that the first two floors of the addition will only be pushed back from the origi- nal building by one metre. The rationale for the slight setback is that it will actually enhance, rather than detract from the strength of the historic corner, says Vaughan.

The first task in the actual construction began with demol- ishing of the interior finishes and selective structural demolition for investigative purposes shortly after PCL came on site in January 2018, says PCL project manager Cody Halbot.

In December of last year Walters Inc. completed the erec- tion of the 130 tonne (145 imperial tons) interior steel struc- ture (shore tower). Comprised of a mix of temporary and permanent steel, its initial purpose is to give support to the heritage façade. Foundations to support the new superstruc- ture are currently been installed, says Halbot.

Erection of the structural steel for the addition will start in early 2020 and work on the addition and the rebuilding of the heritage façade will be undertaken simultaneously, says Halbot, who expects there will 50 workers on site at the peak of the project next summer.

“We took the building down one brick at a time and will be rebuilding it one brick at a time,” says Cadillac Fairview’s senior director of project management, David Stewart.

Although the developer’s official policy is not to reveal costs on its projects, Stewart says Two Queen Street is one of the most expensive office redevelopment projects on a square footage basis in the Toronto area.

“It sound trite, but it’s the right thing to do. We (Cadillac Fairview) want to make this an iconic building.”

To be completed in about 17 months, Two Queen Street will comprise of a retail ground floor which will connect with the Eaton Centre, a second floor which has the potential to be either retail or commercial, offices on the third to seventh floors and an eighth floor restaurant, he says.

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RESTORATION OF TWO QUEEN STREET IN TORONTO REQUIRES
CONSIDERABLE WORK TO REBUILD HERITAGE ASPECTS

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