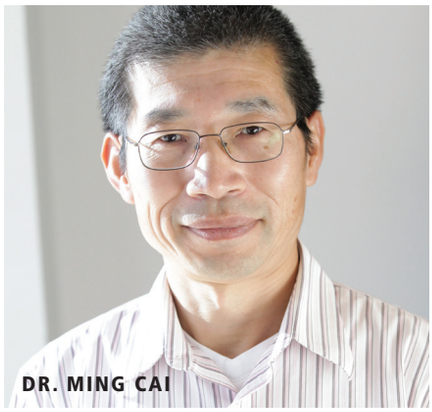

DR. MING CAI

Professor's modified rock bolt design contributes to mining safety

Nearly four years in the making, an undergraduate project from professor Ming Cai's course has produced a technology innovation that aims to improve mining safety and rock stabilization.

By Kayla Perry

Professor Ming Cai's impressive career spans over 25 years of instructing, researching, and working in the engineering industry. Before joining Laurentian in 2009 as a faculty member, Dr. Cai achieved a B.A.Sc. and M.A.Sc. from Tsinghua University in China, and a Ph.D. from the University of Tokyo.

A full professor in Laurentian's School of Engineering, Dr. Cai is also a registered professional engineer in Ontario, and a Research Chair in Geomechanics.

In recent years, he has spent a great deal of time researching rock. His interests lie in topics including rock mass strength, rock mass classification, tunnelling, rock support, and computational geomechanics.

Naturally, his interest in rock mechanics and rock engineering research has translated into some of the courses he has taught at Laurentian, and it was within one of his undergraduate courses that Dr. Cai first began developing the design for a new rock bolt, titled Superbolt.

UNIQUE DESIGN – Rock bolts are conventional measures that are used to support loose rock in excavated mining tunnels. Dr. Cai says that an ideal tunnel excavated in massive and low stress ground will be stable, but there are normally stress-induced fractures, joint discontinuities and gravitational effects that require ground support measures to stabilize the tunnel and create a safe environment.

While installing rock bolts, a slender hole is drilled into the rock wall of a mine's tunnel. The bolt is then inserted into the rock wall, and is secured in place with resin. Often, the rock bolts also secure rows of wire mesh that prevent smaller, loose pieces of rock from falling.

A version of Dr. Cai's Superbolt design features a MCB33 modified cone bolt with a resin-mixing blade, a cone, a reinforcing/de-bonding agent (a corrugated steel pipe), a dome nut, and a dome plate. The de-bonding agent of the steel pipe, coupled with its strength and rigidity, allows for further rock reinforcement: while the Superbolt is physically strong, it can also effectively absorb dynamic energy that is released during a rockburst because of the unique design.

"The bolt has both reinforcing and yielding support capacities, and it can be installed quickly. Thus, it offers potential savings for mining companies to develop mines faster and have effective support with this bolt," he says.

Dr. Cai says the development of more effective rock bolts, like Superbolt, can improve mine safety, especially in Sudbury and other regions with deep mines.

"In shallow ground, there is often loose rock failure, which is easy to secure with conventional rock support technology. In the Sudbury basin, and in Northern Ontario, however, the mines go deeper and deeper underground. There, the ground stress increases due to depth, and it is also affected by mining excavation. This stress can fracture a rock in an unexpected way, and the support in the mine can fail. If this happens, it can cause a rockburst, which is very dangerous."

DEVELOPED IN AN UNDERGRADUATE CLASS – Dr. Cai first recognized the design for this new type of bolt while working with students in his Mining Engineering Design Project course in 2012. He assigned a design project to students working in groups of four, and listed specific criteria for the design of a new yielding rock bolt, including static strength, yielding capacity, ease of manufacture and installation, and cost.

Students took up the design challenge. They began with several different designs, and,in a brainstorming session one afternoon in class, alumnus Ian Van Eyk remembers Dr. Cai noticed something new. "We were trying to design a bolt which would still be effective in supporting the rock, even after a rockburst hits. We decided to brainstorm several different designs for a dynamic bolt that would be resistant to sheer forces, or forces going perpendicular to the rock bolt. Professor Cai encouraged us to work on refining it." Van Eyk says his professor was always helpful. "He gave us the tools to achieve our goals in the course, and if we ever veered off course he'd help put us back on track." In his current position as an Engineering Planner at Vale, Van Eyk says the rock bolt project in the Mining Engineering Design Project course was a very helpful experience in his engineering education.

Of the four students who worked on the rock bolt's initial development, Alexander Watt, Ukelabuchi Tabele, and Ian Van Eyk all graduated in 2012 from the Mining Engineering program and began working for Vale; fellow grad Kevin Pan has been employed at various mining companies and currently works with DMC Mining Services.

Watt also remembers working on the rock bolt project with Dr. Cai and his classmates over the duration of the semester. He says it took self-discipline to finish the project, while balancing full course loads. After his students graduated, Dr. Cai continued to refine the design.

Patenting of the Superbolt was initiated in 2012 when Dr. Cai first disclosed the new design to Laurentian University. Since then the university has pursued its commercialization and patents are pending in Canada and Chile. All four students are listed as co-inventors. Dr. Cai says it may take a few more years for the patents to be issued; it is a lengthy process. All four of the undergraduate students who worked on the project with Dr. Cai were active in the patent application process. Dr. Cai has also secured NSERC CRD funding to develop prototypes.

"Hopefully, this year we'll be able to prove to the industry that this bolt is something that is useful. I'm clearly very passionate about it," says Dr. Cai. Currently, the Superbolt design is being prototyped in collaboration with Sudbury's Mansour Mining Technologies Inc. One day, it could be making underground workplaces safer world-wide.