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Business Stories

Groundbreaking

Innovative foam technique could replace dynamite in tunnel building

By **Tom Ross**, Staff Reporter
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INGREDIENTS COMMONLY FOUND IN INSTANT pudding and toothpaste are helping Chan Young break rock without resorting to dynamite.

Young is the principal in Applied Geodynamics Inc., a small geo-technical company based in Steamboat Springs. He is preparing to launch a breakthrough technique that could dramatically change the way engineers and large contractors break up rock in major construction projects. Young's controlled foam injection method even could make it less costly to dig single-family home foundations on lots with large, buried boulders.

A geophysicist by training, Young has spent most of his career looking for creative new ways to shatter hard rock in mine shafts and vehicle tunnels without the need for explosives. He is refining a technique that uses compressed air trapped in a viscous foam that has the power to break up solid rock far more efficiently and safely than dynamite can. The ingredients in the foam include guar gum, which makes pudding thick, and a benign sodium compound that allows toothpaste to get foamy when it mixes with water in your mouth.

As soon as this summer, Young's controlled foam injection (CFI) device could be put to work enlarging a 134-year-old railroad tunnel spanning the border between Italy and France.

"It sounds a little grandiose, but it has the potential to replace traditional drilling and blasting techniques in 50 percent of civil construction and 25 percent of mining" applications, Young said.

As a young man with a PhD from Stanford University four decades ago, Young was one of 30 scientists working in a Swiss research facility for a manufacturer of air compressors. They were trying to find a way to use compressed air to replace explosives in breaking solid rock. The challenge that they couldn't overcome was the tendency of compressed air to dissipate quickly in cracks in the rock before it could do the job.

Now, after all these years, Young is perfecting a machine that drills holes in rock and then injects pressurized foam into the hole. Young's device seals the hole, so that the expanding air shatters the rock without sending dangerous shards flying over large areas, or creating the toxic fumes that dynamite creates in closed areas such as tunnels.

Young has tested the CFI device in a practice mine in Idaho Springs owned by the Colorado School of Mines, and at a working marble quarry near Redstone.

The CFI device is particularly desirable in places where dynamite is impractical for safety reasons.

Young has formed a business relationship with an Italian company, Ripamonti,

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which manufactures a type of small, tracked excavation implement commonly referred to as "crawler." They will begin in April to create a new CFI prototype based on the metric system. It will be attached to a Ripamonti crawler. A single worker on foot, using a control pad attached to the crawler by a cable, will be able to deliver the CFI to the job site.

The two companies hope to convince a large consortium working on the expansion of the 13.7 kilometer (about 9-mile) Frejus Rail Tunnel, which first opened to traffic in 1871.

The Italians want to enlarge the tunnel, which accommodates two rail lines barely two meters apart, so that it can handle railroad flat cars hauling semi-trailers. The tunnel isn't tall enough, and the plan is to dig the floor of the tunnel deeper. However, there is a strong need to keep one rail line in operation while the other half of the tunnel is being excavated.

That alone makes dynamite impractical. The trains are powered by an overhead high-voltage electrical line that easily could be damaged by flying rock.

At the same time, the Italians must create a small, cube-shaped safety niche every 200 meters in the tunnel. The intent is to create a place where maintenance workers could get out of the way of danger in the tunnel. It's a task for which Young's machine is particularly suited.

At present, construction crews are carving out the safety niches by a laborious method that involves scoring the rock walls of the tunnel with a circular diamond saw blade, then switching to an impact hammer that breaks up the rock. Each cycle takes more than four hours, and it takes repeated cycles to create each of hundreds of niches that must be carved out of the rock.

Young and his collaborators think that when the tunnel consortium sees a demonstration of the CFI device, they'll quickly grasp the savings in time and money it can achieve in the close confines of the Frejus Tunnel.

Dynamite uses 100 times the energy needed to fracture rock, Young said.

"It's horribly energy inefficient, It creates a horrendous air blast, flying rock and toxic fumes," he said.

Venting the poisonous gasses from a tunnel shaft can be expensive.

With the CFI method, an injector seals the inside of the hole so the pressurized foam cannot escape. Within a second, the pressurized foam does its job, and rock cascades away from the point of the hole at relatively slow speeds that don't damage the CFI device.

"Instead of going 'kablooie,' it goes 'whoompf,'" Young said, describing the muted sound that results from shattering the rock.

Whereas dynamite explodes in a tiny fraction of a second and shatters rock with a shockwave and expanding gases, the forces involved in the CFI technique are unleashed relatively slowly and are much more controllable. The residue left behind by CFI is harmless, water-based foam.

Young acknowledges that there have been minor setbacks along the road to perfecting his CFI technique. And contractors have been reluctant to use unproven technology.

"It's been frustrating at times," Young said. "Nobody wants to try something that hasn't been out there in commercial use. You have to find a project where the motivation is very high."

The expansion of the Frejus Tunnel could be just such a project.

The sensitivity to tunnel safety among Europeans was heightened by a 1999 fire in the Mont Blanc Tunnel, Young said.

Some European countries have set out to modernize their tunnels. In the northern lakes region of Italy, many villages are built on the shore of lakes. Frequently, the only road into and out of a village passes through a single-lane tunnel managed by a control signal that allows cars to pass in one direction at a time. There is a push to replace the old, single-lane tunnels with more modern

tunnels. But the amount of development surrounding tunnel sites makes it risky to use explosives.

Young holds patents on CFI in several countries and hopes to acquire an international patent that would eliminate the need to obtain patents country by country. Ultimately, as the technology proves itself, he envisions licensing the technology to a multinational geo-technical firm. But he also knows to expect the unexpected.

"With Mother Nature, you never know what's going to happen. And rocks are the epitome of that," Young said.

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