Guide for typical application of S-Complex™

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Primary Objective: - Significantly improve production rates - Up to 600%

Additional benefits: - 30% reduction in blade wear for the same volume of cutting

- Improved finish of cut
- Up to 3db reduction in loudness of cutting

Mechanical-chemical effects, The Rebinder effect

Technical jargon and why we pursued this line of investigation:

P. A. Rebinder (1928) proposed that the energy of the freshly exposed rock surface to the bit (diamond segment) can be reduced by chemical adsorption, which softens the rock, enhancing the crack generation as a result of indention of the bit. In other words, the fresh rock will be rapidly degenerated due to chemical weathering in a special chemical environment (K.U.M. Rao et al., 2002). Furthermore, the United States Bureau of Mines (USBM) reported an increase in drilling performance by neutralising the surface charge (zeta potential) of rock (A. Bhatnagar et al., 2011, J.E. Pahlman et al., 1989, P.J. Watson et al., 1989). These effects can be applied during the drilling or cutting process by adding certain chemicals to the drilling or cutting liquid.

Practical explanation

By adding as little as 0.5% S-complex to cooling/lubricating/water (adsorption-active liquid) you can dramatically reduce the tensile strength of the rock at the interface of the blade and the material being cut. We call this phenomena the Mechano-Chemical effect.
The effect characteristically takes the form of a manifold drop in strength, an increase in friability, and a lessening of durability the material being cut. In and independent trial conducted by RMIT (Royal Melbourne Institute of Technology) we were about to achieve a 600% increase in diamond core drilling speed, through grey granite.
The Discipline Head of the Civil Engineering department Associate Professor Sujeeva supervised the cutting trials, whilst the Head of the Aerospace and Mechanical Engineering department Professor John Mo oversaw the assessment of the diamond tooling.

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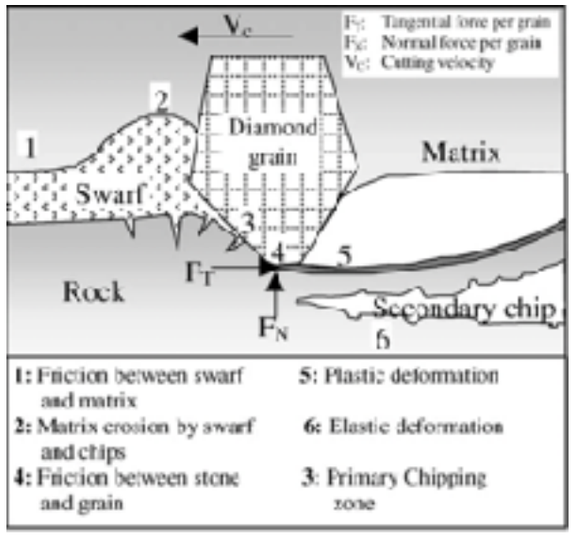
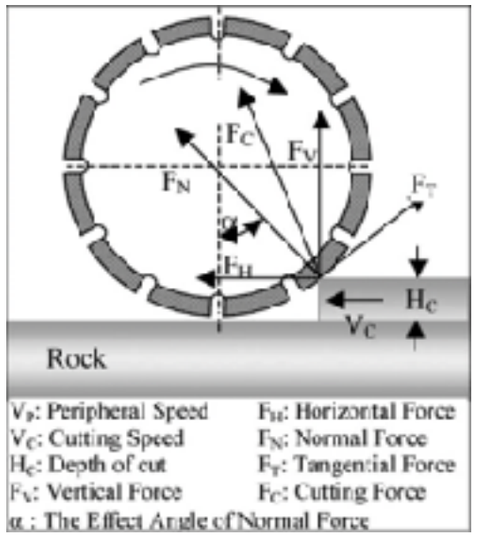
Diamond blade wear

Wear of sintered diamond saw blades can take many forms, but the most common wear mechanism operating on the saw blade during rock cutting, is abrasion. Impact loading and impact fatigue also contribute to the wear of the diamond segments. This wear occurs on a microscopic level, through a process of impact load and shock, and impact fatigue on the individual diamond grains. On impact with rock particles, some diamond crystals exhibit crushing in which the edge of diamond grain is gradually removed. Other grains often exhibit cleavage fracture. (Fracturing on the natural growth lines in the diamonds). The rate at which abrasion occurs is dependent upon the hardness differential between diamond segment and rock. The impact fatigue is also exacerbated by the heating and cooling that occurs as the blade enters and exits the cut. This thermal shock on the diamond creates micro fractures that propagate into macro fractures when water in the fractures expands, which leads to the diamond spalling. One beneficial property of the of S-Complex is that it is preferentially attracted to the diamond over water, the S-Complex has a lower expansion rate inside the diamond which typically yields a 30% increase in tool life.
The wear characteristics of the diamond and the matrix in rock cutting are substantially different and have two different wear mechanisms. Therefore, the matrix and diamonds must wear simultaneously in order to facilitate constant and efficient cutting.
An understanding of rock properties is essential for the proper selection of diamond segment, cutting machine and for the selection of appropriate operating conditions, ie feed speed, rotational speed and depth of cut.

To put this in simple terms: It is essential that the operator constantly evaluates the diamond segments and adjusts the saw parameters to suit the material being cut and the blade they have on the machine. It is also worth noting that diamond blades made in the same factory with “identical materials” can typically differ in performance by as much as 10% and the stone can vary in hardness from one side of a quarry to the other. The operator can never assume that the blade or the stone are the same as the last one.





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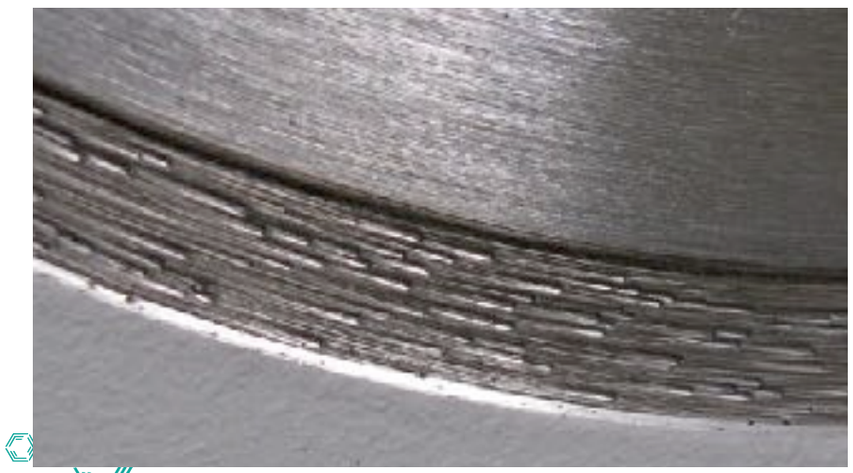
Practical evaluation of the diamond blade

Here the diamonds have been pulled out before they could cut anything. A total waste of money. To remedy this you could either increase the RPM or reduce the feed speed. Most likely a combination of both.

Observations of the blade

Looking at the blade we begin to see fresh diamonds, however there are no comet tails. Reducing the RPM will “soften” the matrix and expose more diamonds.

Comet tails are now present on the blade, we are chasing the sweet spot of wearing away the matrix and consuming the diamonds at an equal rate.
Instead of dressing the blade, a good operator should be able to modify the saw parameters to keep it sharp. It is also worth paying attention the sound of the cutting, you will quickly become familiar with the sound of a sharp blade.



Sharp blade

Blunt blade, lots of grit pop out, no comet tails

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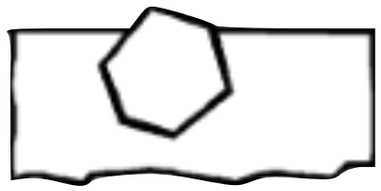
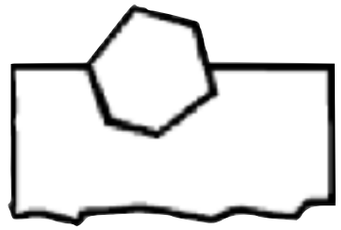
Diamond wear principles

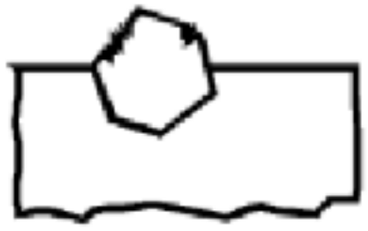


Fresh diamond



Sharp diamond

Macro - chipping and blunt diamonds



Micro - chipping

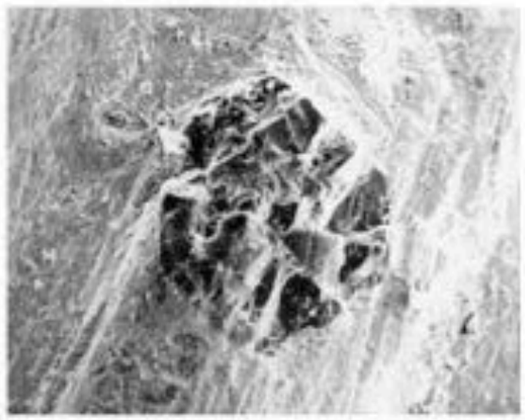
Holes arising from grit pop out

Deep empty

Flat empty

Diamond grit in matrix

Emerging new grit



Fractured grit

Whole segment surface

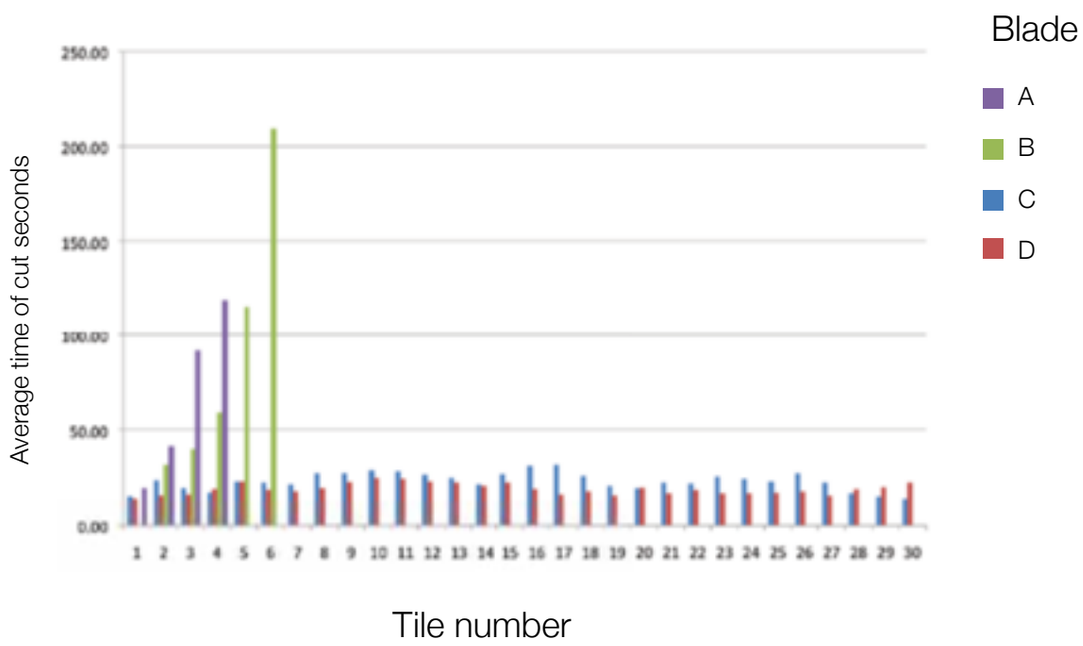
Wear flat on grit

Holes arising from grit pop out

Example of Rache trial of S-Complex™

Trial design:

- 4 continuous rim blades, cutting of vitrified ceramic tiles, with the same feed rate and pressure
- Blades A and B with water, C and D with S-Complex
- Computer connected to the saw measures load and the time of the cut
- Times are averaged over 10 cuts per tile



Result:

S-Complex™ achieves a 6 fold increase in performance as a lubricant compared to water

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Typical application of S-Complex™

A MixRite 2.5 dosing pump is added to the water inlet feed on the saw and **S-Complex™** is added to the system @ 0.4% - 4%

Typical application rate is @ 0.5% to 1%

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Application of S-Complex to work piece

The mere presence of water and S-Complex around the blade does not necessarily indicate that it is being properly applied. It is essential that there is sufficient volume and pressure of the water to overcome the envelope of air surrounding the diamond blade, which is generated by its rotation. Great care must taken to direct the S-Complex onto the blade and into the kerf of the cut, to ensure that the cutting surfaces are kept wet at all times.

An example of an effective cooling system, looks like a turning fork and consists to two perforated pipes extending along the sides of the blade, connected to common pipe at the outer end and fastened to the blade guard. The S-Complex is directed downward at approximately at 30 degree angle to the rotating blade which allows the water jets of S-Complex to penetrate the air envelopes surrounding the rotating blade and cling to the surface of the diamond blade instead of bouncing off.
The S-Complex will then spiral to the periphery of the blade in a thin wheel, wetting the cutting surface and reaching the bottom of the kerf. An additional jet at the front of the saw, pointing directly into the leading edge of the cut, can yield even greater increases in performance.

Reduction in noise: Average 3.3db reduction in sound on a Zambon block saw cutting Austral Black (Compressive strength 193MPa/217MPa, Bulk Specific Gravity 2.97 tonnes/m3)

Reality

Physics tells us that for every doubling of acoustical energy, there is a 3dB increase. Conversely, a 3dB decrease means the sound is cut in half. So, 3 is the magic number right? Well, not so fast. This is where we see a conflict between scientific calculations and perceived sound levels. “Perceived” sound levels report how our ears and brain interpret the sound. In other words, perception answers the question of “What sounds ‘twice as loud’?”

Perception

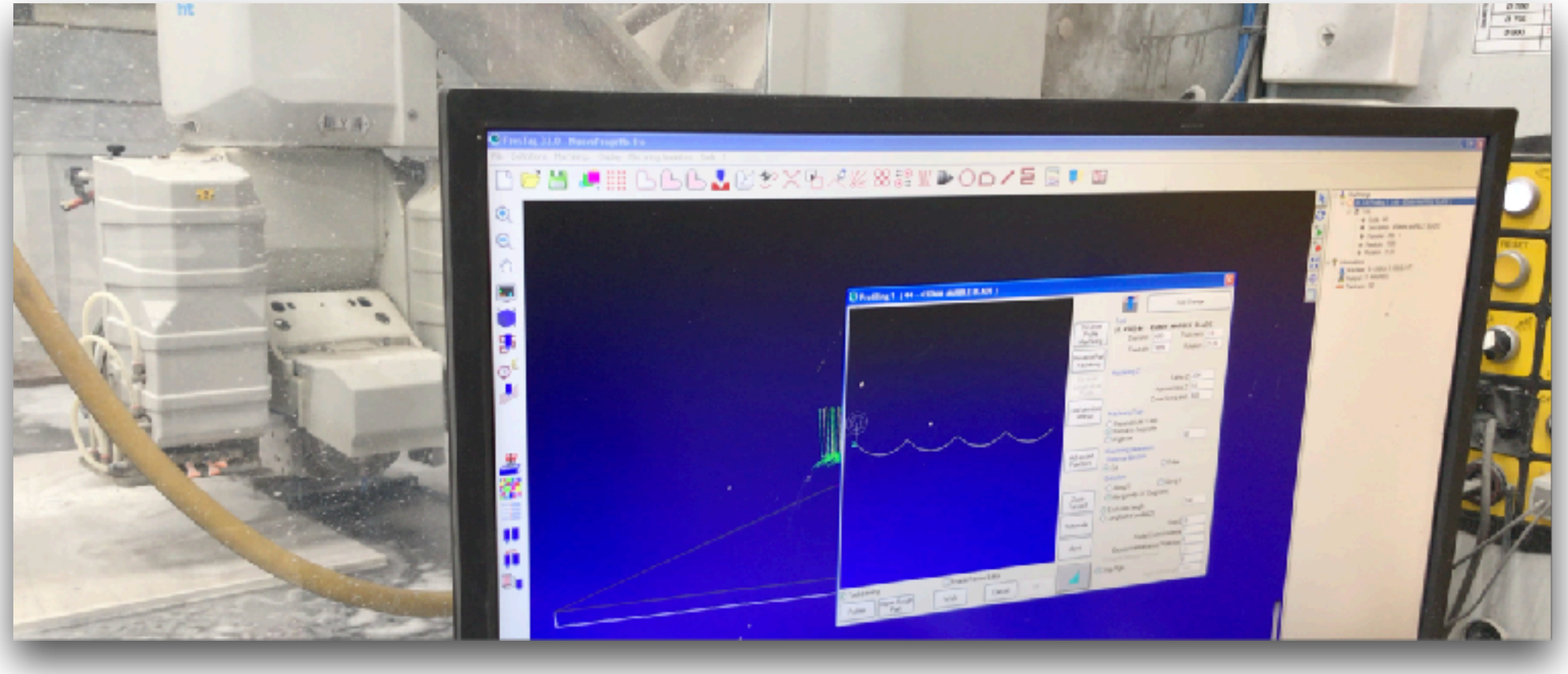
Sound studies tell us time and again that a 3dBA increase in sound level is barely noticeable to the human ear. In fact, you have to raise a sound level by 5dBA before most listeners report a noticeable or significant change. Further, it takes a 10dBA increase before the average listener hears “double the sound.” However the perceived volume is significantly influenced by the frequencies that we are hearing. When cutting very hard material the saw can produce high frequencies that are perceived has extremely loud. By introducing S-complex when cutting Dekton, one customer reported that they no longer needed to wear earmuffs, creating a significantly more peaceful work environment.

Examples of the improved edge finish S-Complex™

Without

With S-Complex™

Examples of the benefits of S-Complex™



15 seconds after turning on the **S-Complex™** the profiling feed rate increases from 1990mm/sec to 4200mm/sec - instantly doubling the production

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Thanks for reading.

Please call or email me if you have any questions.

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