

**How critical is mix designs and
rock substrate preparation for
your shotcrete applications ?**

Wouter Hartman
Senior Geotechnical Engineer

IT ALL DEPENDS ON THE OBJECTIVE OF YOUR SHOTCRETE APPLICATION

• Protection

Personnel safety

Prevention of rock mass deterioration

Prevention of damage to equipment and vehicles

Rock fall prevention – size?

Scat control

Confinement

Maintain access

Prevent ground water seepage

Support corrosion protection

Rehabilitation



7th Nov '05

EAGCG –Shotcrete Workshop



7th Nov '05

EAGCG –Shotcrete Workshop



7th Nov '05

EAGCG –Shotcrete Workshop

BUT IN WHAT

- **Type of Excavation ?**

Shafts, Declines, Cross-cuts, Winder house

Stope access, Draw points, Ore passes – shaft, stope

Crusher chamber, Pump chambers

Substations

Crib room

Explosives magazine

etc.

- **Significance ?**

- **Longevity ?**

- **Size ?**

An Example of Application

To apply shotcrete or sprayed concrete to the rock substrate for : An underground Explosive Magazine
Newmont - Pajingo

The Explosive Magazine consists of a Detonator Chamber, Anfo Chamber and a Powergel Chamber

Excavation and Queensland Regulatory Requirements

- Excavation must be dry and well ventilated
- Rock fall prevention and scat control
- Monorail to be installed

An Example of Application

An underground Explosive Magazine

-The mix design important for:-

Shotcrete consistency – Consistency creates a logistic nightmare – One way was to have the material mix pre-bagged
Control for consistency Q/C slump tests prior to or during application or cube tests after 3-7 days following application

In this case admixtures not important for early strength gain – rather ensure the shotcrete does not deteriorate due to through ventilation

Mona Filament Fibre dosage high – (If shotcrete to crack)

Sand : Cement Ratio – could be 4-3 : 1

125mm thickness – size of excavation 8m – 15m wide





An Example of Application

An underground Explosive Magazine

-The rock substrate preparation important for:-

**Prevention of shotcrete dislodge and set-off detonators,
spark prevention**

**Rock surface drill rig check scaled to create roughness or
scouring effect**

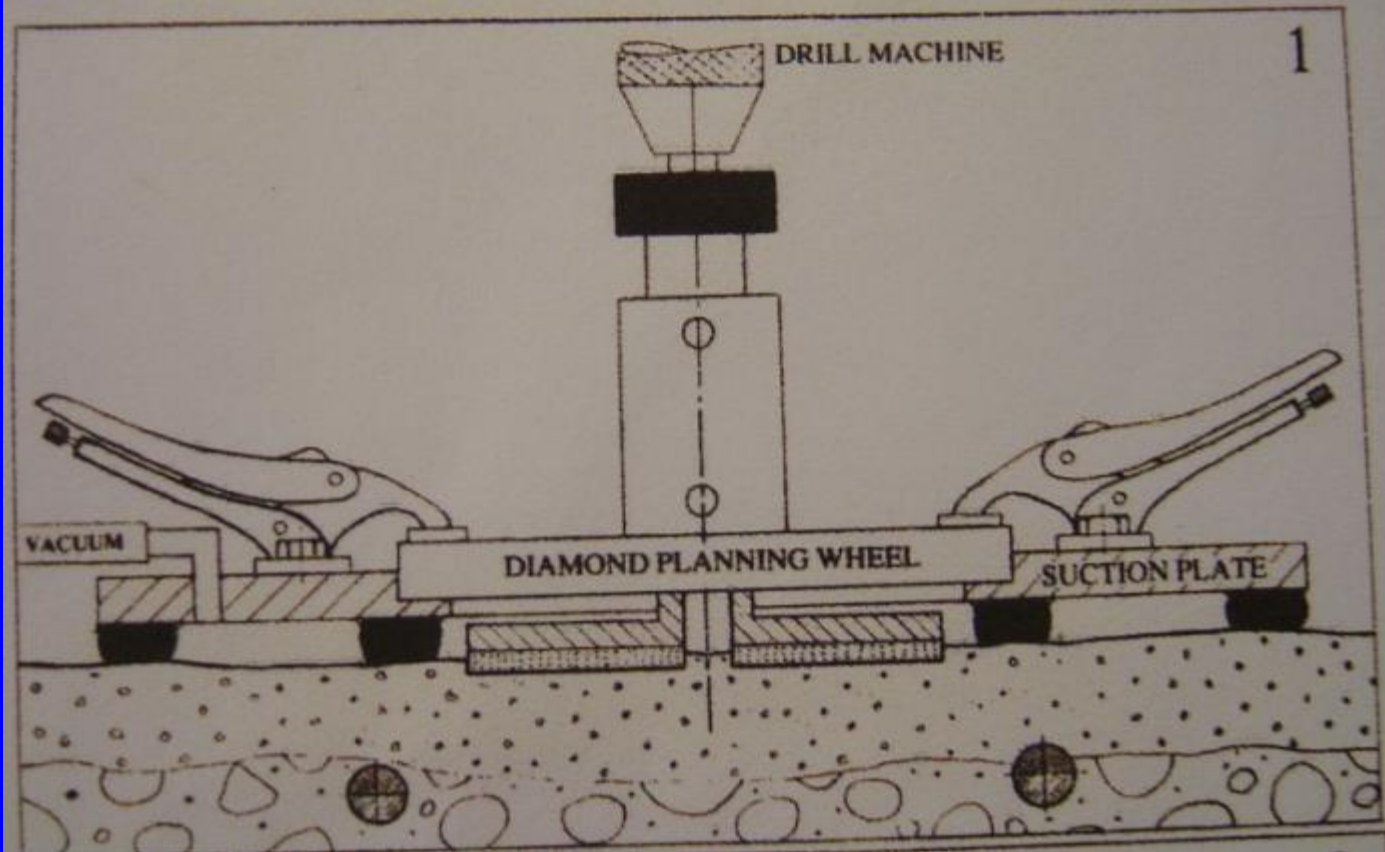
Rock surface to be thoroughly washed and clear of dust

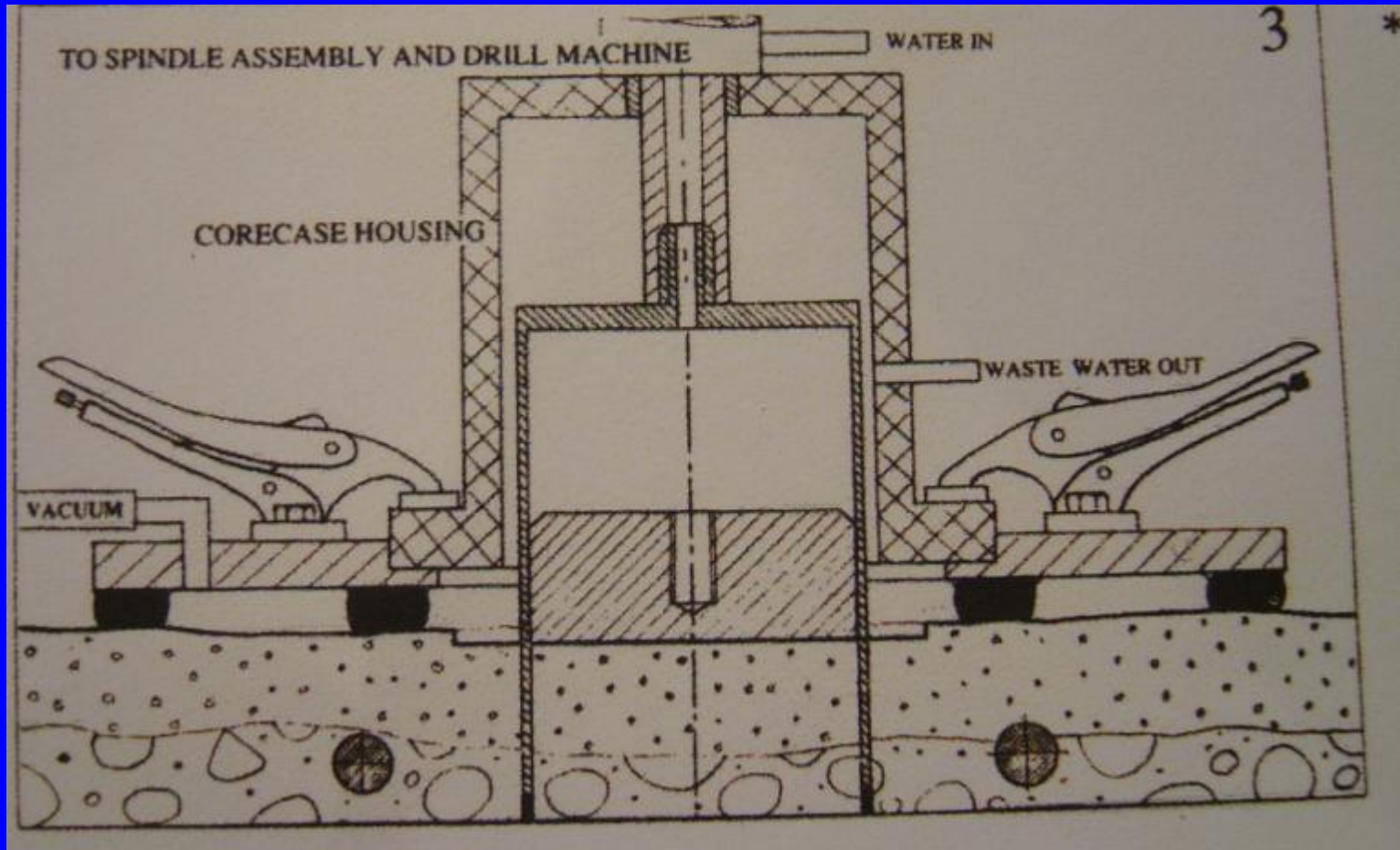
**How sure are we even after all of that, that good bond is
achieved ?? Is the risk to high to take any chances..**

An Example of Application An underground Explosive Magazine

- Bond strength testing can be done by:-
 - A Bond Test Pull machine Kit (German instruments)
 - The Bond test could be done in accordance with a British Standard BS 1881, Part 207:1992
 - Question remains what pull-off limit ? \$\$ MPa ?

BOND-TEST PROCEDURE





An Example of Application
An underground Explosive Magazine

or

**Spend some more \$ - Apply shotcrete, mesh and
Shotcrete over mesh for corrosion prevention**

WHAT'S IN A STORY ?

BACKGROUND



BACKGROUND

NOVEMBER 07, 1994

S2-42\94
CAS.
EXHIBIT

I, WOUTER HARTMAN STATE THAT:

I am a Strata Control Officer on the South Mine of Vaal Reefs Exploration and Mining Company Limited, of which No. 2-shaft is a member. Part of my responsibility is to advise management on matters pertaining to Rock Mechanics.

On November 7, 1994, I was informed that a fall of ground on November 05, 1994, in the 72 N RAW, had resulted in the death of one contractor employee and injury to another. I visited the scene of the accident in the presence of the Regional Mining Engineer, the Assistant Mine Manager and other production officials responsible for this workplace.

The opening-up and rehabilitation of the RAW is currently a priority. The RAW is currently in a high stress environment due to the 72 N 56A pillar $\pm 65\text{m}$ above the tunnel. The recommendation stated that the old support installed should be removed and replaced with 75mm re-enforced steel-fibre shotcrete, 40 ton 6,0m pre-stressed anchor's (6 in a row 2m apart, pre-stressed to 20ton) and meshing and lacing on a 1m diamond pattern.

BACKGROUND

The current applied layer of shotcrete does not meet the required thickness and the meshing and lacing lags $\pm 12\text{m}$ behind the opening up. Most of the 6,0m anchor's installed are not fully tensioned.

The sidewalls and hangingwall at the scene of the accident was highly fractured and consisted of slabbing with clean conchoidal surface breaks which could be related to tensile breaks.

No temporary support was seen at the time of the visit. The only hangingwall and sidewall support observed was the $\pm 15\text{mm}$ average thickness applied shotcrete in places.

The fall was bounded by a near vertical irregular induced stress fracture on the southern sidewall of the RAW. The fall of ground consisted of a slab with dimensions of approximately 0,35m x 0,65m x 1,13m (maximum length) in size.

The position of the dislodged rock suggested that the rock had dislodged at a time when the weight (6,8 kN) was in excess of the shear strength of the applied shotcrete. However, it is not known what had initiated this fall of ground.

CONCLUSIONS

- **Mix design carries a significant weight in shotcrete application but depends on what you want to achieve**
- **Endless hours of numerical analysis and mix design trials are wasted if rock surface / substrate not properly prepared for shotcrete application**
- **How do you managed it: By ensuring specifications are provided to contractors, shotcrete application process is consistent and end product is quality controlled**