SUPER CAUTIOUS CONTOUR BLASTING UNDERGROUND

SÜPER TEMKİNLI YERALTI (DIŞ HAT) KONTUR PATLATMASI

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ABSTRACT

C/er break in construction and mining is normally dealt with by smoooiü blasting. Slim, light explosives charges have been manufactured specially for blasting of the contour. Increased mechanization of rock excavation has called for new explosives that can easily be charged mechanically. A new explosive will be presented together with a special charging method. However, the end result of the first trials ended up in a completely new method for smooth blasting, a Super Cautious Contour Blasting Method.

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1. INTRODUCTION

In tunneling and other underground blasting operations, it is of utmost importance that the remaining rock is of as high quality as possible to avoid rockfall and to minimize reinforcement works like rock bolting and grouting.

Accurate blasting is specially needed in those underground works where the over break has to be replaced with expensive concrete.

The prevailing method for underground perimeter control is smooth blasting, it was introduced in Sweden in the mid 50th and refined during the 60th. Special small diameter explosives with low VOD (velocity of detonation) and low gas content were developed, to mention one, Gurit, which is has stable detonation in diameters down to 11 mm. With this new explosive it was possible to make contour blastings that had a rather light effect on the remaining rock contour.

... simultaneous with the development of smooth blasting explosives, research was going on to define the damage zone for different explosives to the contour. It was found that ANFO in a 45 mm blasthole could cause cracks in the surrounding rock up to 1.5 m from the hole and an 80% dynamite in 25 mm cartridges had a crack extension of close to 1 m from the hole. For the specially designed smooth blasting explosive Gurit the crack extension was limited to 0.3 m.

Increased mechanization of the construction and mining industry has called for faster and simpler methods for the charging of the contour holes with a light and well balanced explosive. The whole work cycle, drilling, charging the blastholes, ventilation, excavation and reinforcement became faster, but the charging of the contour holes was still made in an old fashioned way. Some times tubular plastic cartridges were connected together, but often were separated dynamite cartridges taped to a wooden bar and initiated with a detonating cord. A time consuming method which also added more carbon monoxide into the blasting fumes.
2. **AKFO USAGE IN UNDERGROUND**

ANFO is nowadays used in underground operations to an increasing extent, it is blown into the blastholes from a container through a plastic hose by pneumatic pressure. The charging is normally done from a platform on a charging truck, a fast and simple procedure. However, ANFO is not a good explosive for the contour, it is too strong. Many experiments were carried out to mix ANFO with an inert material which did not participate in the detonation but helped to carry the detonation through the whole column of explosive. Expanded polystyrene spheres showed to be a good material for the purpose, the detonation was stable and it did not contribute much to blasting fumes. The disadvantage with polystyrene spheres was its low density, 0.02 g/c.c. compared to 0.8 g/c.c. for ANFO. The mixture separated during charging with ANFO remaining in the hole and the polystyrene spheres outside. Different methods were tested in order to get an well distributed mixture in the hole but none was successful.

3. **ANFO + EMULSION USAGE IN UNDERGROUND**

It was not until Nitro Nobel started to mix in Emulite matrix as "stickifier" that it was possible to get an homogeneous mixture that did not separate during charging with pneumatic equipment. The new mixture got the tradename Emulet and its volume strength could be varied from 20 % of ANFO to 90 % depending on the content of polystyrene spheres.

The new contour blasting explosive was tested in the construction of the road tunnels under the Karolinska Hospital in Stockholm Sweden with excellent result.

At the time of the tests we were negotiating with a contractor in Saudi Arabia about delivery of explosives and initiation devices to a major underground project. We presented the experiences from Sweden and it was decided that we should start manufacturing of Emulet in Saudi Arabia.

It was a time lag between decision and implementation of a few months and in the meantime the contractor used 25 mm diameter emulsion explosive cartridges taped to a wooden bar of 4 m length separated 30 cm. The cartridges were initiated with 10 g/m detonating cord. We then decided to try 40 g/m detonating cord (which we had in stock for seismic prospection) as smooth blasting explosive and both one and two strings were tried in the holes with good result.

So the explosives that was used in a normal tunnel round were now, 40 g/m detonating cord primed with a cartridge emulsion explosive in the contour and ANFO in the rest of the round primed in the same way. NONEL GT/T was used for initiation. The method resulted in a certain over break.
When Emulet was ready for introduction, the charging trucks had also arrived. They were fitted with two containers, one for ANFO and the other for Emulet. The charger could select the explosive he needed from his platform by remote control.

The introduction of the new explosive, Emulet with a volume strength of 20% of ANFO and the new smooth blasting method was successful but after a while it was found that the method had some shortcomings, especially in incompetent rock.

The rock at the work site where the method was first introduced was a very weathered granite and it happened that some of the contour holes were not fully blasted and it was often the outer part of the hole where rock remained.

The cause of this problem was most probably that the ANFO in the holes closest to the contour caused excessive overbreak so the column of Emulet was interrupted.

This problem did not occur with 40 g/m detonating cord in the contours as the detonating cord is solid and strong while Emulet run out of the hole when the rock disappeared.
The charge concentration of ANFO in a 48 mm blasthole is 1.45 kg/m of the hole. If we reckon with damages to the rock appearing at vibration velocities of 700 to 1,000 mm/sec, it can be seen from SVEDEFO:s graph that these vibration velocities are found between 1.2 and 1.7m from the blasthole and that the damage zone theoretically could extend that far. With a burden distance of 0.8 m, the contour holes are definitively in the risk area.

Emulet with a charge concentration of 0.35 kg per meter has a theoretical damage zone of 0.4 to 0.6 m.

Now trial blasts started with Emulet in the stoping holes closest to the contour and 1 string of 40 g/m detonating cord in the contour holes. The result of the trials was excellent in the weathered rock.
The risk for over break and damage to the remaining rock had decreased considerably.

The same method was later introduced to a work site with good homogeneous granite and the result in place is even better.

4. CONCLUSION

According to all methods for calculation of burden distance, 40 g/m of explosive is far too little to break a burden of 0.8 m which is the actual burden. The spacing between the holes is 0.6 m. It should be needed approximately 4 times as much 80 % dynamite or one column of 17 mm Gurit.

It can be that way that detonating cord with its high VOD and high detonation pressure makes twice as much work as dynamite, but it is most probably so that Emulet in the holes closest to the contour weakens the rock (see fig. 6 between the lines for charge concentration of 0.23 kg/m and 0.5 kg/m that crack extention can reach 0.8 m) enough for a 40 g/m detonating cord to break the rock and give a smooth and nice contour which is relatively stable after the blasting. In reality, the rock must only be loosened, no throw is needed, gravity takes care of that.

Another possibility to decrease the risk of over break from the holes closest to the contour is to charge those with a mixture of Emulet 20 and ANFO thus obtaining an explosive with a strength between ANFO and Emulet. In this case however it was decided not to use that option.

The method to use 40 g/m detonating cord in the contour and Emulet 20 in the holes closest to the contour has shown to be a technically good smooth blasting method. Furthermore it is cost effective and the disadvantage of the detonating cord not being mechanically chargeable is not that big as the cord itself is quite rigid and easy to introduce into the blasthole. The smooth blasting method is now widely accepted.

REFERENCES: