SUPER CAUTIOUS CONTOUR BLASTING UNDERGROUND

SÜPER TEMKİNLİ YERALTI (DIŞ HAT) KONTUR PATLATMASI

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ÖZET

İnşaat ve madencilikte fazla kazı, normalde dış hatlarda patlatma için özellikle üretilmiş ince, yumuşak patlayın şarjları ile yapılmış düzgün patlatmalarla kontrol altına alınır. Kaya hafriyatlarında mekanizasyonunun artması makine ile koloylıkla şarj edilebilen yeni patlayıcıları gündeme getirmiştir. Bu bildiride özel bir şarj metodu ile birlikte yeni bir patlayıcı sunulmuştur, flk denemelerin sonuçlarında yumuşak patlatma için tamamiyle yeni bir metod doğmuştur. Bu, süper temkinli kontur patlatma metodudur.

ABSTRACT

C/er break in construction and mining is normally dealt with by smooiü blasting. Slim, light explosives charges have been monufactured 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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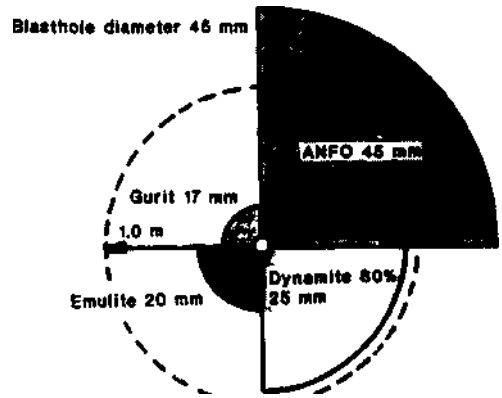
1. INTRODUCTION

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.



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simultaneously 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 extention of close to 1 m from the hole. For the specially designed smooth blasting explosive Gurit the crack extention 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 seperated dynamite cartridged 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 UNDERGROUNG

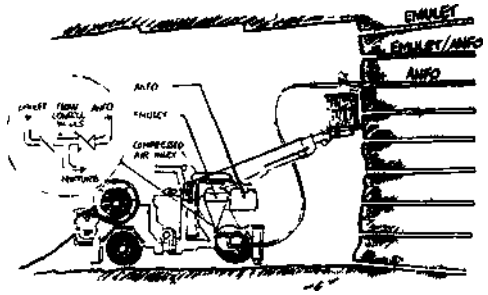
It was not until Nitro Nobel started to mix in Emulite matrix as "stickifier" that it was possible to get an homogeneous mixture that did not separate during charging with pneumatic equipment. The new mixture got the tradename Emulet and its volume strength could be varied from 20 % of ANFO to 90 % depending 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 undeground 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 contractorused 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 prospecting) as smooth blasting explosive and both one and two strings were tried in the holes with good result.

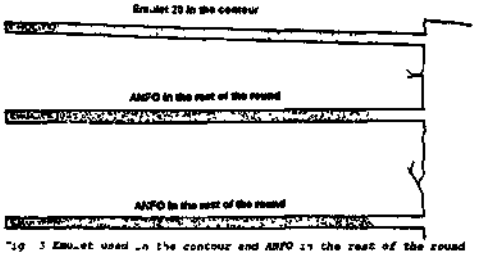
So the explosives that was used in a normal tunnel round were now, 40 g/m detonating cord primed with a cartridge emulsion explosive in the contour and ANFO in the rest of the round primed in the same way. NONEL GT/T was used for initiation. The method resulted in a certain over break.



Tig. 2 Charging truck for ANFO and £muJat.

When Emulet was ready for introduction, the **charging** trucks had also arrived. They were fitted with **two container,** 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.**



Tig 3 Emulet used in the contour and ANFO in the rest of the round

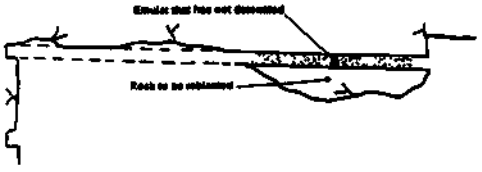


Fig 4 Remaining rock at the contour that is to be obtained

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 over break so the column of Emulet was interrupted.**

This **problem did not occur with 40 g/m detonating cord in the contouras the detonating cord is solid and strong while** Emulet **run out of the hole when the rock disappeared.**

Fig 5 Explosive from the stemming part may cause over break

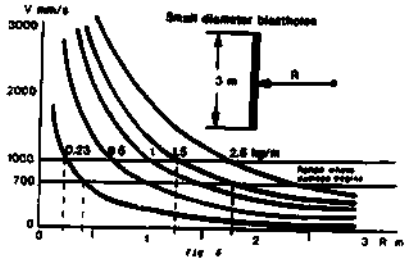


Fig 6

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 definetely 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.

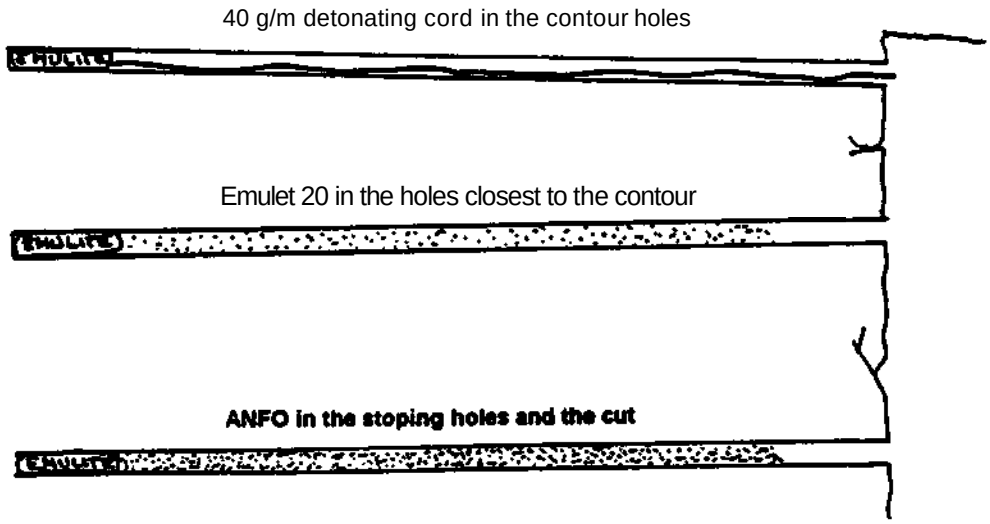


Fig. 7

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.

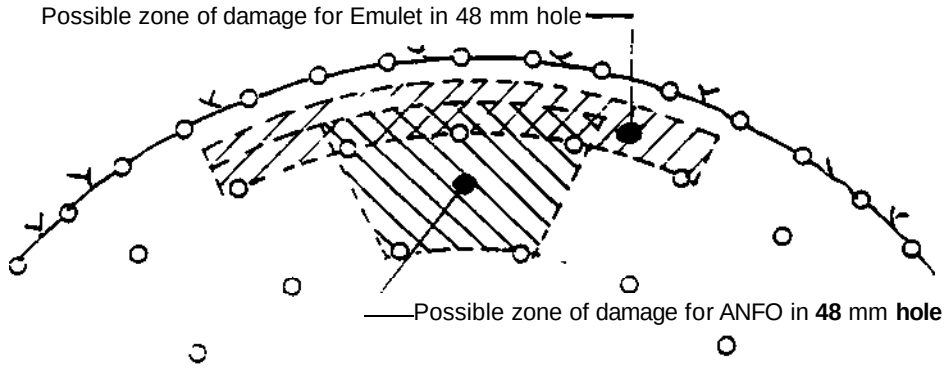


Fig. 8

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.

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