EFEE

NEWSLETTER

In this edition:

Water blasting of steel box stanchions

Misfire detection using wavelet transforms of blast seismograms

The influence of charge confinement on vibration level in blasting

...and much more!

May 2018

NEWSLETTER

May 2018

We in EFEE hope you will enjoy the present EFEE-Newsletter. The next edition will be published in August 2018. Please feel free to contact the EFEE secretariat or write to newsletter@efee.eu in case:

- You have a story you want to bring in the Newsletter
- You have a future event for the next EFEE Newsletter upcoming events list
- You want to advertise in an upcoming Newsletter edition

or any other matter.

Doru Anghelache, Chairman of the Newsletter Committee and the Vice President of EFEE

and Teele Tuuna, Editor of EFEE Newsletter - newsletter@efee.eu

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Dear EFEE members, the President´s voice

It is regrettable to realize, but 5th May 2018 was my final day in position as EFEE President in such an excellent organization and with such a great team, in particular. According to the Constitution of EFEE a President can serve a two year period at most. Time is running very quickly and two years from the Annual General Meeting held in Telford in April 2016, where I was elected as a new EFEE President, are over. I was really very delighted and honoured to work on the highest position in the European Federation of Explosives Engineers. I have to confess that it has been a fantastic learning experience. I have learned how to take decision, criticism, compromise and compliments. I have also learned to be open-minded, to value other people's opinions and to consider other ideas along with mine, to end up with a great final result for the best of our federation.

During the last two years our federation was repeatedly and continuously growing and increasing the number of its members. I have to thank all EFEE partners, EFEE members, Council members, Board members and simply all who contributed to our mutual productive work which resulted in fact to a very positive two years period. Particularly I have to thank our Secretary General Roger Holmberg very much for excellent work. I can confidently state that without his outstanding skills and experience the secretariat of our federation would not have worked as perfectly as it did. Thank you very much Roger and I want to express my biggest thanks to you. I would like to take this opportunity to extend my best wishes to all of you. Even despite the fact that I will continue in EFEE Board as an Immediate Past President I will miss all of you very much – our meetings, our communication, our emails, our phone calls and simply our mutual daily business rush.

It gives me great pleasure to inform you that newly elected EFEE President is my former Vice President Mr. Jari Honkanen, who has done a really great job as a Chairman of Environmental Committee, Chairman of Newsletter Committee, Chairman of Marketing and Membership Committee and obviously as my Vice President.

Igor Kopal, Immediate Past President of EFEE

Dear colleagues

As a newly elected President I must start by thanking Igor for a fantastic two-year period as President. EFEE developed well during this period in all aspects and I can only admire how much effort and energy Igor was able to put into this task and the leadership of our federation.

I also thank the EFEE council and board for supporting my election and trusting me with this very important position. I will do my best to manage as well as Igor and my other predecessors have done.

I am fortunate to have so many of them still in the board to support me.

My closest brothers in arms will be our vice president Doru Anghelache from Romania and of course secretary general Roger Holmberg from Sweden. I would like to take this opportunity to welcome also a new member into our board, Doctor of technology, Mr. Mathias Jern from Sweden who replaces the world renowned Mr. Donald Jonson in the board. Donald has been an influential force in EFEE for several years and served 9 last years also in the board and 2010-2012 as President. Donald will still support Mathias in this exchange for a period of one year as an external advisor and quest in the board meetings. I thank Donald for his dedication and great contribution for EFEE so far and especially for the wonderfully arranged Stockholm conference last year!

Perhaps my background is of interest to those of you who do not know me? My first contact with EFEE took place in the Brighton conference in 2005. I later started to serve EFEE as the national council member and representative for Finland in 2009 and my main interests have been in the work of shotfirer and environmental committees where I was also a chairman for several years. I hold an MSc degree in rock engineering and my first job within the industry was over 30 year ago in 1987 when I was practising secondary drilling and blasting of oversized boulders in an underground limestone mine for one summer midst of my studies.

I admit it is long since I last earned my living as a shotfirer in 1992-1995. After graduation in 1995 I worked with mobile equipment for mining and construction first at Atlas Copco and then at Tamrock which was merged into Sandvik. Nowadays I work as a group president for Forcit Consulting group of companies, one of the leading blasting and vibration consultants in the world with nearly 100 consultants and 2000 vibration monitors employed in Finland, Sweden and Norway. I still hold also a shotfirer licence and vibration expert qualification in Finland and I participate training of shotfirers and issuing of new licences in Finland.

The most important task for the President of EFEE is to lead, unite and support the board, council and committees in all their efforts and work for EFEE and our industry. Our common task is to advance the important mission of our organization not forgetting to constantly develop our operation and the federation. That requires a lot of thinking and new ideas which is always achieved best by uniting our minds and co-operating on our mission. In addition to that we need ideas and suggestion from our members and partners – how can we improve in your opinion? We welcome all of your ideas so please do not hesitate to contact me if you have any suggestions!

EFEE conferences have developed constantly over the years and reach a very high standard. The Stockholm conference in 2017 was evaluated by delegates to be the best ever in all aspects.

In this issue of Newsletter we publish some of the technical papers presented there. The next conference will be held in my home town Helsinki, capital of Finland in September 2019. It will be the 10th EFEE World Conference on Explosives and Blasting and we will do the best we can to make it an anniversary event it deserves to be. Organizing of this conference is already well on its way as we speak and the call for papers will be issued in November. Successful conferences and your participation in them are important for EFEE and the funding and continuation of our work.

I thank you all for supporting the work of EFEE and I am looking forward to meeting you in Helsinki September 15.-17.2019! By visiting us you help Finland stay the happiest country in the world :)

Jari Honkanen, President of EFEE

EFEE

NEWSLETTER

The influence of charge confinement on vibration level in blasting

ABSTRACT

Blasting in urban areas entails strict measures to control the vibration levels. It is a common opinion among blasters that an increased charge confinement results in higher vibration levels. But is there a physical explanation for this belief or is it just a common misunderstanding established a long time ago? A study was conducted to investigate if such correlation exists. The study composed of a pre-study and a field test. The pre-study included a literature survey to investigate the roots of this common belief, as well as field observations from a number of misfired tunnel rounds. The field test included blasting of 13 single-hole shots with full breakage and 10 totally confined single-holes, all charged with a dynamite explosive of 1 kg. Vibration signals were measured by three-axial geophones and the signals were analysed with respect to the confinement. Neither the literature study, nor the follow-up of misfired rounds, nor the field test could confirm any relation between the degree of confinement and the vibration level.

The results so far indicate that further research should be carried out to investigate whether such relationship exists or not. This is necessary not only to find actual evidence or debunk this general opinion, but also to understand the physical implications of confinement on blast vibrations in civil applications and minimise its negative effects.

INTRODUCTION

Today in Swedish tunnelling projects the production may be stopped if the allowed vibration level is exceeded; this obviously causes increased costs and time delays to the project progress. In general, the reason for stopping the production is the risk of damage to buildings, construction or any other sensitive object. In order to get the starting permit after the production stop, the contractor must present actions in the deviation report where it is shown that the next blasts will not exceed the vibration limits. In order to take some actions an analysis of the blasted round must be conducted. Compared to tunnelling 10-30 years back in time, the monitoring and documentation of the single round is much more thorough and the results are more accessible. Blast reports are easy to find in databases and all rounds are being monitored with time/history presentation of amplitude where the signal resolution often allows for identification of single holes in each round.

Logs from the drill rig and the mixing/charging unit will also provide information on drilling geometry, accuracy and drilling machine parameters as well as weight of each charge. The accessibility to modern monitoring techniques has decreased the amount of speculation in analysing a blast round but there are still many uncertainties left to explore. For example, the introduction of electronic detonators with short time delays makes it easier to identify single charges in a blast round but it can still be difficult to separate charges especially at longer distances.

The analysis of the blast round is usually conducted by the contractor's blasting engineer. The engineer, together with the certified rock blaster, is responsible for drill, charge and initiation plans. Sometimes also the client's engineer will take part in the analysis work and in very rare cases the client involves a blasting specialist. Possible reasons often pointed out for the high vibration level include:

- human mistakes in planning the blast round;
- human mistakes in drilling, charging and hooking up the blast round;
- material malfunction;
- detonation failure, sympathetic detonation of two or more charges or dead pressing of a charge caused by a nearby detonation;
- and charges being more confined than normal, for example the lower corner holes in a tunnel round.

There is a broad spectrum of possible reasons behind the high vibration levels. Some of them are easier to confirm than others. For example, human error can be easy to confirm provided the tunnel crew is aware of the error and want to share the information. Vibration monitoring can explain detonation failure especially in the first opening part of the tunnel round. The influence of confinement has been claimed to influence the level of vibrations and is often pointed out as the reason for exceeding vibration levels but is one of the more difficult parameters to confirm. A charge could be too confined due to:

- incorrect charge calculation (charge weight is too small for the drilled burden);
- incorrect interval-time (holes behind are initiated before holes ahead);
- incorrect selection of explosive for the burden or influence of dead pressing;
- unfavourable selection of geometry;
- or drill hole deviation.

Usually, not too long after the blasting work in a project has been halted, a conclusion is established based around documentation and experience. Quite often the correction of confined holes is one of the measures taken. The drill plan is changed in order to reduce the risk of over-confined holes. However, such measures should not be used as a correcting action before we establish a fundamental understanding of how the confinement of a charge influences the vibration level.

This is especially true when this action may have a direct influence on time and costs.

In order to further examine the influence of confinement on vibration level two projects were executed, a pre-study and a field test. Both studies were sponsored by BeFo (Rock engineering research foundation) in Sweden.

PRE-STUDY

The pre-study comprises a literature study and an assessment of a number of observed misfires in tunnels. The misfires were tunnel rounds with correctly detonating charges but yielding a pull or breakage with more than 50% reduction compared to plan. This was in order to establish a basic knowledge about the roots of such beliefs among blasters, as well as to investigate the evidence in previous tunnelling projects.

Literature study

The effect of blast confinement on ground vibrations has been an area of interest for many studies. However, there is no collective conclusion as to whether such effect exists or not. A quick look in some classic blasting handbooks will, only in some cases, confirm a relationship between confinement and vibration level:

- Langefors & Kihlström, The modern technique of rock blasting, third edition 1978: the authors do not mention the effect of charge confinement on vibration level.
- Persson, Holmberg & Lee, Rock blasting and explosives engineering 1993: the authors note that confinement condition is one of the parameters involved in vibration control and also mention measures to reduce the charge confinement and thereby reduce the vibration level.
- Olofsson, Applied explosives technology for construction and mining 1997: Olofsson points out that 'Steeper hole inclination or other conditions increasing the constriction of the blast (misfires etc.) may cause considerable increase of vibration velocity'.

However, a thorough literature survey revealed that the opinion of the blasting community is divided into two categories regarding the influence of confinement on vibrations. Most of the early studies mention the confinement as a significant factor in vibration levels in blasting (Andersson 1985, Jimeno *et al.* 1995, Siskind *et al.* 2002), while some other studies point out to the opposite direction (Blair & Armstrong 2001, Uysal *et al.* 2007).

Different methods and techniques have been utilised to investigate this effect. Several studies used field tests in semi-controlled setups (Bergmann et al. 1973, Liu & Ludwig 1996, Ramulu et al. 2002, Ramulu et al. 2005, Ramulu 2010) and confirmed that more confinement yields larger vibrations.

On the other hand, Blair & Armstrong (2001) conducted a re-analysis of the raw vibration data from some of these studies and claimed that most of these conclusions are based on a prevailing assumption that the effect from confinement already exists. In addition, the statistical evidence behind the effect was biased and did not support the common belief. Blair & Armstrong (2001) further confirmed this by a series of experiments as well as a Dynamic Finite Element Model (DFEM) which showed the influence of confinement on vibrations are very limited. Ironically, their model showed that under certain circumstances the vibration levels decrease with increasing burden, which is precisely opposite to the belief of mentioned studies, but agrees with field experiments of Uysal et al. (2007).

Altogether, the many trials conducted to investigate the effect of burden on vibrations do not point to a single conclusion. The varying experimental and statistical methods utilised by researchers have led to entirely contradictory results. Based on the literature, a confident conclusion cannot be drawn about the effect of confinement on blast vibrations. Such controversy is partly due to different theories behind vibration production and partly owes to different experimentation approaches and divergent presumptions about the effect of confinement.

Observation of misfired tunnel rounds

In order to find proof for or against a relation between charge confinement and vibration levels 7 misfired tunnel rounds, 13 reference rounds and 6 re-blast rounds and their vibration signals were analysed. A misfired round is defined as a blasted round with fully or partially unsuccessful results, *i.e.* advance of 50% or less, without claiming the reason for the misfire. In the study the vibration levels from the misfired rounds were compared to the levels from rounds blasted before or after the misfired round. Also the signals from the re-blast of the misfires were monitored.

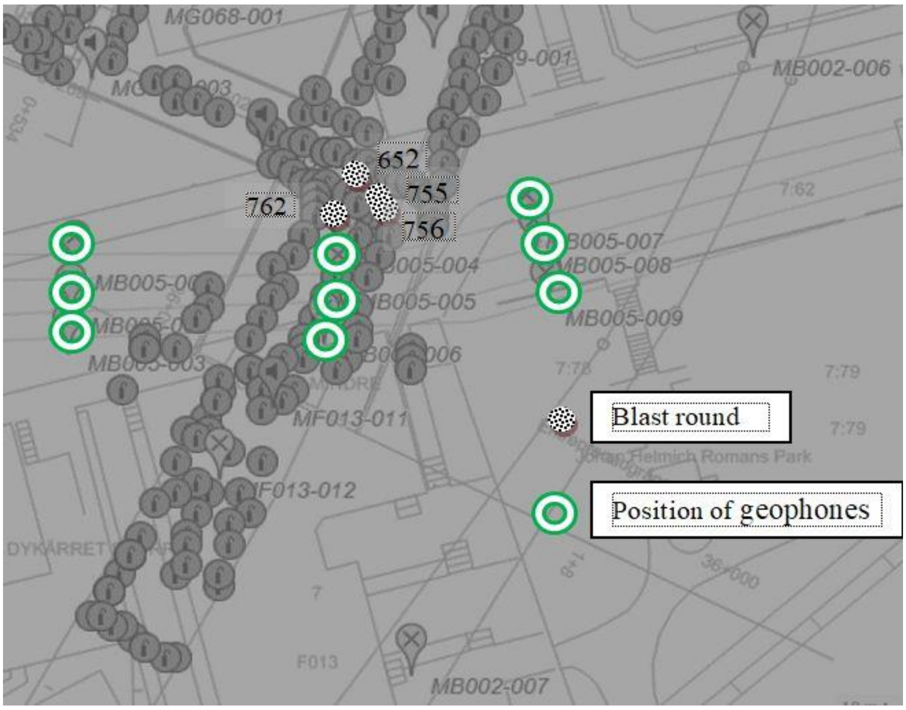

Figure 1. The Citybanan project, round 3. The 4 fired rounds at the centre are one misfired round, one re-blast and two reference blasts, surrounded by triaxial geophones.

The vibration levels for each round were monitored in many locations. An example for the monitoring scheme is presented in Figure 1 where 11 geophones were used. The number of measuring points and so the amount of data varied between the projects, but in two of the rounds sufficient data was collected and it was possible to conduct a statistical analysis.

was twice as high as the misfired round.

Figure 3, another misfired round in the same area shows that all 4 reference rounds had a higher vibration level in all measuring locations compared to the misfired round and the following re-blast.

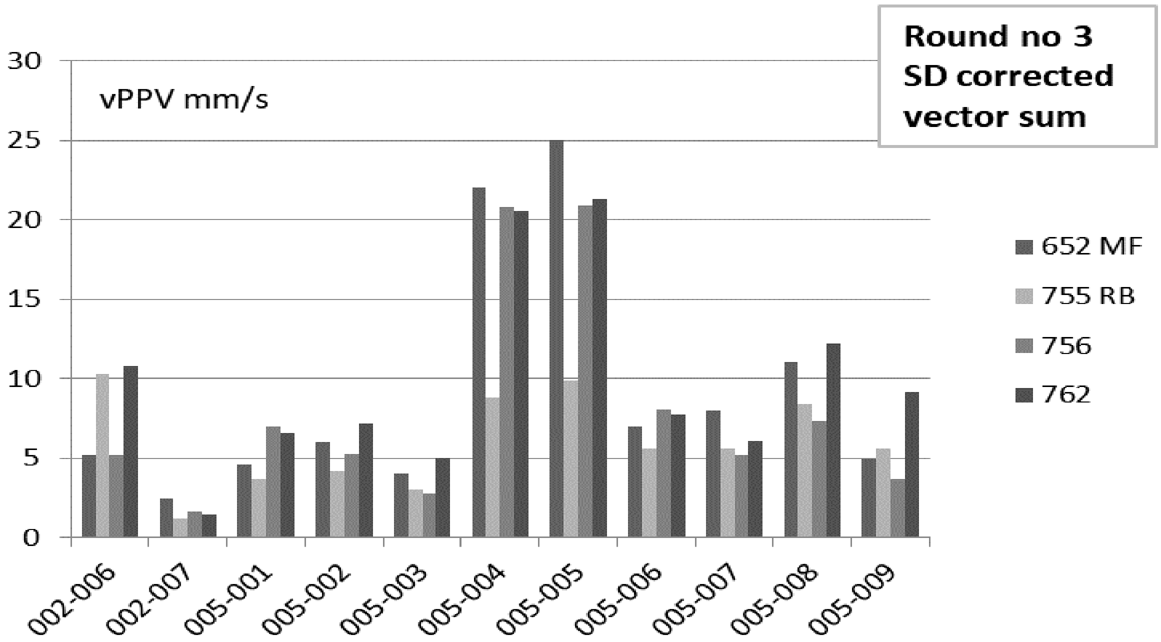

Figure 2. Results from round no 3, data are scaled distance corrected. Round 652 is the misfired round, 755 the re-blast and 756 & 762 the reference rounds.

Result

Figure 2 shows the result from round no.3. At most of the measuring points in this round (8 of them) the vibration levels from the misfired round were in the same range or lower than the reference rounds; in three of them the misfire is lower. The re-blast vibration level is in general the same or lower as the misfired round except in one measuring point where the re-blast

Rounds 3 and 4 provided enough information for a statistical analysis as well. The univariate analysis of variance (ANCOVA) was conducted to check the difference between the vibrations based on confinement conditions. The pairwise comparison of the rounds showed that there is no significant difference between the vibration levels from the reference, misfired, and re-blast rounds. Figure 4 visually confirms this as it presents the logarithmic plot of vector PPV values against the

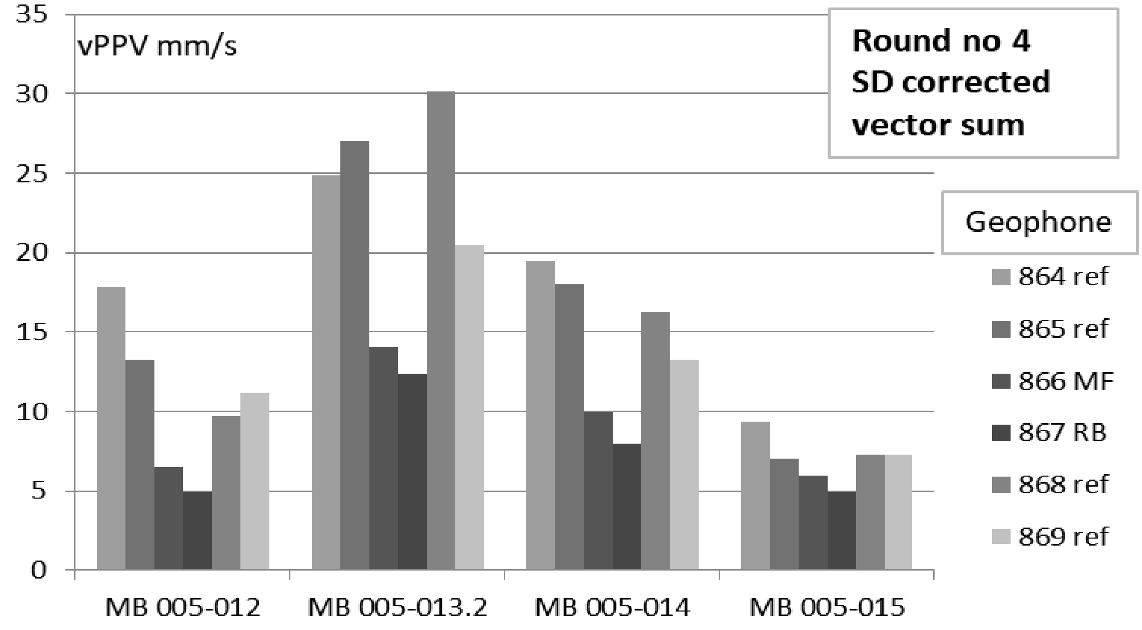

Figure 3. Results from round no 4, data are scaled distance corrected. Round 866 is the misfired round, 867 the re-blast and 864, 865, 868 & 869 the reference rounds.

scaled distance. For both rounds almost all VPPV values lie within the 95% confidence interval of the reference blasts, implying that there is no difference between the vibrations from different confinement conditions.

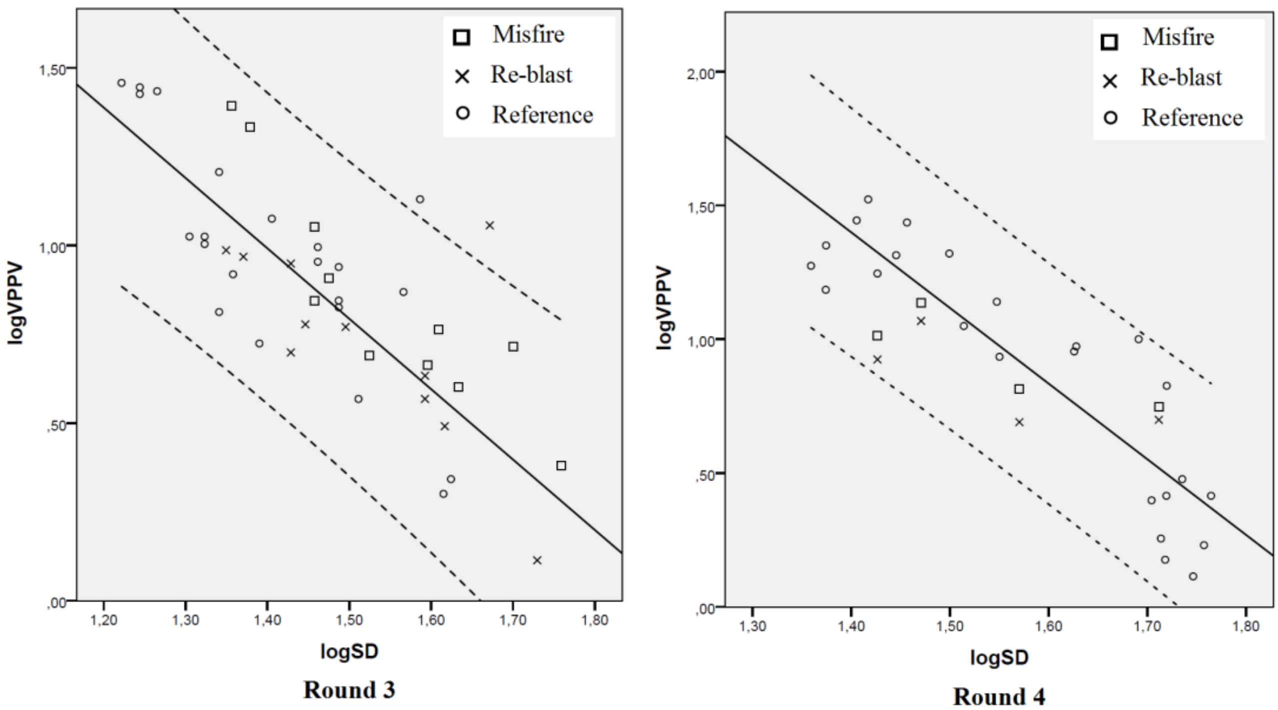

Figure 4. Logarithmic plots of scaled distance (SD) versus VPPV for rounds 3 and 4, with regression lines and confidence intervals.

FIELD TEST

Introduction

The objective with a separate field test was to compare the effect of confinement on vibration level in a controlled environment by blasting single charges and by using a specially designed monitoring system. The area in which the tests were carried out was relatively small with small variation in rock conditions. Going from the misfired tunnel rounds in the pre-study to the field test gave a more reliable test set up.

The test site was situated in a rock quarry north of Stockholm, operated by one of Sweden's larger contractors NCC. A large area in the quarry was already cleaned off from soil and dirt and therefore it was easy to find a proper area for the test. A natural vertical slope provided a perfect, undisturbed bench face for the charges that were blasted with a normal burden.

A geological mapping was conducted prior to blasts to be used in case of unexpected results from the vibration monitoring system. The rock in the test area consisted of fine to medium grained gneiss granite with two sets of fractures. Both fracture systems were vertical and were oriented perpendicular to one another. Warm and dry weather conditions prevailed throughout the whole testing period.

Field test geometry

A 3-D survey was initiated as a first action when starting the field works. As a result of this survey a 3-D model was established which enabled for good quality data of depth of charges and monitoring positions and distances between the charges and the monitoring geophones. Also the practical blast planning work became easier to conduct when all set-out of hole positions could be made by a survey instrument. In Figure 5 a cross-section of the test area is shown. The model could also be used for drill planning design.

Blast hole design

The size of the test area gave space for 13 holes with normal breakage and 10 totally confined holes. Three holes were drilled for monitoring purposes. The row of 13 holes at normal burden was drilled approximately 1.25 m from the free face. The row with confined holes was drilled approximately 16 m behind the free bench face and the 3 monitoring holes in between the two rows. The hole diameter was 45 mm for blast holes and 76 mm for the monitoring holes. Hole depth was around 3 m and the target was to have all charges and the monitoring geophones at the same level (Figure 5).

In order to calculate the correct distance between charge position and measuring point each hole collaring position, hole inclination and hole depth was surveyed after drilling.

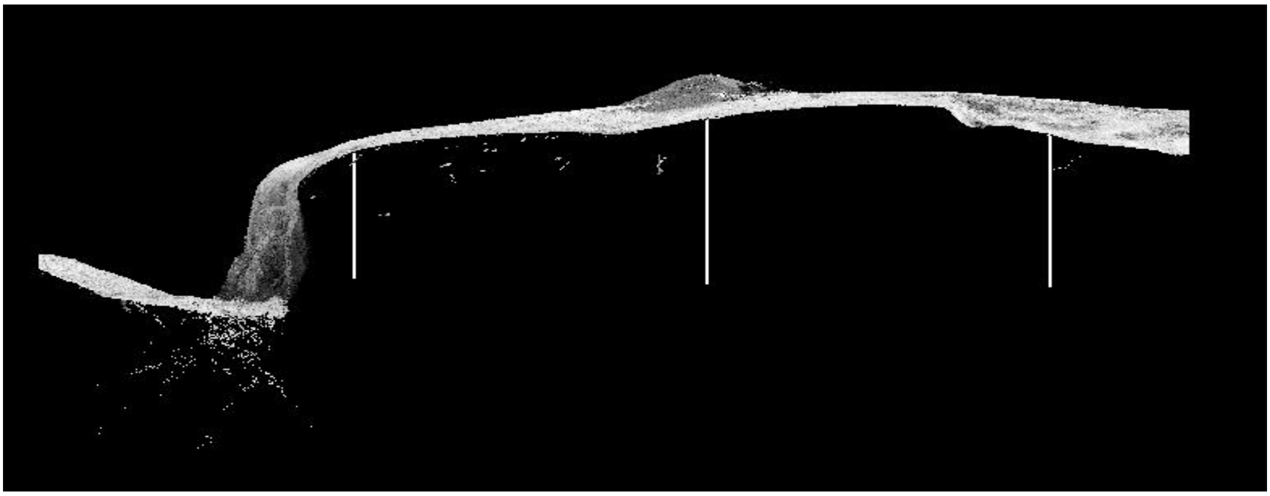

Figure 5. A cross-section of the test area 3-D model provided a good basis for the planning work. To the left is the charged hole with a normal burden, to the right the totally confined charge and in the centre the hole with fully grouted geophones.

The final test geometry is shown in figure 6. The black dots, 1-13, are the holes with normal burden and the white holes, 1-10, are the confined ones. In between are the three monitoring holes, M10-M12.

Each hole was charged with a dynamite type of explosive, Minex Eco plastic pipe with a diameter of 32 mm.The charge weight was 0.95 kg.

Figure 6. Hole collaring positions. The black dots, 1-13, are the holes with normal burden and the white holes, 1-10, are the confined ones. In between are the three monitoring holes, M10-M12.

The charge was initiated with Firex VA Ms electric detonator. All holes were stemmed using gravel stemming material. The hole distance was approximately 2 m. All holes were blasted as single holes and the order was decided according to the breakage of the previous hole. Figure 7 shows the principal hole geometry.

with a normal burden. Scaled distance is shown on the horizontal axis and vibration level on the vertical axis. However, since the charge weight is close to 1 kg the scaled distance value is close to the actual distance between the charge and the geophones. The result in each data point in the graph is the vector sum from the three directions.

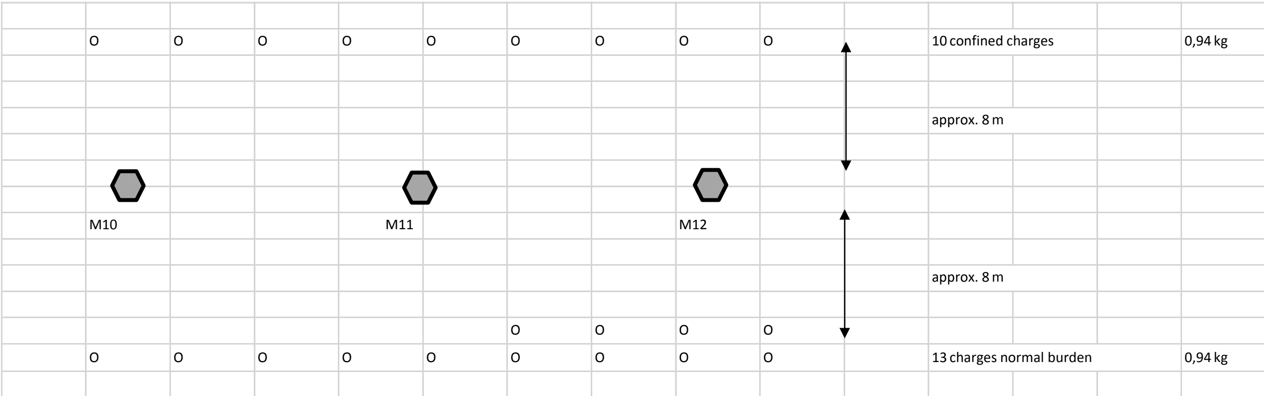

Figure 7. Schematic drawing of the hole geometry

Monitoring system

All vibration monitoring was carried out by Swebrec at Luleå University of Technology. Three 3-axial geophones were fully grouted in boreholes M10-M12 shown in Figure 7. Frequency range was 2.6–2000 Hz. The data was recorded by a 32-channel data logger, at 25 kHz sampling rate, and thereafter transferred to a PC computer and analysed using MATLAB.

Results

In Figure 8 all data from the field test is shown. The plot includes all 12 geophones and 23 single shots. The white dots are the totally confined charges and the black dots show the results from the 13 charges blasted

It is quite difficult to find any differences in the result between the confined charges and the charges blasted with a normal burden. In the complete BeFo report from the test a more thorough analysis is presented. Different parts of the test area, different directions and different measuring points were analysed and correlations to the geology were studied. In all these cases, except one, the previous conclusions persist, *i.e.* no significant differences could be found.

The exception mentioned above was when the data from measuring point M10 in the right part of the test area was evaluated. Figure 9 shows that the confined charges gave higher vibration amplitudes compared to the ones with normal burden.

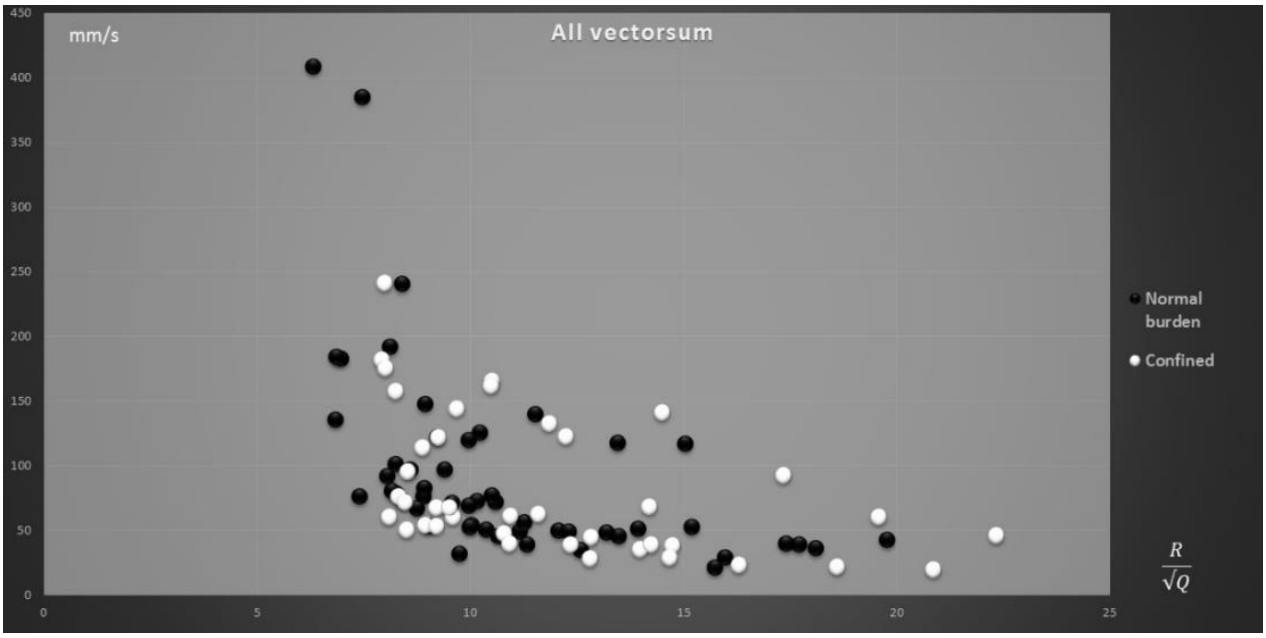

Figure 8. The results from all charges and all measuring points. The white dots are the totally confined charges and the black dots show the 13 charges blasted with a normal burden. Scaled distance is shown on the horizontal axis and vibration level on the vertical axis.

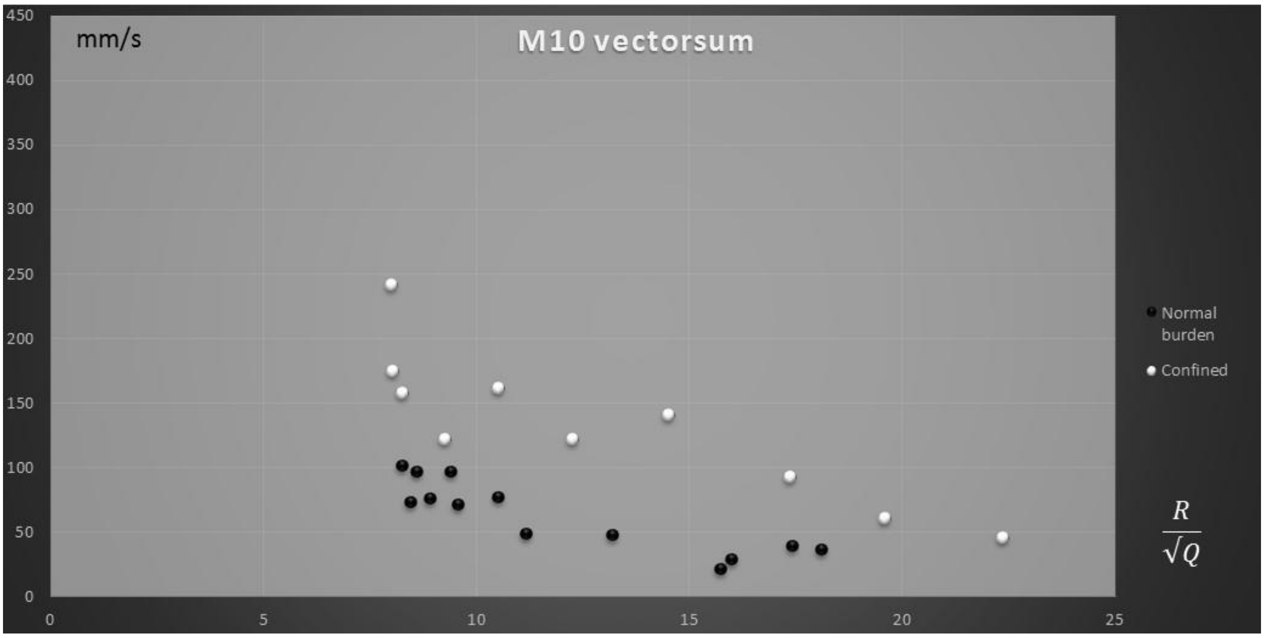

Figure 9. The results from only measuring point M10. The white dots are the totally confined charges and the black dots are charges with a normal burden. Scaled distance is shown on the horizontal axis and vibration level on the vertical axis.

This could not be explained by any specific geological feature in that area of the test compared to other parts. Even from a statistical point of view, the confined and free faced holes did not show any significant difference. Figure 10 shows the vector PPV values vs. scaled distance for two groups of confined and free faced shots.

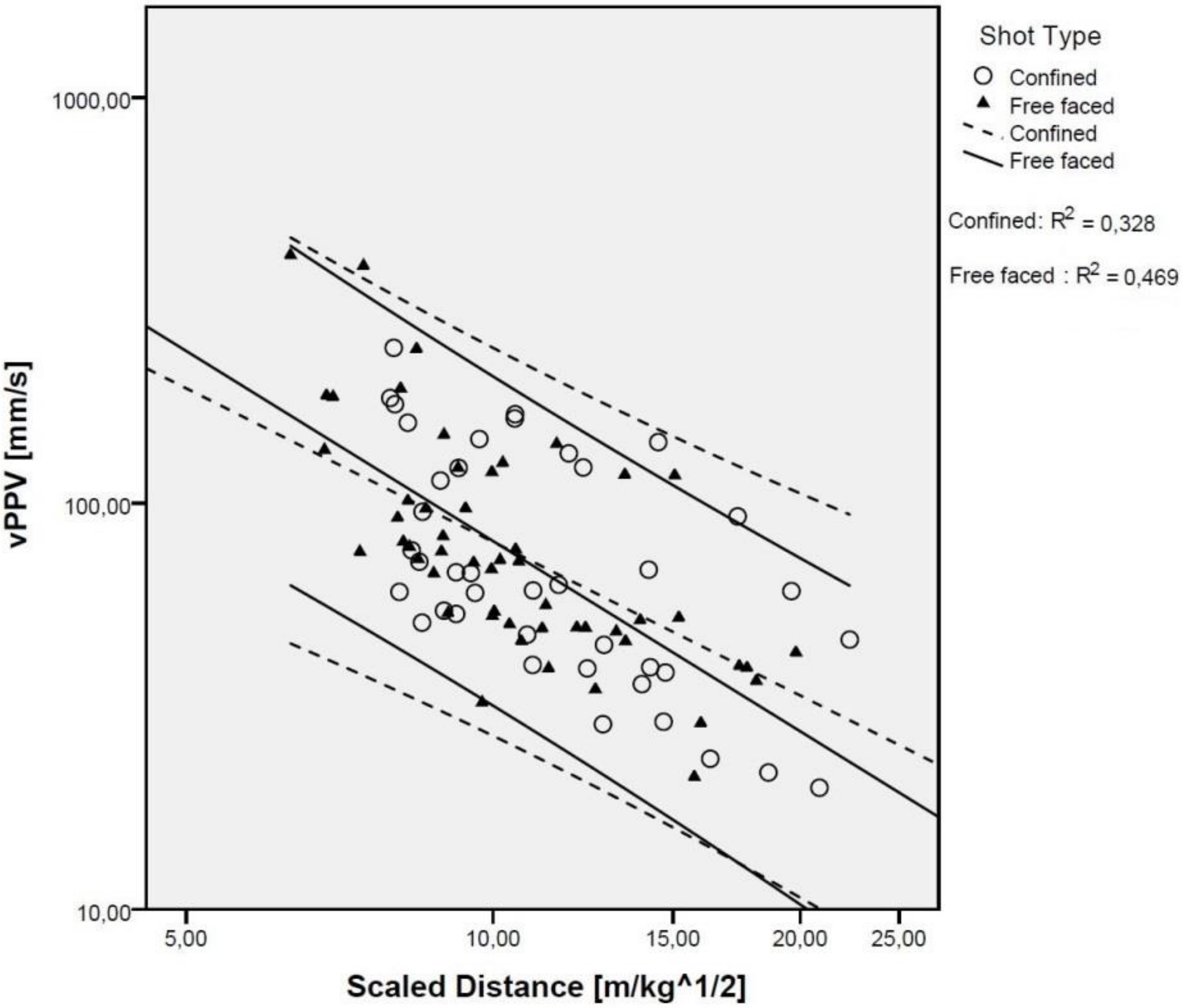

Figure 10. Vector PPV values vs. scaled distance of shots, grouped according to confinement condition with their corresponding regression lines and confidence intervals.

As seen, the regression lines are very close to each other and even the 95% confidence intervals are much alike.

Due to the fact that the charge weights in all holes were equal (ca. 1 kg) and all holes were within very close range, we can discard the scaled distance and compare the VPPV values directly. Figure 11 presents the histograms of the VPPVs separated by confinement condition. The histograms clearly show that there is no distinguishable difference between the peak particle velocities in relevance to the burden.

As a matter of fact, the largest vibrations were registered from two free faced shots, which is contrary to the general opinion in question. In addition, most of the registered VPPV values were in a similar range for both confined and free faced shots.

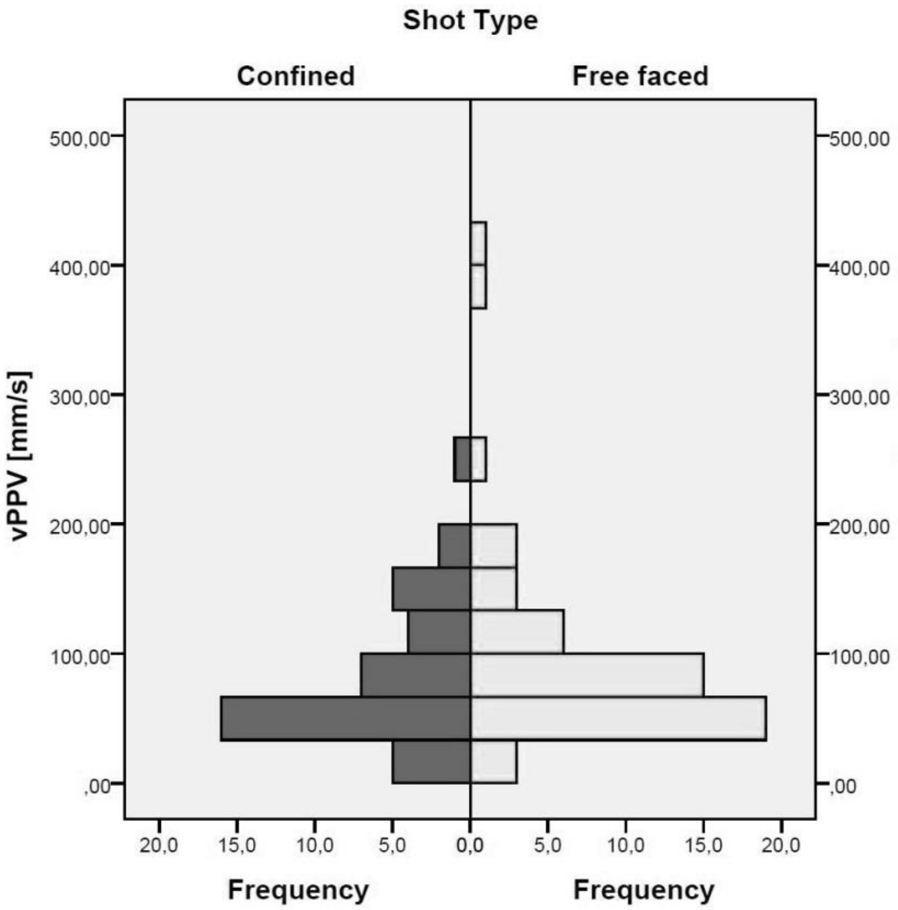

Figure 11. Histogram of all vibration data separated by confinement condition.

correcting action is often to modify the drill plan in order to reduce charge confinement.

According to findings of this study, this action may not be correct and the confinement may not be the reason behind higher vibration levels.

On the other hand, the tests in this study were based on conditions that are not always applicable in normal blasting. The scale was smaller than that of common bench and tunnel blasting.

Conclusion

The results from the study of the misfired rounds and from the field test show no or very little relation between level of vibration and the degree of charge confinement for a typical smaller charge used in tunnel blasting. It can be concluded that a bore hole in a blast round which is wrongly drilled (giving the charge more confinement than normal) does not necessarily have to give a higher vibration level. This is often the perception among production blasters.

Based on this perception, when a blast exceeds the vibration limits, the

Tighter drilling pattern and smaller charge weights have been used. Vibrations were measured within a 20 m range from the blast hole and only single holes were detonated. However, the test was executed under controlled conditions. The quality of data for charge weight, geometry, and vibration signals is high. The benefit of working within a small area is that the variations in geology and other structural features are limited, even though they may exist.

In this project both vibration data from normal tunnelling production and single-hole tests have been used. The overall result points in the same direction. No correlation is found between the degree of confinement and the vibration level.

This project has not been trying to explain this result or to verify the physical background to it. During the time of the project and afterwards different people have come up with explanations why the common opinion is that an increased confinement gives higher vibration levels. Some of them are presented below:

- some claim that this has been obvious in most cases by own experience;
- some believe that more energy travels into the rock behind the hole if the burden is larger;
- the charge weight is higher than planned and noted due to compensation by the charging crew for a wrongly drilled hole;
- the charge weight could simply have been higher than planned due to lack of knowledge, equipment failure or just carelessness

This project will not put an end to this common opinion among rock blasters, but hopefully it will contribute to the interest in the issue of charge confinement and vibration level. More people involved in rock blasting may be alert and more observations will be made to collect facts in order to come closer to the answer regarding a possible relationship between charge confinement and vibration level.

It is still too early to abolish the belief about confinement effect on vibration, but we are certainly on the path to explore it further and increase our understanding about it.

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Misfire detection using wavelet transforms of blast seismograms

ABSTRACT

Misfires are dangerous. That can be said without any ambiguity. What can be ambiguous is *when* and *where* a misfire occurred in the shot. There are clues, though: the blast itself broadcasts information about each hole's firing in the seismic waves. Seismic waves with the highest vibration frequency represent the detonations. Wavelet transform analysis of blast waves determines frequency as a function of time. This is displayed as ridges on a figure that resembles a relief map. Ridges at high frequency have been shown to correspond directly to detonations.

Recent analysis of a blast with a suspected misfire of several holes detected the absence of firings at expected times, *i.e.* a misfire. The paper briefly describes the basis for wavelet transform analysis. Next, we show wavelet transforms for a properly detonated blast.

Finally, we show how wavelet transform analysis is used along with the expected firing times to assess a misfire.

INTRODUCTION

One morning Gunnar, an experienced blaster, fired a shot at the limestone quarry he had been working at for over ten years. It was a typical shot for the quarry. They use electronic detonators, put telltale shock tubes in the holes, and video each shot. Seismographs monitor the few nearby houses, but they never get complaints. Initially, everything seemed fine. But Gunnar had a feeling something wasn't quite right. The muckpile looked a bit lopsided, different from the previous shots. The detonators seemed to have fired, but the video camera didn't pick up the telltales today. Was there a misfire, or perhaps something different about the geology in this part of the pit?

There really was no way to tell, and Gunnar, a very careful man, decided to assume that there was a misfire and dig carefully. You don't take chances with undetonated explosives in the muck. What a pain. And what a waste of money.

But is there really no way to tell? Let's think about this. What is a misfire, anyway? Simply put, it is 'the complete or partial failure of explosive material to detonate.' Now, when explosive detonates, it must generate an impulse on the surrounding material – that's what will fracture the rock! That impulse eventually becomes elastic (no longer fracturing rock), and propagates as vibration.

Therefore, each hole in a blast tells the story about whether it detonated or not in the ground vibration signal. That signal generally looks too complicated to unravel. Only with long-period delays recorded at close distance are the firing times separated well enough for individual detonations to be distinguishable. Otherwise, it is almost like all of the holes are talking at once. Almost…

What about the seismic records at Gunnar's quarry? To decipher the story each hole tells here, we need a tool to analyse such records. That's what this paper is about.

DETONATION SIGNALS

The initial pulse generated by an explosive detonation is very high frequency. Of course, as this pulse propagates away from the borehole, it is reflected and refracted at various discontinuities – fractures, bedding planes, joints.

With each bounce, and each time it fractures more rock, it loses a bit of energy, the frequency decreases, and these waves are added on to the tail of the original pulse. Therefore, though the propagated wave may get quite complex due to the many reflections, there is still a remnant of the initial pulse in the recorded wave.

When detonations are separated by a relatively long time interval as in many tunnel blasts, and if the waves are measured fairly close to the shot so that the frequencies are still high, pulses due to the individual detonations can be seen. Many times, however, such as in Gunnar's blast, the firing times are relatively close together and the waveforms from individual holes are long. It becomes impossible to visually distinguish individual detonations. Another tool is needed to identify detonations, and a key is the fact that there is a remnant of the detonation at high frequency buried in the reflections and refractions.

Figure 1 shows a waveform from a fifteen hole quarry blast recorded at 300 meters. This shot was fired with electronic detonators, and fired properly.

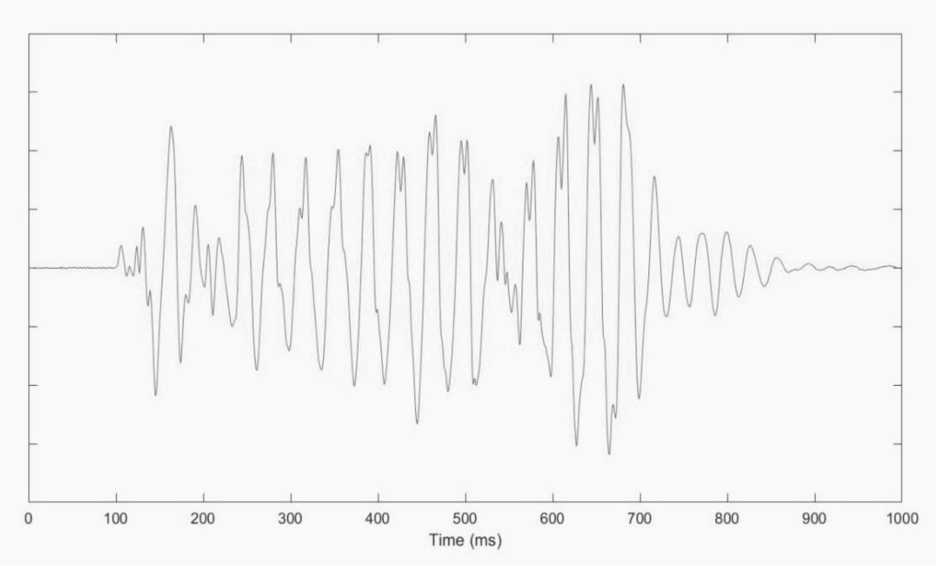

Figure 1. Fifteen hole blast waveform.

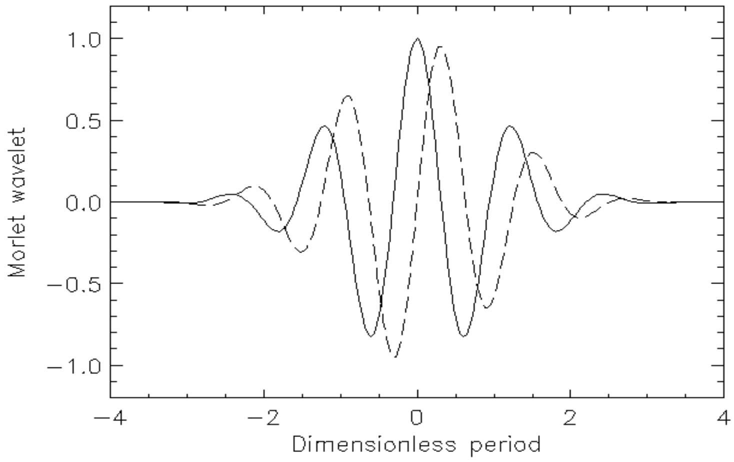

Figure 2. Sample mother wavelet – 'Morlet'.

well-behaved blast seismogram, like the ones in Figure 1. Briefly, wavelet transform analysis is based upon the matching a short simple wave as it is computationally passed through the wave that is to be analysed. The short simple wave is called the 'mother wavelet'. A representative example, called the Morlet wavelet, is shown in figure 2.

There are quite a few large oscillations in the seismogram, and one might be tempted to associate these oscillations with firings. This would indicate, however, that there was significant variability in the shot at about 200 ms and 550 ms. There was no evidence of such issues in evaluation of the results.

As we shall see later, it is low amplitude pulses that are representative of detonations, but they cannot reliably be picked out from waveforms such as these. One can see small wiggles in the waveform, but it is not clear if these are associated with the detonations.

WAVELET TRANSFORM TECHNIQUE

To analyse a seismogram for assessing blast performance, a different technique is needed. In previous papers (Anderson 2013, 2015, 2016, Anderson et al. 2015, 2016), we have shown that wavelet transform analysis can be used to extract the representatives of detonations from a

Calculation of the wavelet transform then follows this process:

- a compact form of the mother wavelet is translated along (swept across) the waveform, and convolved with the signal waveform (i.e. the blast seismogram);
- the wavelet is then dilated (expanded) and Step 1 is repeated, he amount of dilation is termed the 'scale', low scales correspond to high frequencies, and high scales to lower frequencies;
- this is then done for all of the scales desired.

The resultant amplitudes are then displayed on a plot called a scalogram, a projection of a 3-D plot, something like a relief map, with the following axes:

- the left-right axis is time in milliseconds;
- the front-back axis 'scale' (1/frequency), axis units are on the right

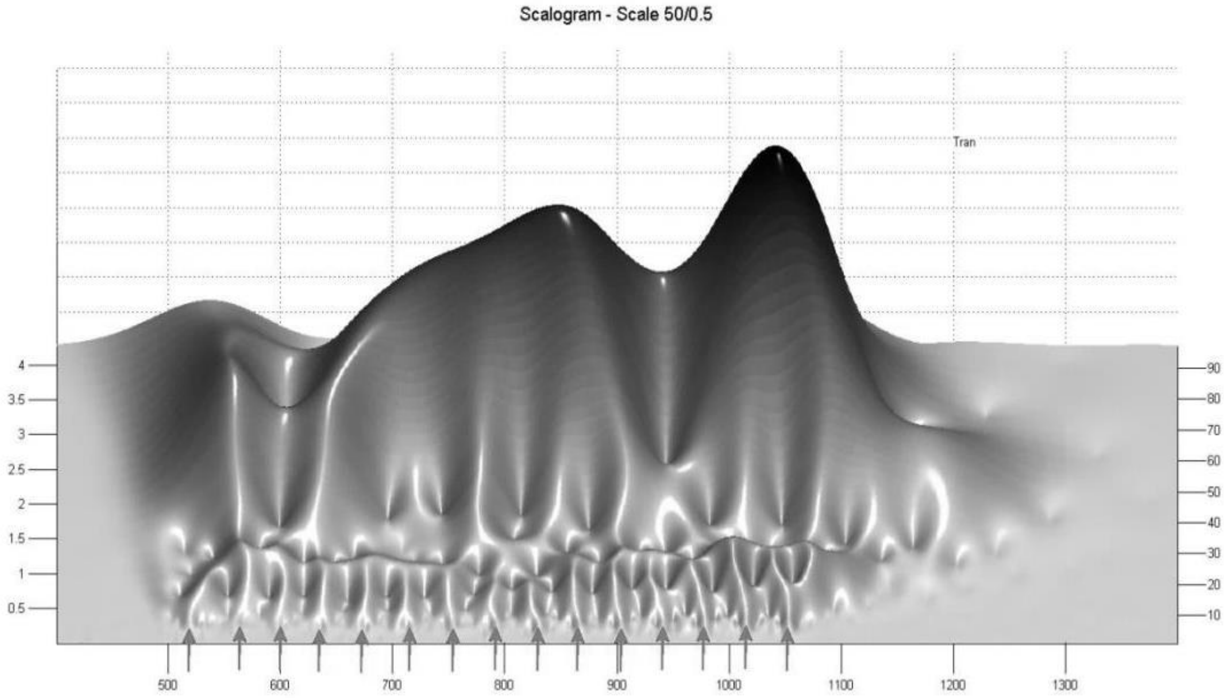

Figure 3. Wavelet transform scalogram.

- the vertical dimension is the amplitude in arbitrary units, the arbitrary amplitude axis units are on the left.

The height of the peaks is proportional to the vibration energy in the wave at a particular time and scale. The scalogram is also darkness coded from light (lowest amplitude) to dark (highest amplitude), and an artificial 'lighting' is applied to make the relief stand out.

A scalogram depiction of wavelet transform analysis of the seismogram in Figure is shown in Figure 3.

The low-frequency energy (in the background) dominates the figure. This energy, due primarily to the influence of the geological path, is not what we are really interested in.

In the foreground (high frequency), and at much lower amplitude, are fifteen ridges at regular intervals. These are noted with arrows. The times for each of the ridges match the design firing times for the shot. We have seen in numerous examples that this technique can detect detonations in seismograms recorded in the near-field as well as at distance.

So now, how about Gunnar's problem? What can wavelet transform analysis say about a misfire? We have analysed a blast where there was a concern that several holes may not have fired, even though the muckpile moved.

SUSPECTED MISFIRE

A blast in a quarry in the US seemed to behave strangely, though there wasn't obvious evidence of a misfire – just like Gunnar's hypothetical blast. There weren't any problems with the seismograph readings, but something didn't seem right. Only one seismograph recorded this blast, which was deployed for liability compliance purposes and not to study firing times. The seismograph was 600 meters away from the blast, as shown in Figure 4.

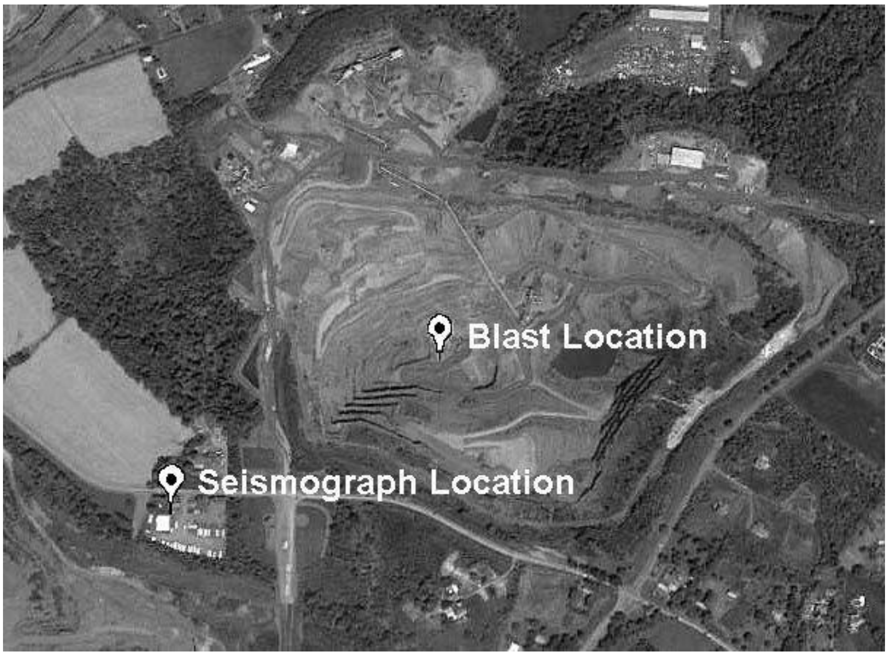

Figure 4. Blast location map.

The design for the blast, including the relative locations and designed firing times, is shown in Figure 5. The shot layout indicates that there were 25 drilled and loaded holes in two rows, with the initiation point five holes in from the right-hand side. The recording seismograph was to the left and behind the shot.

Because the shot opened several holes in from the right-hand end of the shot, the vibration signature from the holes to the right of the opening hole would be travelling through broken rock, and might not be recorded strongly. In particular, broken rock is good at filtering out the high frequency vibration that we are looking for in the wavelet transform analysis.

The client needed to know whether a misfire was likely for this shot. We conducted the wavelet transform analysis to accomplish this.

ANALYSIS USING WAVELET TRANSFORM

The wavelet transform analysis of a seismogram from this blast is shown in Figure 6, along with the waveform. Again, the waveform is not useful for determining firing times, but shows how difficult such a task would be. Note that there are ridges in the foreground, like the ones in Figure 3, from about 65 ms to about 500 ms. The waveform continues beyond 500 ms but the ridges stop.

We have picked the ridge locations, and displayed most of the picks on the scalogram in Figure 7.

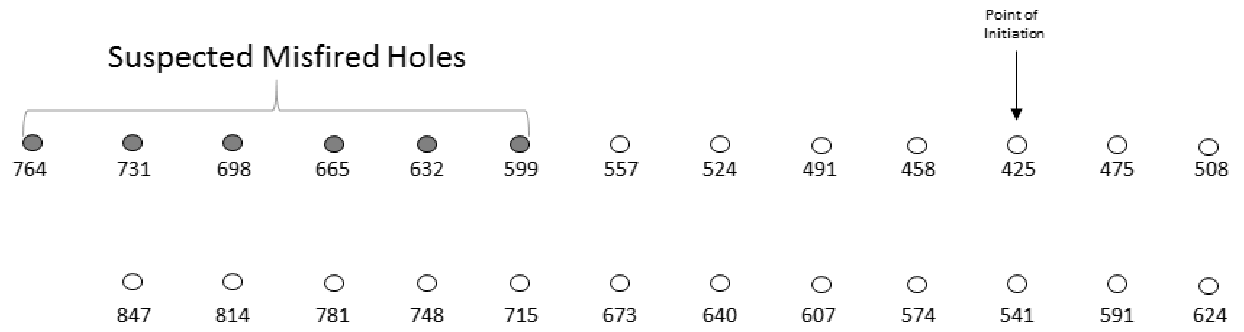

Figure 5. Blast design.

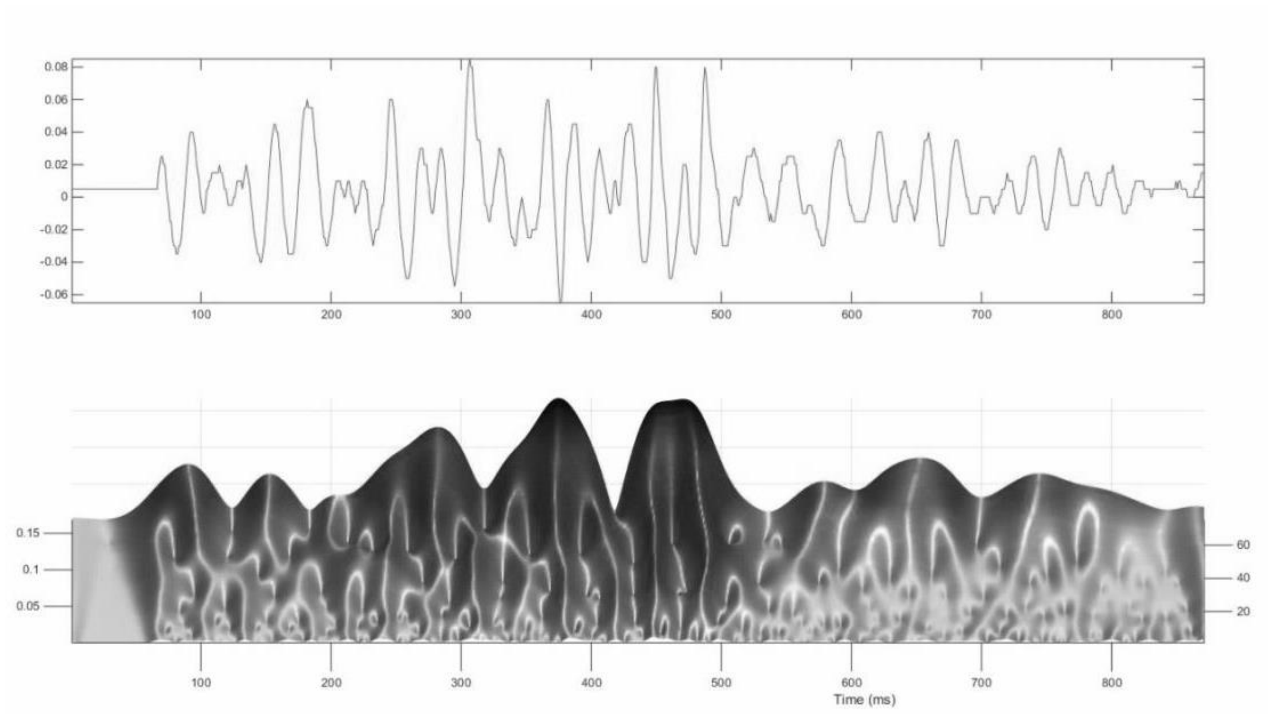

Figure 6. Seismograph and wavelet transform of suspected misfire.

You can see that it would be basically impossible to pick these high frequency pulses out from the waveform – they are really just small discontinuities or 'blips' in the waveform. The determined firing times are shown in Table 1.

The Raw column contains the numbers from the analysis (i.e. the ridge times).

The time between holes is a calculation of firing time differences – the between-hole delay. The Cumulative column adjusts the Raw data to start at 0 ms. Finally, in the Absolute column the times are adjusted to start with the designated 425 ms 'initiation time' in the blast design.

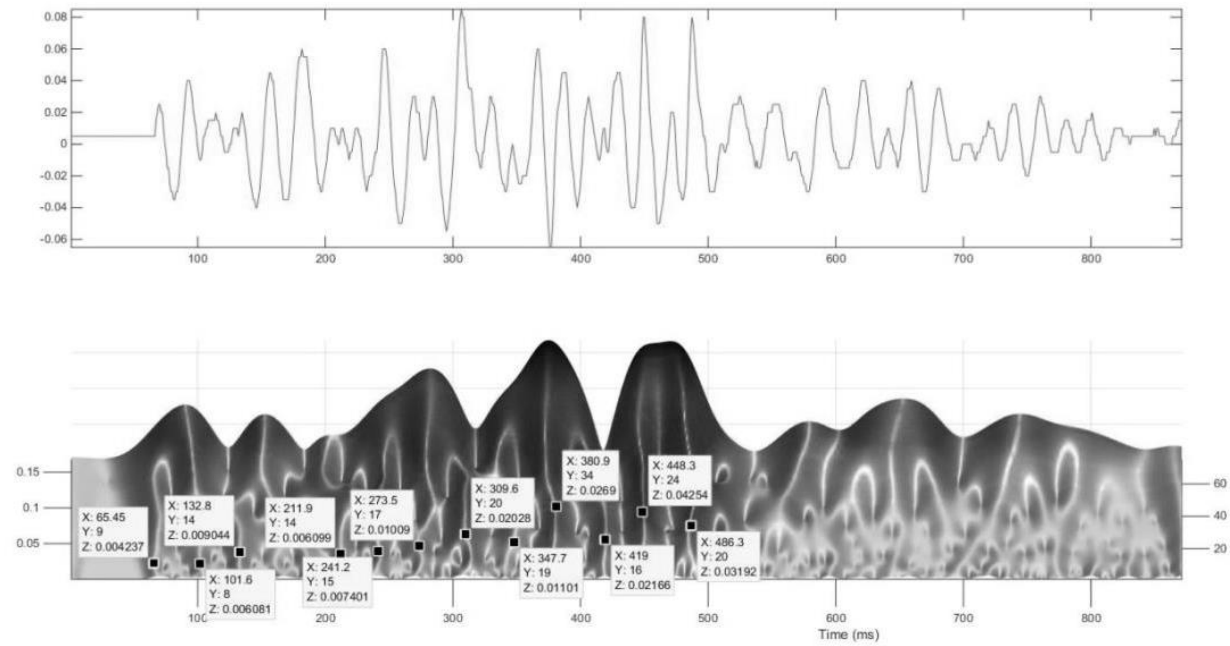

Figure 7. Waveform and scalogram of suspected misfire with ridge times picked.

Raw	Time/ Holes	Cumulative	Absolute
65.45	0	0	425
101.6	36.15	36.15	461.15
132.8	31.2	67.35	492.35
159.2	26.4	93.75	518.75
184.6	25.4	119.15	544.15
211.9	52.7	146.45	571.45
241.2	29.3	175.75	600.75
273.5	32.3	208.05	633.05
309.6	36.1	244.15	669.15
347.7	38.1	282.25	707.25
380.9	33.2	315.45	740.45
419.0	38.1	353.55	778.55
448.3	29.3	382.85	807.85
486.3	38.0	420.85	845.85

Table 1. High frequency ridge times picked from wavelet transform.

RESULTS

Clearly some of the firing times match the designed times, and others don't. However, we have seen cases where 'shadowing' of the vibration from holes occurred when there was evidence that the whole shot fired properly, so lack of a good pulse doesn't necessarily mean that the hole did not fire properly. More than one seismograph record will allow waveforms taken at various azimuths to be compared, minimising the shadowing effect.

There also is some scatter in the determination of the ridge times (they are not perfectly straight) as well as scatter in the firing times because, as we understand, a pyrotechnic (non-electric) initiation system was used.

All of that being said, we have made a direct comparison of the firing times obtained from the wavelet transform calculations with those planned for the shot. In TABLE the column for the times determined from the ridges is labelled 'Absolute', the second column shows 'Planned' firing times, the third column indicates the firing times for holes detonated on the 'right hand side' of the shot – *i.e.* those holes whose vibration may have been shadowed by the detonation of the holes at 425 ms and 541 ms. The final column indicates the firing times that may have shown a misfire.

The matches of firing times are fairly close in many cases, but not all. There aren't ridges indicating a detonation for the holes in the 'shadow zone' (as discussed earlier) on the right hand side. This seems unambiguous, and could have been corrected with another seismograph record collected at a different azimuth.

There is some ambiguity about association of the firing times for three ridges at about 601, 633 and 669 ms. Each of these could reasonably be associated with two firing times: either a suspected misfire or one of the regular detonations. Where there are clear matches, the 'Absolute' times appear to be slightly earlier than the associated 'Planned' times. In each of these three ridges, taking this into account favours association with the non-misfire holes. However, the last three of the suspected 'misfire' holes seem to be clearly absent from the wavelet transform figure, and ridges corresponding to detonation of the last

Absolute	Planned	Right hand side	Misfire?
425	425		
461.15	458		
	475	X	
492.35	491		
	508	X	
518.75	524		
544.15	541		
	557		
571.45	574		
	591	X	
600.75	599		X
	607		
	624	X	
633.05	632		X
	640		
669.15	665		X
	673		
	698		X
707.25	715		
	731		X
740.45	748		
	764		X
778.55	781		
807.85	814		
845.85	847		

Table 2. Wavelet transform times compared with design firing times.

five second row holes do appear to be present.

One other potential factor to consider is travel time for the waves. Separation of the holes will induce either increased or decreased apparent delay due to the short time for the wave to travel between holes (a few milliseconds). This again is a function of azimuth relative to the blast orientation. We have not included such consideration in this analysis.

CONCLUSIONS

From a wavelet transform analysis of one seismic record of a blast, it appears that there is evidence of missing detonations in the firing sequence. One set of detonations missing in the record is likely due to shadowing of the vibration record by detonation of previous holes in the path of succeeding wave propagation. Another seismograph in another direction should have picked up the detonation of these holes.

The other detonation sequence may match the suspected misfire holes, though there is some potential ambiguity regarding the association of some of the firing times determined from wavelet transform analysis with the planned firing times. This may be due to scatter in detonation times due to pyrotechnic delay. Alternatively, there is some ambiguity in determining appropriate times for the ridge locations.

However, in general, it appears that there is evidence from the wavelet transform analysis to support the contention that misfire occurred in the final six holes of the front row in the shot under consideration. We conclude that wavelet transform analysis can be used to routinely detect firing times for a blast measured with a standard seismograph, like taking a snapshot of the detonations. When expected firing times are known, this methodology can be used to rapidly assess whether a blast fired properly or not, thus detecting misfires.

This procedure can be part of a misfire identification protocol, as recommended in an earlier paper (Anderson et al. 2016).

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BACK TO TOP

Water blasting of steel box stanchions

ABSTRACT

Since 2001 a very elegant blast demolition method for hollow box steel stanchions in structures has been developed in Germany and is known as 'water blasting'. A correctly calculated charge of a detonating cord in a box stanchion filled with water cracks all edge welds easily. As a result the stanchion is completely destroyed. The charge weight depends not on the thickness of the box plates but only on the weld thickness. Such water blasting causes moderate influences to the surrounding. Importantly, by using this method no large pre-weakening of the stanchions is necessary. Forty-five large, power station steam boilers have already been blasted by this new method in Germany. Other power plant utilities like filter, buildings, silos and bunkers and complete steel plants could be tackled using this method too. The only requirement is hollow stanchions. The fundamental points of this method and some examples of spectacular blasts will be shown in this paper.

THE PRINCIPLE OF WATER FILLED STEEL BLASTING

In the past hollow iron columns were occasionally filled with water and small linear charges. The resulting blast was very effective. Around the year 2000, I thought 'why should we not do it with modern industrial steel stanchions?' If steel stanchions are hollow, like box columns or tubes, can't they be filled with water and blasted with a central-linear charge for example detonating cords?

The water carries the blast energy without loss. The central charge has to crack only the relatively small welding seams with the thickness 'a' and cracks the stanchion along the full length of the charge. The separated plates are no longer held together and they are bent out very easily. The stanchion is completely destroyed. The necessary charge weight is relatively small.

In the case of a tube stanchion the whole wall thickness has to crack. That is why tubes need more blast weight then box stanchions and the rest of the tube has more stiffness and stability than the plates.

Less appropriate for this technique are connected profiles such as H-Profiles or with additional plates see Figures 4 and 5. Their remaining stiffness after the blast remains fairly high.

Only one small circled hole on the top of the blast zone is necessary to fill water and explosive in. That is why a large pre-weakening is not necessary.

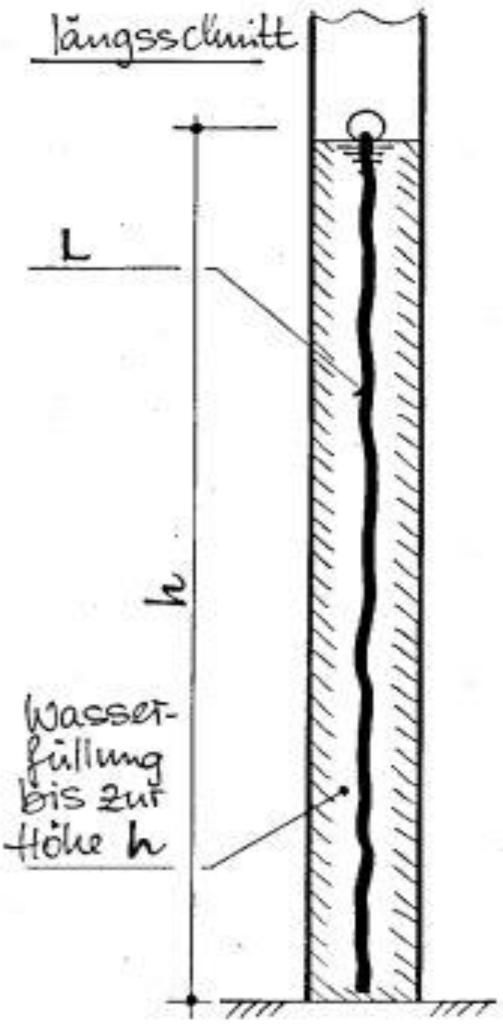

Figure 1. Water filled and charged steel box stanchion.

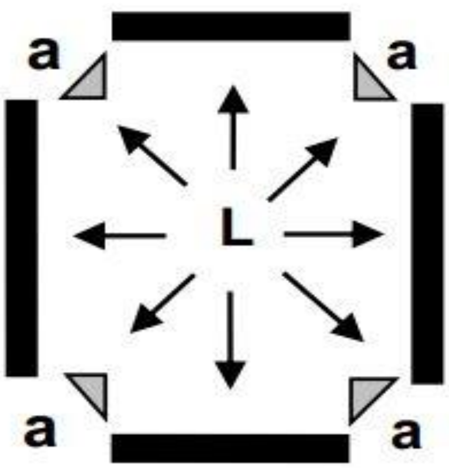

Figure 2. Water filled and blasted steel box stanchion.

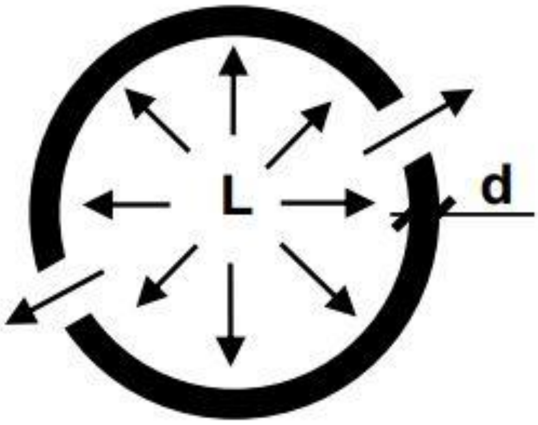

Figure 3. Water filled and blasted steel tube column.

TEST PHASE

In 1999 at a power plant in east Germany some tests of profiles, like H-H and U-U, took place to explore optimal load weights for water blasts. At this time we still thought that the load weight depends on the volume of the water filled in. These tests were continued in 2001 at another power plant (Hagenwerder).

In the protection of an old shelter we applied several load weights in equal box stanchions (see Figures 6 and 7). But the optimal load weights are optimal for the used water volume only. We did not know any better at the time.

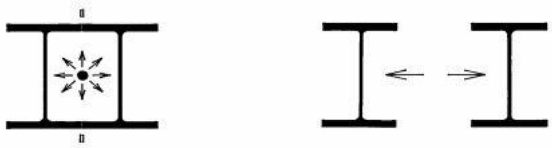

Figure 4. Two or more H-profiles, suboptimal.

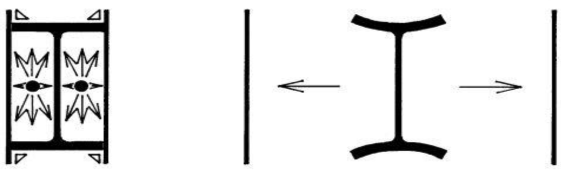

Figure 5. H-profile with plates suboptimal.

FIRST APPLICATIONS

In 2001 6 structures were water blasted and in 2003 a further 4 large steam boilers at power plants in Saxony were also water blasted. The 85 m tall boilers at Hagenwerder were each stood on 6 steel box stanchions with cross section areas of 1.8 m x 1.5 m. Four of these six stanchions were water filled and blasted to a height of 40 m.

Figure 6. Preparation of water blasting.

The only difficulty was making a trough (sic) hollow space in the stanchions. After the successful blast the separated plates of the stanchions were moving like noodles (see Figures 8 to 14).

Figure 7. Good result of the test blast.

The explosive used when water blasting the steel stanchions (Melzer 2004) had weights between 40 and 800 g/m. On occasions plate fly was a problem. The furthest distance recorded was 126 m (see Figure 15). It is obvious the existing formula for determining the charge weight lacks reliability yet.

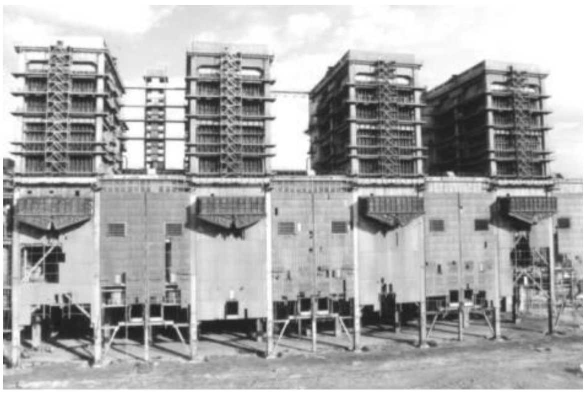

Figure 8. Boiler house, power plant Hagenwerder.

Figure 9. 40 m high reach stanchion water blast of the first boiler.

Figure 12. Boiler house is tilting underway.

Figure 10. Boiler house from south.

Figure 13. Boiler house is tilting almost complete.

Figure 11. Boiler house tilting commences.

Figure 14. Foot of a box stanchion after the blast.

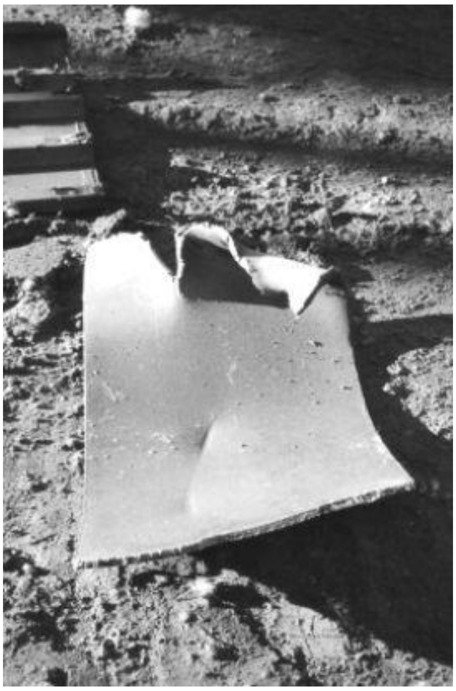

Figure 15. Plate fly after water blasting.

A BETTER LOAD WEIGHT FORMULA

All actual existing calculations of charge weights in blast demolition I know of were found empirically and not in clear physical relations. That is why in 2014 a research was started to get better formulas of load weights for blasting (Melzer 2015). The basic idea was that charge weights of steel water blasting does not depend on the water volume but only on the tensile resisting of the steel bandage, respectively its weakest member the edge welding - and of course of the performance of the explosive. For a water steel blasting I have derived the following simple formula:

$$\mathbf{L^* = ¶ \cdot Z^2 / S} \qquad (1)$$

With
L* the load weight in kg/m
Z the tensile strength of the bandage in MN/m;
and S the explosive power or 'blast strength' in $MN^2/(kg \cdot m)$.

$$\mathbf{S = p^2 / \rho L} \qquad (2)$$

p the explosion pressure [MN/m^2],
and ρL the explosive density [kg/m^3].

Example:
Eurodyn 2000: $S=p^2/\rho L=152.4^2 / 1400$
$S=16.58\ MN^2/(kg \cdot m)$

The tensile force Z depends for welded boxes only on the welding seams with the thickness 'a' (see Figure 16) and the ultimate tensile stress σZ:

$$\mathbf{Z = \sigma Z \cdot a} \qquad (3)$$

Example:
Eurodyn 2000: $S = 16.58\ MN^2/(kg \cdot m)$,
welds: $a = 6$ mm, $\sigma Z = 470\ MN/m^2$
$Z = 470 \cdot 0.006 = 2.82\ MN/m^2$;

$$\mathbf{L^*=¶\cdot\sigma Z^2/S =¶\cdot 2.82^2/16.58= 1.506\ kg/m}$$

Example:
Eurodyn 2000: $S = 16.58\ MN^2/(kg \cdot m)$,
tube: $d = 10$ mm, $\sigma Z = 470\ MN/m^2$
$Z=470\cdot 0{,}01=4.70 MN/m^2$;

$$\mathbf{L^*=¶\cdot\sigma Z^2/S=¶\cdot 4.70^2/16.58= 4.185\ kg/m}$$

This formula does not depends on the blast body volume. With it you can calculate the charges of water filled steel stanchions, water filled concrete stanchions or silos and other hollow structures.

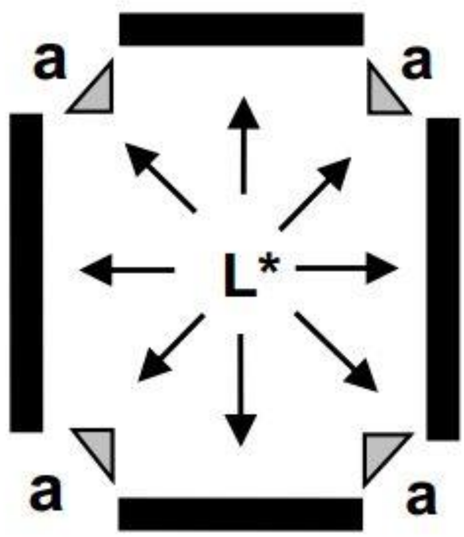

Figure 16. Water filled and blasted steel box stanchion.

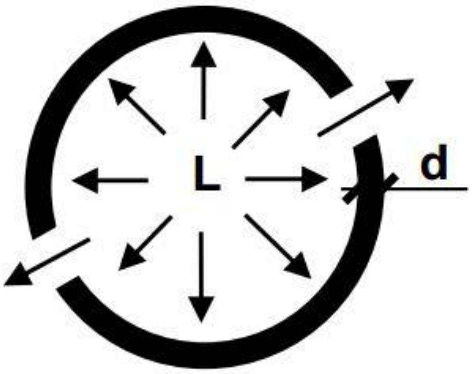

Figure 17. Water filled and blasted steel tube stanchion

LAST EXAMPLE

A large boiler house at the Thierbach power plant in Saxony was demolished by only using water blasting of the main stanchions supporting the boiler. The charge weight was determined using the new formula derived in 2015.

In January 2015, the separate number 1 boiler was water-blasted.This was followed in February by the three remaining boilers (2 to 4).

All blasted stanchions were at the same time over a height of 15 m correctly destroyed with no plate fly. None of the wall stanchions of the boiler house were to be blasted.

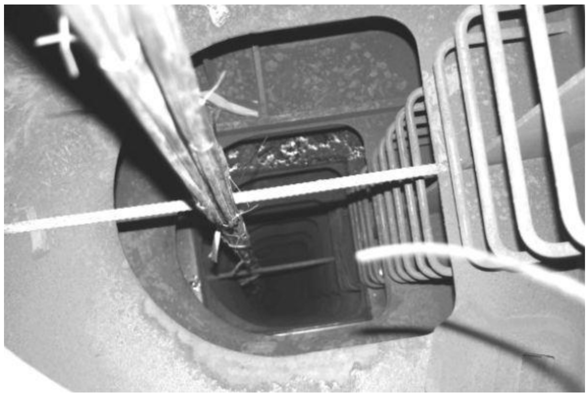

Figure 18. Charged inner of stanchion still without water.

Figure 19. Water blasting boiler stanchions Thierbach.

Figure 20. Boiler tilting.

Figure 21. Boiler tilting.

Figure 22. Boiler tilting.

Figure 23. Blast result: boiler debris heap.

SUMMARY AND CONCLUSIONS

The blast demolition method 'water blasting' can replace other steel blast methods like linear shaped charges or kicking charges in case of hollow stanchions (with a closed cross section).

Because this method needs no large pre-weakening it is safer than other methods. Because of the cheaper explosive in regard to linear shaped charges and with an easy realising of high reach blasting zones the 'water blasting' method is cheaper too. The water dust of the blast can help to take down a part of the dust cloud. The new water method has so far been used on 56 steel structure objects in Germany. This number contains 45 large steam boilers in power plants. Hollow objects, constructed of reinforced or pre-stressed concrete, such as bridge pillars or silos are also able to be blasted with this new water method.

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Accident – explosion of misfire in conical crusher

Accident description

- On 27th June 2016 during excavation of a rock pile with excavator, an explosion of dynamite occurred in the course of aggregate producing in the mobile crushing plant for production of crushed rocks.
- The mobile crushing plant consisted of 3 basic parts. The first one was a primary crusher for crushing rocks to a fraction of 150 mm. The second one was a secondary conical crusher and the third one was a mobile three sieves separator.
- The explosion of a misfire in the conical crusher damaged the crusher itself and also some other parts in the second part of the technological line, such as the ultrasonic sensor, feeding belt, conical crusher, and hydraulic hoses for lubrication of the crusher.

Found explosive

- During a visual inspection of the remaining part of the rock pile and the first part of the mobile technological line (jaw crusher) no explosive residues were identified..
- During the inspection of the second part of the mobile technological line, red-brown mass of plastic consistence was detected on the upper part of the feeding belt. The mass was identified as a residue of dynamite.






Expertise of found explosive

- The found explosive residues were delivered to the producer for confirmation that it was really dynamite and for the analysis if that kind of explosive residues were able to detonate in the conical crusher without initiation by a detonator, depending on the age (14 months from bench blasting) and exposure to weather conditions.
- The expertise confirmed that it was really dynamite and its sensitivity to friction was equal to a newly produced explosive. During a laboratory test it was proved that in the conical crusher an explosion of found explosive residues could occur without ignition by a detonator.

Parameters of the bench blast

The bench blast was executed on 18th February 2015 as a two row blast with:

- 30 head boreholes (#101-#130) in the first row;
- 32 head boreholes (#201-#232) in the second row;
- 20 snake (foot) boreholes (#P01-#P20).

From the ground plan perspective, the drilled head boreholes had a shape of the letter "L", where the boreholes #123 and #223 were the corner boreholes. The diameter of the head boreholes was 115 mm and diameter of the snake (foot) boreholes was 100 mm. The snake (foot) boreholes were 4 m long. The head boreholes were 20 m long, except boreholes:

- #102 and #202 which were 7 m long;
- #103 and #203 which were 14 m long;
- #122, 124, 222 and #224 which were 10 m long.

At the bench blast, 6 525 kg of explosives were used in total, consisting of:

- 525 kg of dynamite in cartridges of diameter 65 mm;
- 500 kg of emulsion explosive in cartridges of diameter 65 mm;
- 1 000 kg of emulsion explosive in cartridges of diameter 75 mm;

- 4 500 kg of ANFO explosive in 25 kg bags.

At the bench blast, an electric initiation system was used with 144 pieces of electric detonators in total, consisting of:

- 82 pieces of detonators with 8 m wires;
- 17 pieces of detonators with 15 m wires;
- 5 pieces of detonators with 20 m wires;
- 40 pieces of detonators with 30 m wires.

In the snake (foot) boreholes the explosive charge was initiated just by 1 detonator and in the head boreholes each explosive charge was initiated by 2 detonators (bottom and upper initiation charge).

Result of the accident investigation

The explosion occurred at the processing of a rock pile in the area corresponding to the boreholes #123 - #130 and #223 - #232 that means, according to the ground plan, in the shorter part of the "L" shape. The misfire occurred as a result of a stop in the explosion transfer between the cartridges of dynamite and cartridges of emulsion explosives because of a piece of rock which had fallen between those cartridges.

According to the manual of the explosives used, a direct contact of the cartridges is necessary for a reliable explosion transfer between the cartridges. From the investigation it appeared that in the boreholes #125 - #130, #223 and #225 - #232, that means in 15 boreholes, the detonators were with shorter wires than the borehole depth was. The depth of those boreholes was 20 m but the detonators used for priming in bottom part of the boreholes were only 15 m long. In those boreholes, also other cartridges of dynamite and emulsion explosives were loaded under the priming charge because water was present and also because of better fragmentation in the corner part where the snake (foot) boreholes were missing.

As the priming cartridge was not loaded as the first one (that means placed on the bottom of the borehole), the master blaster substantially breached the appendix #3 of the General blasting project for the bench blasts and also the technological procedure of blasting works.

In that technological procedure in chapter 3 the procedure of loading the boreholes with electric initiation system is described as follows: "The boreholes with a length exceeding 10 m must be according to this procedure loaded in the way that into the boreholes the initiation charge will be dropped down at first and then other cartridges by free fall or by pumping from loading truck up to 0,5 m under the stemming.

Then the next (second) initiation charge will be dropped, the length of the stemming will be rechecked and the borehole will be stemmed.” For this breach, the master blaster was fined with a total amount of 6 000 CZK (approx. 240 EUR).

District Mining Authority for the Regions of Moravian-Silesian and Olomouc, Czech Republic

EFEE Annual General Meeting

Dubrovnik, as it turns out, is a quiet, seaside city with astonishing views to red roofs and white sails on bright blue waters. It is situated on the coast of the Adriatic sea, down the south end of Croatia. It's colourful history dates back to Byzantium times.

On an early May weekend, thunder reaches the city with heavy rain, it seems that nature knows what's going to happen on the next few days. Already, some people from explosives industry are here, and others are coming very soon – it is time for the Annual General Meeting of the European Federation of Explosives Engineers.

You would think that the beauty of the city and the warmth of springtime in Croatia were responsible for attracting EFEE meeting here, but no, it was all about business – besides all the other work, EFEE hoped to meet the representatives of Croatian National Association.

The thunder slowly receded and the sun shone the next day. Even though the weather seemed ideal for a walk on a beach, the EFEE people gathered for a meeting in Rixos Hotel, Dubrovnik, already at 8.30 a.m. on Friday. The meeting room was full of buzz, warm greetings and excitement as it was time for the EFEE Committees to report the work they've done the previous 6 months and discuss new assignments.

There are overall 9 Committees in EFEE: The Environmental, Shot-firer, EU-directives, Conference, Membership and Marketing, Newsletter, Finance and Audit, Election, Constitution committee.

The Environmental and Shot-firer committees both have big projects ongoing which will greatly benefit all EFEE Members. The EU-directives Committee is keeping us informed with everything done at the highest level in the EU regarding the explosives regulations. The Conference committee is all about organising and reporting about EFEE world Conferences. The Membership and Marketing committee is responsible for keeping EFEE well known and respected. The Newsletter committee works non-stop to give out the EFEE Newsletter 4 times a year with good technical articles and news from EFEE. The Finance and auditing, Election and Constitution committees are responsible for keeping a critical eye on EFEE work.

Everything went according to plan and soon after midday the Committee members and chairmen had done their reporting and given their proposals for the EFEE Board, and then they were able to go and explore the old city of Dubrovnik. At least those, who were not the Board members.

The EFEE Board is responsible for, in short, all management and general monitoring of the interests of the Federation, including the external representation of the Federation. This means a lot of decisions, some intense discussions for finding best solutions and weighing of all proposals made earlier. Although, at first, this seems very important and boring at the same time, there's always some fun moments when people get lost in translation and in the end there are monkeys on Gala dinner.

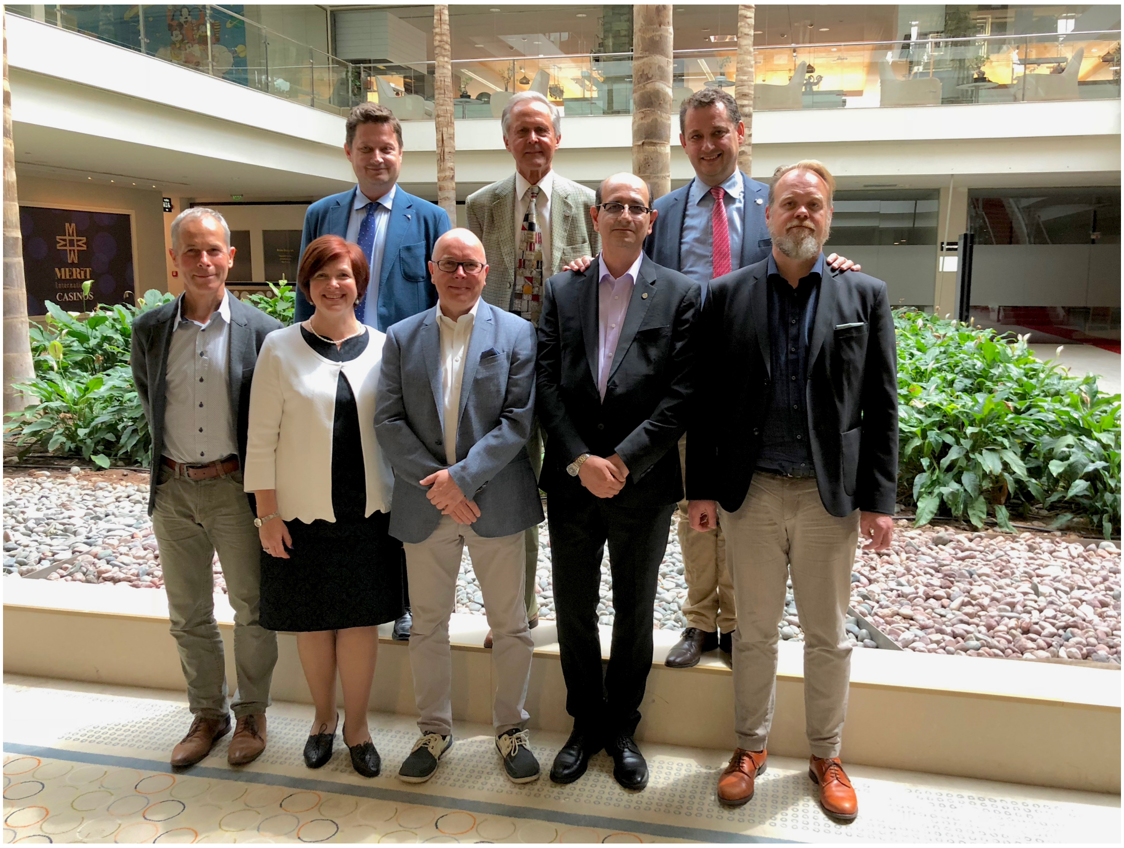
The Board meeting continued and the discussions lasted a long time - it was almost dinnertime when the meeting room doors opened and Board members flow out making the corridors lively with their chatter. But then a change of dress-code and good food with drinks were always better in a good company. The best ideas have often been created behind white tablecloths, especially when the discussions happen between successful people with similar global interests and background.

The next day there was some electricity in the air. It was time for some real decisions and voting for the future. The meeting room had been changed to a bigger one and the atmosphere was more formal. The voting was about proposals made in Committees, the election of new Council members, and last but not least, the election of the New President of EFEE.

It happens once in every two years. The Council proposes candidates, and the only thing left to do, is agree on them.

There's usually never a shortage of candidates for the Board, nor the Council. The work in EFEE has to be done by someone, it is voluntary but is a great honour in itself. It is also of utmost importance that everyone agrees with proposed candidates. The overall feeling of every EFEE meeting is friendly, people are open and accepting, and the newcomers are welcomed warmly. Which means, people get to know each other, share dinners and in the end always agree with to move forward together.

The good work done by Committees was approved and their proposals weighed and voted for. Two new Council members were voted in and then, this Council in turn, voted for the new Board.



The new EFEE Board members


The new EFEE Council members

Not long after was the time to shake hands - The new EFEE President is now Jari Honkanen, the Vice President is Doru Anghelache, the Immediate Past President is Igor Kopal. The treasurer is Heinz Berger, and Board Members are Viive Tuuna, Jörg Rennert, Mathias Jern, Johan Finsteen Gjodvad and this time it is decided to also have a Guest Member in the Board – Donald Jonson.

There was no question whether the outcomes of the Annual General Meeting deserved to be celebrated. The room full of people all headed out to a sunny balcony, ordered beers and prosecco, and a cheerful "cheers" was probably heard on the other side of the coast.

The Immediate past President Igor Kopal and the New President Jari Honkanen

Teele Tuuna, Editor of EFEE Newsletter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BACK TO TOP

EFEE Membership

Become an EFEE member and take use on the following benefits:

Reduced fee for attending EFEE Conferences.

Reduced fees on workshops in conjunction with EFEE conferences.

On-line access to proceedings from all earlier EFEE Conferences except 2000 and 2003.

Access to the EFEE web page with information and possibilities to interact with members.

Gain access to list of European standards on vibrations and air blast through the member section of the EFEE website.

Gain information of and possibilities to influence the EU shot firing procedures and attend standing committees like EU-directives, Environmental and Newsletter.

Supporting of professional explosives engineers.

Network of professional explosives engineers.

A possibility to be part of the EFEE Council and influence the EU explosives society.

Four electronic Newsletters per year.
Information on conferences and professional courses.

SAFEX information on incidents in the explosives industry.

Corporate Members also have the benefit of a 25% discount on ads in the EFEE Newsletters

Visibility on the EFEE website.

There are different types of membership in EFEE: National Association membership, Corporate membership, Individual membership and Student membership - more information info@efee.eu.

New EFEE members

EFEE likes to welcome the following members who recently have joined EFEE.

Corporate Members

AVA Monitoring, Sweden 3GSM GmbH. Austria

Upcoming Events

Fragblast 12
June 9-15, 2018
Luleå, Sweden
www.fragblast12.org
There will be a course for commercial explosives and mining company personnel, particularly those that might be attending Fragblast 12 in Lulea, the course will be jointly run by the universities of Cambridge and Lulea and held on the campus of the latter for three days.
https://www.csc.cam.ac.uk/academic/shortcourses/det2018

25th WORLD MINING CONGRESS
June 19-22, 2018
Astana, Kazakhstan
www.wmc2018.org

HILLHEAD 2018
June 26-28, 2018
Derbyshire, UK
www.hillhead.com

Mining Expo International
September 6-8, 2018 Las Vegas, NV, USA
www.MiningExpoIntl.com

14th International Conference on Drilling and Blasting Technology - 2018
September 19th-21th, 2018
Velence, Hotel Juventus, Hungary

Blasting technique and pyrotechnics 2018
September 25 – 27, 2018
Hotel Valeč, Czech Republic"
www.sttp.cz

Excavation and rock technology days
January 17-18, 2019
Best Western hotel Haaga, Helsinki
Official language: Finnish (foreign presentations in English)
Contact info regarding the conference:
ari.kahkonen@infra.fi

45th Annual Conference on Explosives and Blasting Technique, ISEE January 27-30, 2019
Nashville, Tennessee, USA
mangol@isee.org

Informationstagung für Bohr-, Spreng- und Ankertechnik
Place: CAMPUS SURSEE
Bildungszentrum Bau, CH-6210 Sursee LU, Switzerland Date: 13. / 14. September 2019
Official language: German
www.sprengverband.ch

EFEE 10th World Conference on Explosives and Blasting
September 17-19, 2019 Helsinki, Finland
https://www.efee2019.com/

EFEE is looking for a part time MARKETING ASSISTANT

whose main tasks will be:

- **marketing of advertisement space in our Newsletter**
- **marketing of EFEE memberships**
- **finding additional advertisers and members**

The applicant should be self-motivated and have adequate written and verbal English and an enthusiasm for sales work. Knowledge of the explosives engineering industry is an advantage. The position is also suitable for a student.

This position is for part time work with estimated working time of 10-20 hrs / month with potential to increase.

Enquiries and applications with CV and salary request should be sent to Mr. Doru Anghelache chairman of the Newsletter and Membership & marketing committees at office@ar-de.ro before 15th of June 2018

European Federation of ExplosivesEngineers
Fédération Européenne des Spécialistes de Minage
Europäischer Sprengverband

Registered in Austria No. (ZVR-Zahll) 635276217

With this project called PECCS – Pan European Competence Certificate for Shot firer/blast designers, EFEE's aim is to create a course, according to the valid EFEE European Shotfirer Requirement, to be used for standardized assessment of technical competencies for the shotfirer/blast designer profession in Europe.

We welcome specialists and authorities of this industry to participate on our final Test Course in Dresden, Germany: Restaurant Coschütz, Kleinnaundorfer Str. 1, 01187

www.shotfirer.eu

The project is funded by European Commission under the Erasmus+ program.

PECCS
www.shotfirer.eu
info@shotfirer.eu