Comments on Rock blasting

Clearance zone

By Bruno Pimentel.

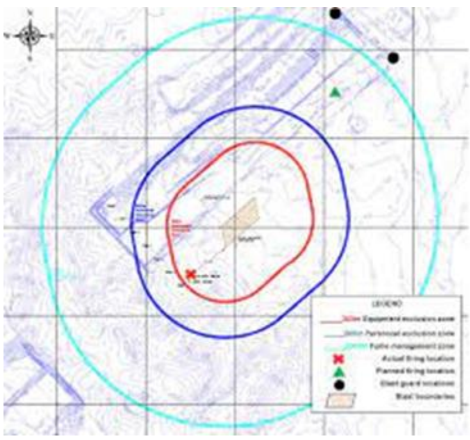
The clearance zone is one of the most well-known topics regarding the rock blasting, after all, everyone involved with the mine operation or civil works, or even those located close to an area where it will happen a blasting, has already had to leave because of a clearance zone process, and even some of them were introduced to blasting activity through it and this is the only face of the blast they know.

I confess that most of the time I'm on the inside and involved with the activity, but like many, I've been on the other side, and when we're on the outside, it's really an "inconvenience" to have to stop everything and be practically "expelled” from our site, because of something dangerous that someone else is going to do. And I use the word “inconvenient” here just to be polite, because to some it seems like it’s much more ***.

This reminds us of several situations that we have experienced or that some colleagues have shared, which do not seem to have logic, but they happen, where some people, because they think they should not be forced to leave or simply because they do not want to leave their sites for the clearance zone process, they do absurd things, like hiding behind cupboards or inside bathrooms, and all this to keep working or doing something, which is absolutely not worth risking their lives to do so, because we are not talking about surgical teams with patients in the operating room, but we're just talking about people answering emails or making a report, who are bothered by the inconvenience of going out to the clearance zone.

Not that it's not important what we all have to do, or as we say, that it's not "inconvenient" to have to leave because of a blast, but we're pretty sure that no one should "love" a report so much that they want to risk their own life, and that's why we decided to write this article, so that we can all know a little more about the clearance zone, and thus understand that we are all part of this process, and that no one should feel excluded or expelled because of the activity of others, because the purpose of the clearance zone is to ensure our safety and the continuity of our operation.

So, in summary, we can present the Clearance zone process, as an activity that is part of the rock blasting process, normally carried out a few minutes or hours before the detonation is triggered, with the purpose of driving people out of the risk area, as well as preventing other people from accessing the areas that will be affected by the blasting effects, until the complete clearance of the post-blasting area.



It is important to understand that this process, in addition to being a standard practice to ensure everyone's safety, is also a legal requirement, and is not optional, and must be performed during any blast, anywhere.

So just as an example, here are the requirements established by the Brazilian standard NR22 for performing a blast:

22.21.23 The Rock Breaking process using explosives must comply with the following conditions:

a) be preceded by the sounding of a siren, in the case of an open pit mine;

b) <u>the risk area must be evacuated and properly supervised</u>;

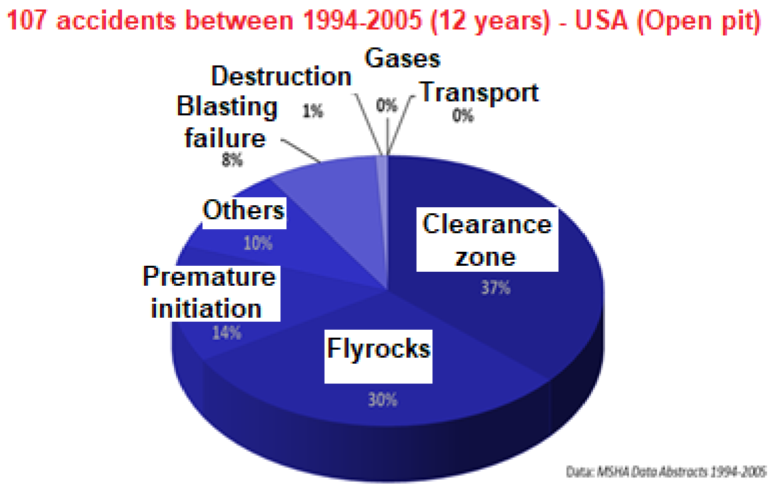
c) blasting schedules previously defined and recorded on visible signs at the entrance to access the mine areas;

d) provide shelter for the eventual use of those who trigger the detonation and

e) follow the current technical standards and the manufacturer's instructions.

We also need to understand that the clearance zone is directly linked to the radius of influence of a blast, which we can say is the distance at which it is possible that the detonation can cause damage due to its unwanted effects, such as excessive launch of fragments, vibrations, air wave, dust, gases and others, and therefore the importance of moving equipment and people, so that they are not within this radius of influence, which will vary in size according to the location and characteristics of each blast.

To illustrate the importance of the clearance zone, we have here a survey of accidents related to rock blasting with explosives during a 12-year period in the United States, from 1994 to 2005, where 107 accidents were officially recorded during this period.



Where we can clearly see that the highest number of accidents were directly related to the Clearance zone, around 37% of accidents, and we can still say, as we will comment a little later, that the 30% related to flyrock events can also be indirectly linked to the topic of Clearance zone.

This survey also indicated the main causes of accidents, and referring to the Clearance zone (37% of accidents) they were:

- ✓ Poor definition of the minimum distance
- ✓ Lack of positioning of guards and signage in all accesses
- ✓ Incomplete evacuation of personnel and equipment to a safe distance
- ✓ Lack of area verification before authorizing the blast

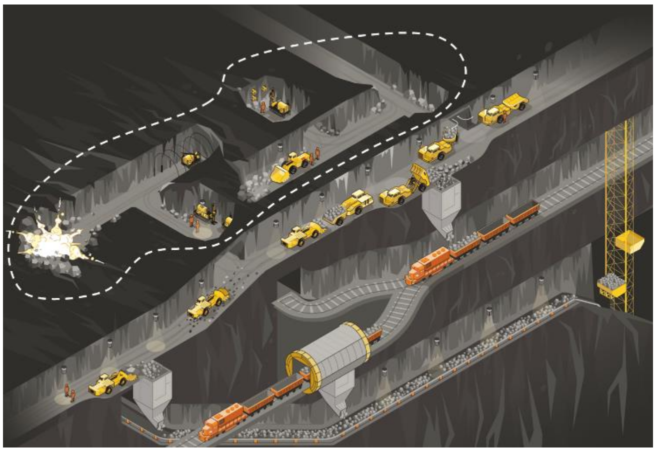
- ✓ Poor communication between blaster, mine supervisor and guards
- ✓ Non-compliance with procedures and instructions

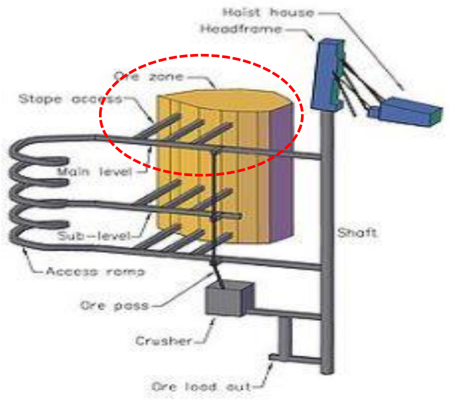
With this, it is clear the importance of the Clearance zone in the blast process, and therefore, despite being “inconvenient”, we have this activity as indispensable in the performance of any blast.

It is also important to understand that just as we normally do a macro division of rock blasting into underground and open pit, we also have differences in the clearance zone in these two environments.

We can say that in the underground operations environment, despite having the same level of demand and importance, the clearance zone tends to be smaller and more easily executable, due to the more restricted space, which makes the effects of the blast also restricted to smaller environments.

In summary, we can say that the release of material is one of the minor concerns of the clearance zone in underground environments, as the release is usually restricted to the tunnel where the blast is carried out, and therefore, the main points to be analyzed are the levels of vibration and gases generated by the blast.

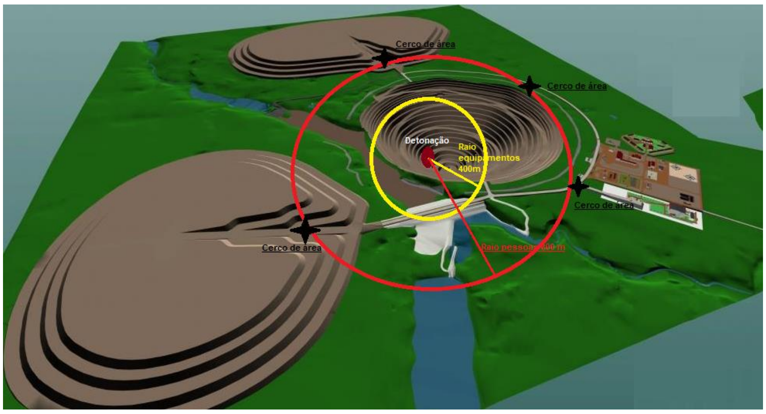




So, it is common for the clearance zone to be limited only to the level where the blast will be performed, but in the same way it will depend on the characteristics of each blast and the effects generated by it.

With this we can say that we have a great advantage in underground environments, as the clearance zone impacts a reduced number of people, where normally we will not have offices, industrial or public areas to be evacuated.

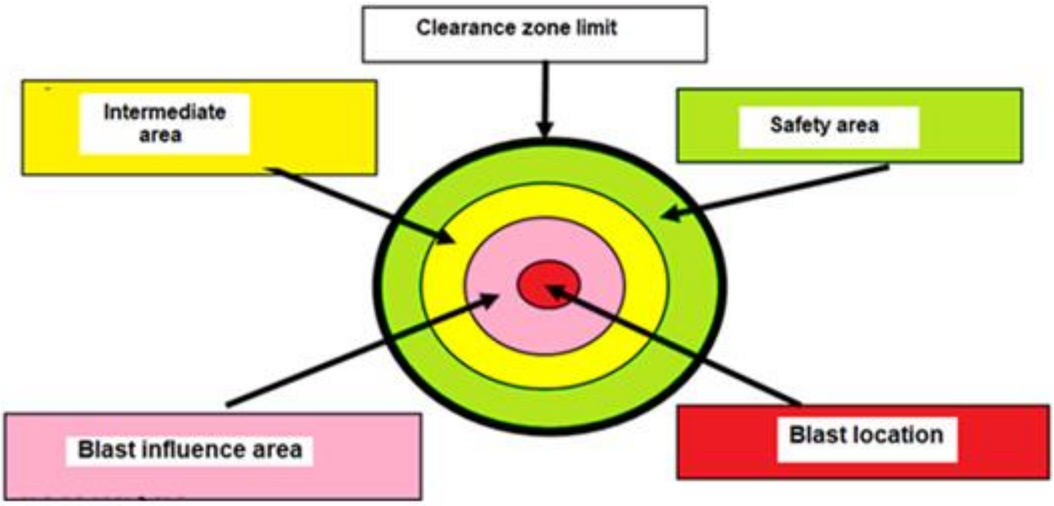
On the other hand, we have the open pit environment, where the clearance zone has larger dimensions and greater impacts, which is why most people usually associate the theme directly with this type of environment, where depending on the location of the blast, it can be It is necessary to evacuate a large number of people and equipment, in addition to the fact that it can often affect urban areas, and thus it is necessary to involve government agencies in the process, such as the police or civil defense.



That's why we usually focus much more on concepts related to the open pit environment, as it is much more extensive and has a much greater radius of influence, in addition to the fact that open pit blasts are usually much larger than underground blasts, and that clearance zone concepts are easily adaptable to either environment.

In this way, we will continue with the broader view of a blast to open pit, and for that we will understand a little of the concepts involved in the definition of the areas that involves the determination of the clearance zone.

Sorry for my poor artistic skills, but here is an illustration of the main boundaries or areas involved in determining a clearance zone.



First, we have in our figure, our central point, represented here in red, which indicates the blast location, that is the place where we will perform our blast, and represents the volume or block rock in which we will be applying the explosives to carry out the rock blasting process.

Then in pink, we have what we call the blast influence area, which is where normally the effects of the blast will occur, that is, the normal release of material will be in this area, we have a lot of gases and dust covering this area after the blast, we have a great effect of the air wave and the vibrations, and so we can say that it is an area that will suffer the direct impacts of the blast, and of course that is why it is not safe for people, equipment and structures, because everything that is in this area is subject to direct impacts from the blast.

It is important to understand that the size of this area is proportional to the size of our blast, as well as the control we have over its effects, for example, a large production blast, in which we use high levels of energy, will have a large influence area, but a controlled blast covered with protective material may have a very small influence area.

In yellow, we have what we call the intermediate area, which is the region where we normally don't have major impacts on our blast, but there is a real probability that some fragment can be launched at a greater distance, or that the wind will drive gases and dust, and even that vibration and airwave levels can be a little high. So, it is usually characterized as the area between the area of influence and the safe area.

Although this intermediate area suffers less impacts, it is still a risk area, and therefore it is still not safe, and the most we could have in this area, are physical structures that cannot be removed, where we should control the effects of our blast so that they do not cause damage to these structures, or when the risk of damage is admissible, that it is minimal. For example, in mining, we could consider a workshop or support area in or near the mine pit.

The safe area is our safety limit, where we don't have records of impacts generated by previous blasts, and usually contemplates the extra safety margin we give to our blast. Therefore, we consider that the probability of damage in this area is very low, which is why many operations already consider this area to be a safe area for equipment and installations, thus reducing the movement of this equipment, since the risk of impacts it is very low. But as it's still considered our safety margin, there can't be people in that area at the time of the blast.

Here in our figure, the safe area is represented by the green area, and its end determines the clearance zone limit, which under normal conditions is where it is determined that the probability of any impact from our blast should be null, being the point where we establish access control barriers, and do all the evacuation of personnel beyond that limit, at the time of the blast.

Opening just a parenthesis here, I just wanted to take the opportunity of the topic to make a few small observations:

- *The clearance zone boundary, determines the safe distances of our blast, and is the boundary line for determining the concept of flyrocks, that the occurrence of a rock fragment that is thrown beyond this limits, as soon as any fragment that lands on any one of these areas within the clearance zone limit, in the definition is not a flyrocks, even if it hits some structure or equipment that is within that limit, because within the limits it would be considered an accident of excessive material release, and only outside the limits is considered flyrocks. (We will look at this in more detail in a later article)*
- *That's why the limit for the occurrence of flyrocks, even established by most legislation, is zero, because after this limit, that is, after the clearance zone, we should not have impacts from our blast.*
- *Another related example is the issue of vibrations, where we can say that it is possible and “permitted” that we have vibrations beyond this limit, but these vibrations cannot go beyond the limits established by the norms, that is, beyond that point the vibrations cannot may cause damage as it is our safety limit.*

Returning to our line of reasoning, the size of each of these areas will depend on parameters, but just as an example, we can say that the blast location will be exactly the size of the blast, the area of influence can have a radius of 100 meters, and it is common to consider the intermediate area as twice that, so its limit would have a radius of 200 meters, and the limit of the safe area as twice the intermediate area, and so we would have that it would go up to a radius of 400 meters, which would be the limit of our clearance zone.

In a simple and practical way, we can say that the determination of the clearance zone is influenced by a series of factors, such as:

- Operational features
- Characteristics of the blast site
- Operational procedures
- Legal requirements and limits
- Blast Plan Scaling
- Presence of structures and people
- Safety margins
- Blast history
- Others

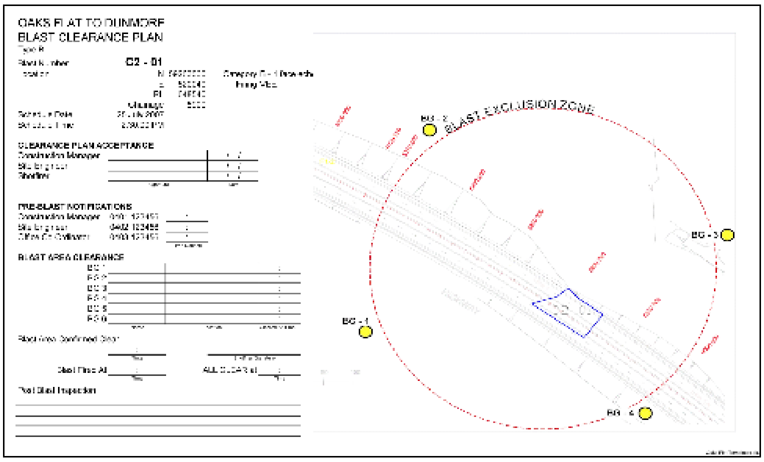
But, as we always like to say, there is no magic formula to determine the ideal size of these areas, and thus the clearance zone, so there are several practical possibilities used to estimate the measurements and thus determine the initial limits for each operation, which must subsequently be analyzed and revised periodically according to the blast history carried out.

It is common for new operations to use consulting services, seek information from explosives and blast service providers, or create a team of specialists, but we can say that there are 4 main alternatives for determining the initial values for the clearance zone limit:

- Theoretical formulas to determine the expected release of the material + safety margin established by each operation
- Specific software that makes launch simulations
- Using other similar operations as a reference
- Conducting blasting tests

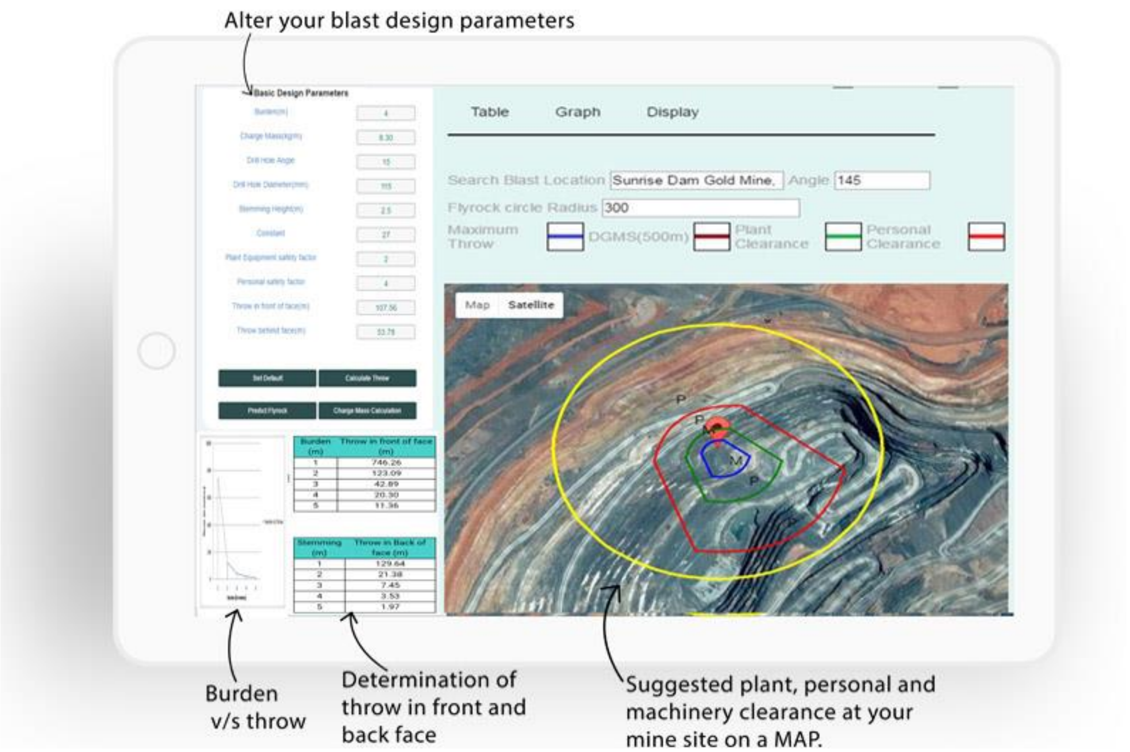
The simplest theoretical way to determine the initial limits of the clearance zone is through the formulas suggested in some literatures, which are usually developed from some practical tests and theoretical assumptions, and take into account mainly the parameters of the explosive, the hole and the rock, but unfortunately these formulas are only an initial reference, considering that they cannot contemplate the countless variables, particularities and characteristics of the different operations, which will affect the release of the material.

Normally these formulas will indicate the radius of influence of the blast, that is, the maximum release expected for the material, and so we need to add a safety margin, to determine the intermediate area and the safety area, where it is very common to use factors from 100 to 200% for each of these areas.



The second alternative is through the use of specific software, many of which are based on theoretical formulas or on a database of several operations, to determine material release forecasts, and based on that they suggest possible clearance zone limits, where many can be calibrated with some particular characteristics of each operation and with safety factors.

An example of software that I have tested recently is MineExcellence, where we can see a simulation in the figure below, and that normally, based on blast plan parameters, determines a launch distance of the material, and thus makes estimates to establish the critical ranges. and the safety distances, which can be constantly adjusted using the empirical data of the operation.



The software works directly through an online platform and has a mobile application for cell phones, which can be easily used in the field, allowing us to change the data and visualize the danger zones for equipment and people on the operation map, where in any situation critique, we can change the parameters of the blast plan on the spot and immediately assess the reflection at the boundaries of the areas.

It is also possible to create a database, which serves as a reference to determine specific parameters and characteristics of each operation and thus adjust the simulations over time.

Another more practical way is through the use of values used by similar operations, which use similar parameters of blast plan and rock characteristics, where the reference of some operations added to the experience of specialists, serve to evaluate the similarity between the blasts, and thus establish initial clearance zone limits, which must likewise be adjusted over time.

Finally, whenever possible, regardless of the use of any of the three previous alternatives, a basic recommendation is to carry out some blasts tests, which can have well-controlled sizes and characteristics, with good safety limits, and thus evaluate different configurations and the their results, serving as an initial basis for determining safety distances or for confirming those suggested by any of the other methods.

In practice, most operations already have safety distances and clearance zone limits established, so the need to determine these limits is really limited to specific situations of new operations.

A negative side of this is that most professionals and operations are working with clearance zones that have no idea how they were determined and often do not re-analyze them to verify their effectiveness and safety margin.

In addition, it is common to make a series of changes to the blast parameters, or several changes that have been made since the determination of these limits, and not assess how these changes impact the clearance zone, such as changing explosives supplier, charge ratio, blast sequencing, and several other parameters.

So just as most operations have performance indicators for our blast quality parameters, such as power factor control, fragmentation control, or vibration monitoring, it is highly recommended that we establish a material release control indicator. , and for this we recommend monitoring two measures:

- The throw distance of the material mass, typically measuring the distance from the edge of the fragment pile, also known as the edge of the material skirt, from the free face.
- Longest throw distance for isolated fragments.

Because with these two measures we can create a database, and relate the characteristics of each blast with the maximum launch area, evaluating the changes according to each blast.

This database should serve as a historical reference, in the same way that it should help us to assess the impact of the various changes that we have in each operation, guiding us over time, so that we can adjust the safety limits of the clearance zone, at the same time as served as a reference, which should not be lost with the exchange of professionals.

Expanding the topic further, we need to remember that although the main reference for determining the clearance zone in open pit operations is the release of the material, we cannot forget about the other effects of our blast such as vibrations, airwaves, gases and dust, which also are reference in underground operations, and therefore, the ideal would be to monitor all these parameters, and evaluate their influence for the determination of the clearance zone.

For example, in underground operations, we should take the vibration limits and the dispersion of gases, as a reference for assessing the clearance zone, where, no matter how simple, the different changes in the characteristics of the rock, can indicate different vibration limits for each level, and this implies the need to adjust the clearance zone.

The scenario of each operation is who should determine the critical indexes to be monitored and taken into account in the clearance zone assessment, but it is a fundamental safety issue of all blasts, which we should pay much more attention, mainly because it is the related cause. with the majority of accidents related to rock blasting.

In addition to determining and evaluating clearance zone distances, the practices used to ensure the safety of this operation, such as the use of signs, lookouts, communication and others, are fundamental in all aspects, but we will not comment on them here because they are more widely known, but if the opportunity arises, we will bring more details on the topic at some other time.


So to finish today's article, which has already become longer than we intended, we need to understand that we have two risk situations that need to be monitored regarding the release of blasted material.

The first is related to the risk of excessive material release, which consists of an event when a blast launches the material beyond the intermediate area, reaching the safety area, where equipment or facilities may be. In this case we may have material damage, but the entire event will be contained within our clearance zone, so people will be out of that risk.

Generally, when we have an excessive release of material, it is contained within the limits of the clearance zone, being very rare an event in which a large amount of material is released beyond the limits of the clearance zone, normally limited to situations where the safety limits have been poorly established.

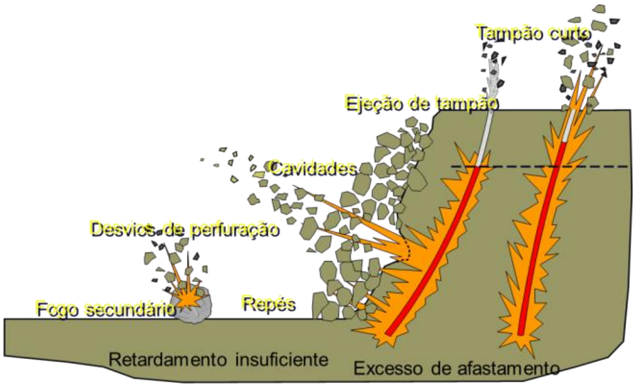
Usually situations like this are generated by failures in the correct dimensioning or execution of the blast plan, and represent a general failure situation of a blast.

In addition to this situation, we have a second type, which are the flyrock events, which are characterized by the launch of one or several fragments beyond the limits of the Clearance zone, and this is a conceptual difference, because we can only consider flyrocks when we pass the limits of the Clearance zone, so if we don't go over these limits, we'll just have an over-release, whether it's a fragment or the whole material.

Flyrocks can originate from an excessive launch or from a point situation, where it is usually related to a premature escape of gases, by a specific point, which launches fragments to great distances. So we can have detonations with the release of well-controlled material, but for a particular situation, often even unknown, we can have a flyrock event.

We can usually use various techniques known as “controlled blasting” to limit the release of material, which can help us control the risk of excessive release, and just as we can use the same techniques to control the safety limits of our blast, or ie to size or adjust measurements in our clearance zone.

It is important to understand that even controlling the release of the material, we can still have potential risk situations, known or not, that can result in flyrocks, and therefore normally saying that there are no specific techniques to control flyrocks, and that prevention, through the identification of risk situations, is the best way to establish criteria for each blast.



The subject of flyrocks is very critical, and as we saw at the beginning, it is the second item that most causes accidents related to the rock blast process, so we will write a specific article on this subject.

Well, that's it, let's stop here today, otherwise we'll write a book...

We intend to write several articles, as a way to spread the known in rock blasting and exchange experiences with everyone!!

Please, if you liked it, comment and share, so we can keep creating articles like this and exchanging ideas.

We also have a course that details all Rock blasting activity very well, so if you are interested or know someone who is, just access the link below:

Portuguese -> https://lnkd.in/d5eivncS

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