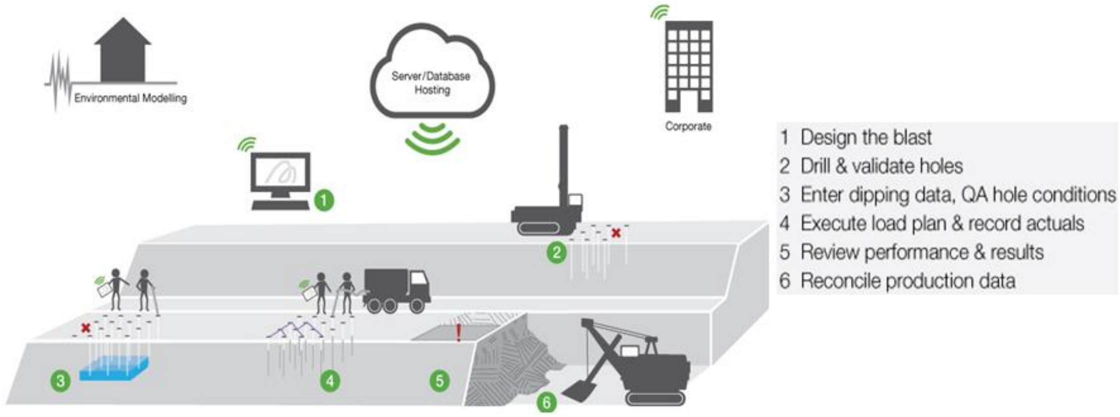
Methodologies for initial blast plan design

By Bruno Pimentel.



Hello my friends, I hope you are all well and we apologize for the delay in our publication today, as we usually publish early, but today we still had to finish our article due to the rush during the week, so we published it later.

We leave here the links to our Newsletter so you can check our previous articles, as well as register, so that you are automatically notified of each new article we publish:

Português

https://www.linkedin.com/newsletters/blast-de-rocha-c-explosivo-6941709482355748864/

English

https://www.linkedin.com/newsletters/rock-blasting-6959820770344595456/

In today's article we are going to continue the previous article, where we finished commenting on the 3 main methodologies for elaborating an initial blast plan, which refers to a blast plan to be carried out in a new operation or new area where we have never carried out a blast, as well we have no previous blast plans to build on. So today we are going to make some general comments about each of these methodologies.

So, as we saw in our last article, considering that the beginning of a blast plan depends on the scenario, the objectives, the information and the resources we have available, and each scenario will give us a different starting point, in summary we can say that there are 3 main methodologies that we can use to draw up an initial plan:

1. Theoretical formulas = use of formulas and estimates to determine the controllable parameters of the blast plan starting from the uncontrollable ones or key parameters.

2. Benchmarking evaluation or previous experience = using references of similar operations or conditions to carry out a similar design adapted to the specific characteristics of the blast to be carried out.

3. Specific objective = use of a main objective as a reference for determining the blast plan parameters, where simulations are often carried out with software or approximation equations.

1. Theoretical formulas

Elaboration by theoretical formulas is the most basic methodology for designing an initial plan, which consists of using formulas and estimates recommended in the literature to determine the controllable parameters of the blast plan, generally using the uncontrollable parameters or key information/considerations as an initial reference. of the blast to be performed.

NOTE: Uncontrollable parameters are those, which, as the name implies, we cannot control, but which directly interfere in the preparation of our blast plan, for example, such as an operation that has the drilling equipment already determined and therefore we cannot choose the best one diameter, first we have to work within the limitation of this equipment, and thus the diameter will be an uncontrollable parameter. Another example could be the height of the bench, which has already been previously established by the stability characteristics of the rock, so we will have to elaborate our plan already based on a standard height.

When using this methodology, a special care is that most formulas are empirical, determined under certain specific conditions and that despite being a valid approximation to be analyzed, they are not accurate or ideal for all scenarios. That's why it's important to check the recommendations for your application.

In the literature we will find several formulas, where we will have some more complex ones and other simpler approximations for the different blast plan surfaces, where the most complex ones are normally used for more complete studies and the approximations are very used in the operational day to day to evaluate if the design is consistent with the recommended basic conditions or even to elaborate simpler blast plans.

This methodology is used in most training courses, as well as in the literature, to present simple examples of initial blast plans. It is also widely used in academic/scientific studies, as well as by consultancies to draw an initial baseline plan for comparison with tests and other assumptions.

Most literature or studies will point out some formulas for determining base parameters, but not a complete guide for preparing the blast plan, so it is necessary to evaluate which formulas we are going to use and mainly what the starting point is (initial considerations), as they may vary according to the formulas to be applied.

We usually analyze the uncontrollable variables and the information that we have available so that we can evaluate which other parameters we need to determine, and from there we choose the formulas to determine these parameters and we can also use more than one formula to be able to have a comparison.

Another important point is that many formulas indicate a range of values, and the determination of which limit to use (lower, medium or higher), depends on the objectives and experience, being necessary to evaluate the criticality level of the parameter and the risk potential of the scenario to take into account the necessary safety margin for the initial blast plan.

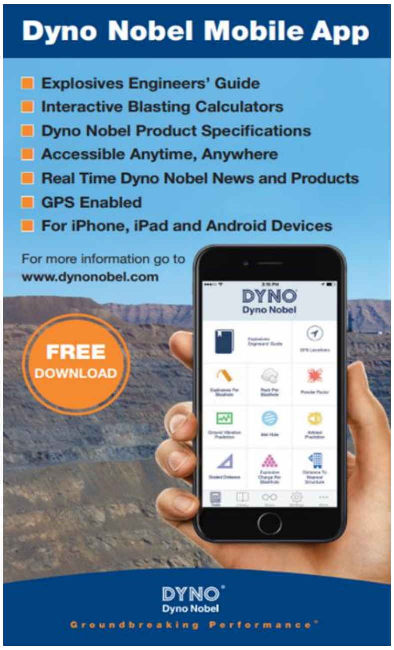
It is also important to keep in mind that if we use different formulations they may present different results, due to the variation of the assumptions for their determination, as well as the test scenarios, so it is important to be careful, and once again use experience to weigh with the actual scenario of the blast to be performed.

Once the formulations have been used to determine the parameters of the initial blast plan, the preparation and design of the plan is carried out manually or with the use of design software.

Blasting	Parameters	Values	Units	Functions
Number of holes	-			-
Features (staged mesh)	Bench height		m	-
	Inclined holes		º	-
	Burden		m	-
	Spacing		m	-
	Subdrill		m	-
	Stemming		m	-
	Hole lenght		m	-
	Hole diameter		mm	-
	Drilling standard deviation		m	-
Volume of blasting rock	-		m^3	-
Amount of explosives	-		kg	-
Blasting velocity (in situ)	-		m/s	-
Nominal blasting velocity	-		m/s	-
Absolute weight strength	-		kcal/kg	
Relative weight strength of ANFO	-		(%)	-
Explosive types	1 ou 2 types			
	BCL (Bottom Charge Length)		Function 1	#DIV/0!
	CCl (Column Charge length)		Function 2	#DIV/0!

It is possible to find some spreadsheets or even software/applications, usually from explosive manufacturers, that automatically calculate the parameters through theoretical formulas, just providing some initial data.

Likewise, it is possible to find tables or graphs that relate the various variables, which we can say are a representation of some of the formulas and that often facilitates their application, since we do not need to do the calculations, just follow the graph or table. taking into account the value of the reference parameter.



2. Benchmarking evaluation or previous experience

Another methodology, which is often used to complement the theoretical formulation, but which can also be used independently, is based on the evaluation of benchmarking or previous experiences, which consists of using references from other operations that have similar conditions, to serve as a basis for carrying out an initial blast plan, adapted to the specific characteristics of the blast to be carried out.

It is common for new operations to hire consultants to carry out Benchmarking studies, which is nothing more than a competition study process, which can be a deep analysis of the best practices used by companies in the same sector and which can be replicated in their operation.

In the same way that consultants and experienced professionals also use their knowledge and previous experiences to serve as a basis for defining initial parameters, always analyzing the similarity with other detonations carried out in the face of the particular conditions in the new blast.

Benchmarking studies can be used both for carrying out initial blast plans for new operations or even for optimizing operations that seek to improve their operational practices and results, but it is more common to be carried out by large companies due to the costs involved.

It is also common to carry out visits to closely assess the conditions of the operation, especially when they are made in partner companies or that are open to the exchange of information.

Depending on the available information and the compatibility of scenarios, it is possible to replicate some of the configurations used or just take some key parameters as a reference, which served as a starting point for the initial designs, where we can use theoretical formulas as a complement or just adjust intermediate values according to margin of safety or specific characteristics of the operation.

The most standard practice of this methodology is the use of Power factor (PF) as a reference parameter, mainly looking for similar rock type and conditions, thus adapting the other initial parameters according to the operation specifications, so that they deliver the same RC or according to a determined adjustment range.

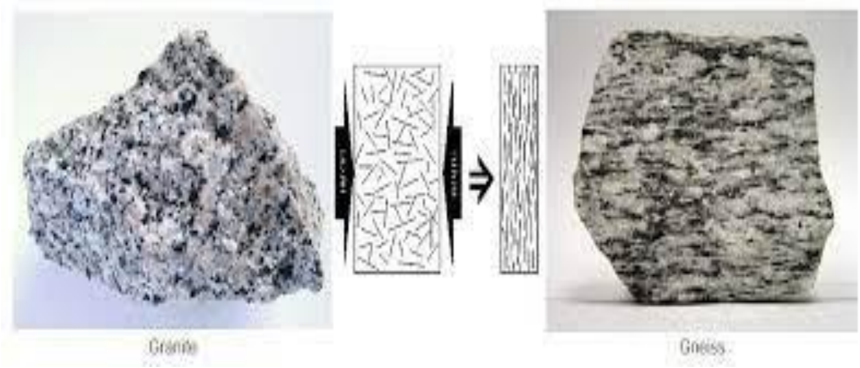
Taking the power factor as a reference and the uncontrollable parameters, theoretical formulas can be used to calculate the other parameters or else make approximations according to the experience and knowledge of the professional to arrive at the initial blast plan.

Using experience, the same principle can be followed, but instead of looking for references in similar operations, professionals will use data from the history of detonations that they have already carried out to serve as a basis, comparing conditions and their practical experience. This is very common for consultants or construction professionals who perform blasting in many different locations.

Rock type	**PF(kg/m³)**
Hard	0.7 – 0.8
Medium	0.4 -0.5
Soft	0.25 – 0.35
Very soft	0.15 – 0.25

Regardless of whether the analysis is based on experience or on benchmarking, it is necessary to carry out a complete comparison of scenarios, so that you can be more assertive in the adjustments and evaluations to be carried out, always analyzing:

- ✓ The characteristics of the rock and the scenery;
- ✓ Objectives and results in each situation;
- ✓ History of abnormal events;
- ✓ Procedures and operational practices of the reference;
- ✓ Evaluate legislation and safety limits for each scenario;
- ✓ Others.



When possible, it is also important to analyze the opinion of those who are using the reference configurations, as there may be details that they can share more precisely or ideas about possible adjustments that have not yet been made.

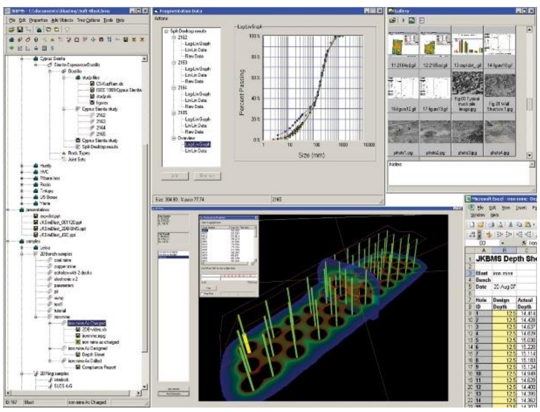
In larger operations, it is also possible to carry out some field tests to have the possibility of carrying out more precise adjustments before the effective start of the operation.

3. Specific objective

The third methodology that we are going to mention today arose mainly due to the advancement of technology, it has been gaining more and more space due to the possibilities that technology brings to analyze many possibilities and variations of scenery very quickly. We call this methodology "Specific Objective", which consists of using a key objective as a reference for determining the blast plan parameters, where modeling and simulation software is normally used to design an initial blast plan that aims to maximize this objective. .

There are also some studies that suggest some approximation equations or algorithms, which aim to determine key parameters to maximize the results of some specific objectives. Here it is worth differentiating the technique from theoretical formulas, which aims to determine all parameters as a function of uncontrollable parameters or initial considerations, while in this methodology what is done is to seek to optimize the parameters so that they deliver the maximization of a specific objective, at first leaving all other objectives as secondary, and that can be analyzed later as a formula to optimize the plan as a whole.

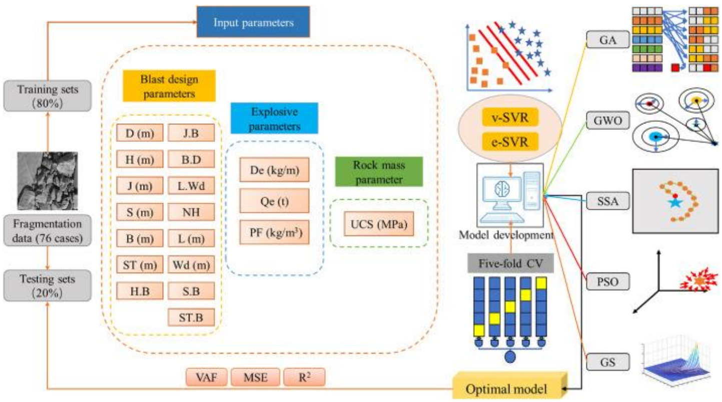
Usually this methodology is used in projects that need specific results, but with the growth and availability of technology, it has been the main source of simulations for optimizing blast plans in improvement projects, mainly of the "mine to mill" type that aim to maximize the entire process chain through rock blast improvements.



Generally, the key objective is fragmentation, but there are already several software programs that allow the simulation of material movement to optimize excavation or for dilution control, as well as some that will simulate vibrations, optimizing operations in urban areas or close to critical structures. .

These software are different from conventional design software, and it is usually necessary to insert a series of information about the rock and the location, to create a model similar to the real situation, and thus, based on this model, a series of simulations are carried out, modifying parameters until a configuration that best delivers the expected objective is found.

The quality of the model and simulations will reflect the information we provide, so the more accurate and representative of reality they are, the closer the simulations and results will be. Based on this, it is important to evaluate what kind of information each software requires in order to function correctly.

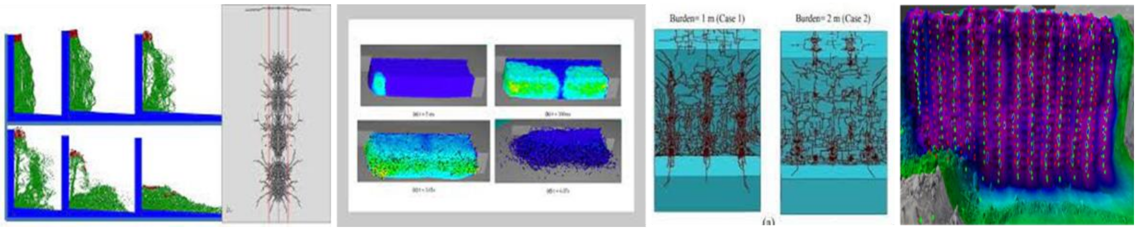


There are also some design software that allow an initial prediction, serving as a first approximation of possible outcomes. These are good options for carrying out studies on a daily basis, in order to determine a certain correlation between predictions and results, serving as a basis for the continuous improvement process of the blast.

An important point of attention is that, no matter how complete the software is, there are several variables that we cannot consider in the model, so in the same way as the previous methodologies, the simulations will give us an initial blast plan, which will need to be adjusted over time, but as we compare the simulations with reality we can optimize the modeling to a point where we have very satisfactory results.

Normally, these software are widely used by consultants, service providers and companies that supply explosives, which, in addition to their expertise, will also have a large database of different detonations to serve as a basis for comparison.

As we said, there are also some approximation formulas suggested in the literature, mainly for estimating a possible fragmentation, material release or vibrations, which are usually more used in scientific studies and also some of them are the basis of the algorithms used by the software, but in day-to-day operations, it is difficult to apply it to determine an initial design, given that the software does a much more detailed job and that manually, conventional formulas are usually used to determine the basic parameters, and when necessary, it is carried out adjustments until a satisfactory result is obtained.



Well that's it guys, let's stop here, the idea was to finish the topic in today's article, but there are still a series of considerations about the choice between these three methodologies and some general observations that we want to make, so we'll leave it to finish in a next article to not make this one too big.

As we mentioned in the last article, there is a great deal of complexity around this topic, where it is not always easy to define the best initial path, especially for a new operation that we have no knowledge or real data about, and in these situations professional experience is essential. who takes most of the responsibility, and on the other hand the easiest and safest path is the possibility of carrying out initial tests that are fundamental for determining a more robust and safe initial plan, but that is not always possible to be carried out , mainly in small operations or punctual detonations.

We will comment more on this in the next article and as always it will depend a lot on the scenario, so we ask you to comment and share experiences you may have had or even those who want to contribute in a more active way sharing a case study is much more than welcome.

As we always ask, please comment and share, so that we have increasingly safe and quality detonations!!!

Blasting Trainings wants to help you shape the world with safety and quality.

Rock Blast Courses:

Português -> https://lnkd.in/d5eivncS
English -> https://lnkd.in/dsrq7PGm

www.blastingtreinamentos.com

blastingtreinamentos@gmail.com