ROCK BLASTING DEFINITIONS

Lecture 1

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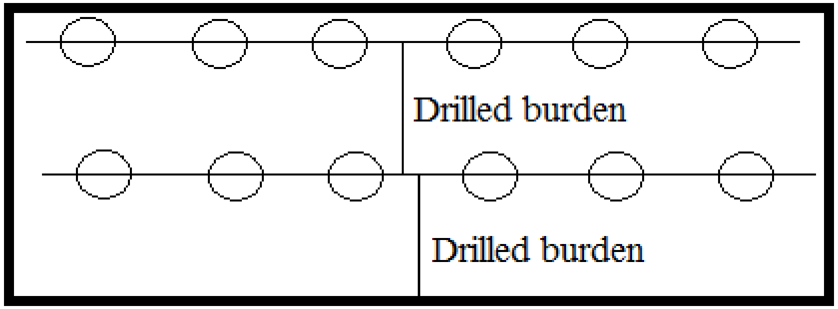
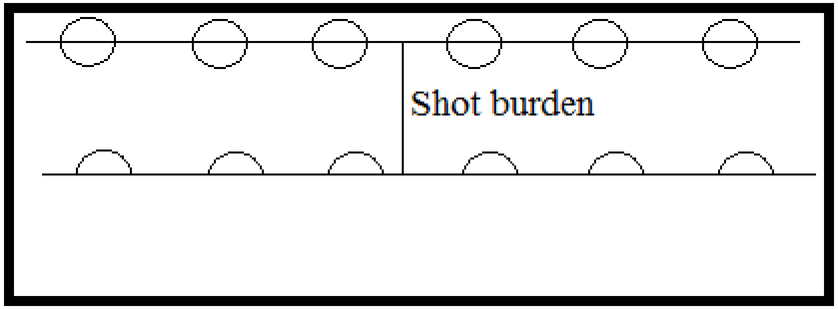
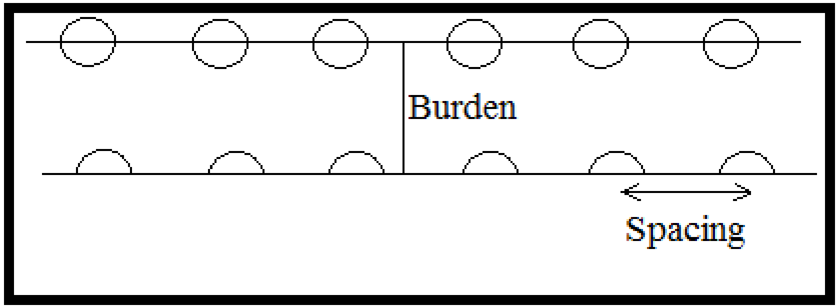
•**Burden** – There are actually two burdens, the drilled burden, and the shot burden. The drilled burden is the distance between a row of holes and the nearest free face and is measured perpendicular to the row of holes. It is also the distance between two rows of holes. The shot burden can change slightly from drilled burden because it represents the distance between a detonating hole and the nearest free face that has developed in the blast. In either case, the burden represents that volume of material that a detonating hole or holes are expected to fragment and shift. The term usually refers to the drilled burden when laying out the shot.

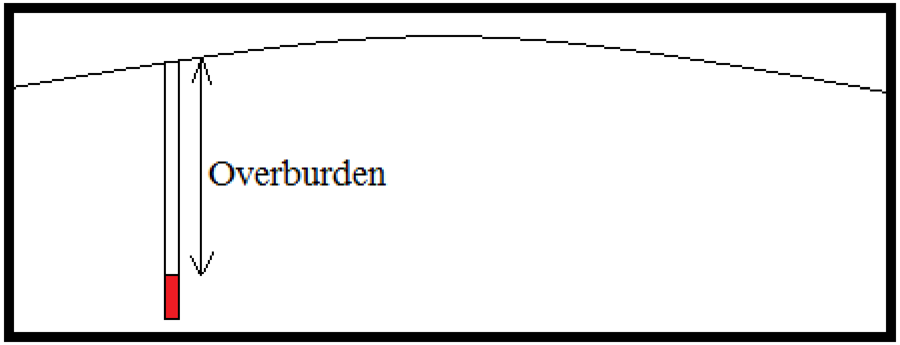




•**Spacing** – Represents the distance between holes in a row. A drill pattern is always described in terms of burden and spacing, in that order. (i.e., a 6 x 8 pattern has a burden of 6 feet and a spacing of 8 feet.)

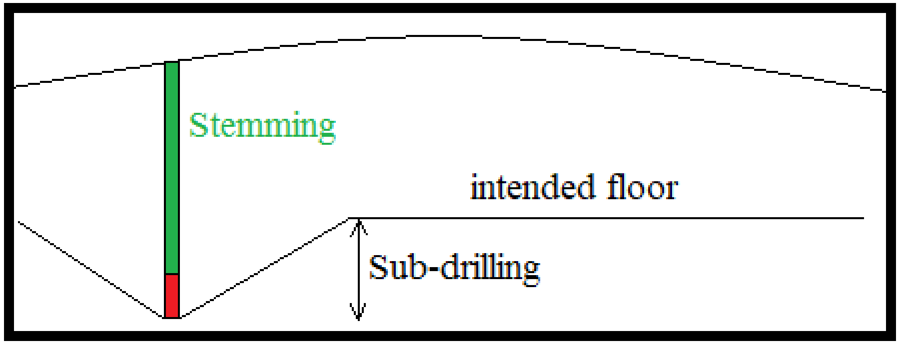


•**Overburden** – Don't confuse this term with Burden above. Overburden is soil and other materials overlaying the rock to be blasted. Usually removed before drilling but occasionally left in place to confine the blast and allow loading explosives higher in the hole (nearer the top of the rock).

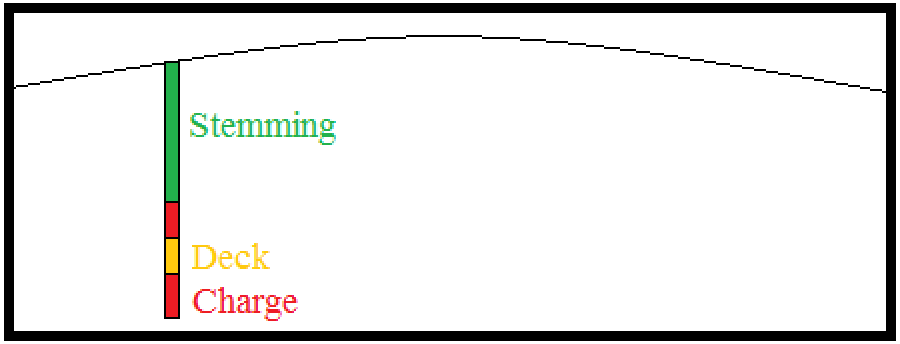


•**Sub-drilling** – The amount of hole that is drilled below the intended floor of the excavation. Except in those situations where the rock is in horizontal bedding planes, the detonating charge will usually leave a crater at the bottom of the hole rather than shearing the rock on a horizontal plane. Because of this, it is not uncommon to sub-drill an amount approaching half of the burden distance in order to be able to excavate to the intended depth.

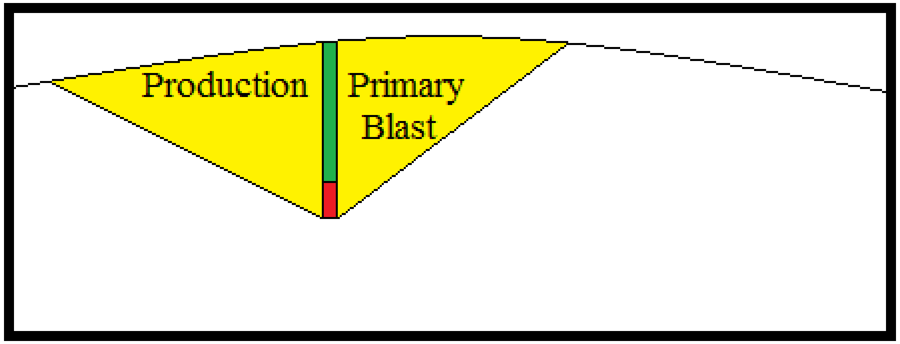
•**Stemming** – In order to confine the energy from the explosive, the top portion of the hole is stemmed or back-filled with inert material. Because of their proximity to the hole, drill cuttings are usually used, although other materials, including stemming plugs, can be used.

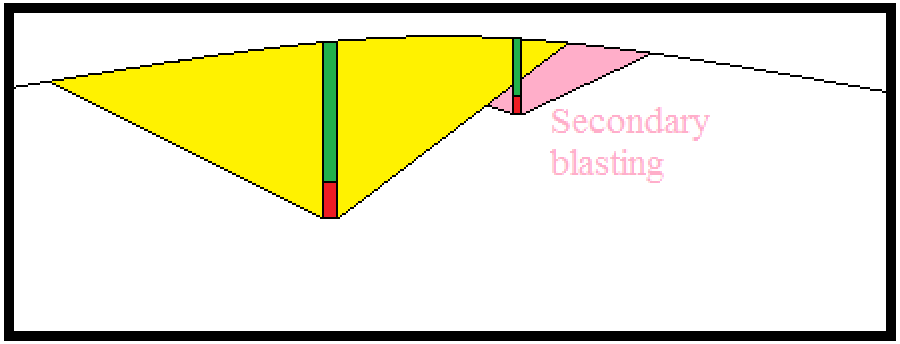


•**Decks or decking** – This is a means of separating two or more charges within a hole. This is usually done to (1) reduce the amount of explosive detonating in a given instant by having the decks fired on different delays, or (2) avoid loading explosives in weak zones, voids, or mud seams in the rock. The decks are separated by inert stemming material and each deck requires some means of initiation.



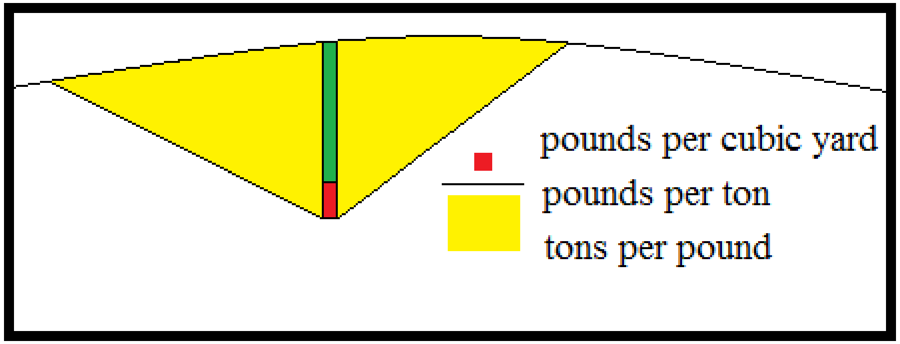
•**Production or Primary Blasting** – A blast that is intended to adequately fragment a given volume of rock. The rock may be removed in one or more production (or primary) blasts. If an excavation is of sufficient depth to require removal in more than one lift, each lift would be removed utilizing one or more production blasts.



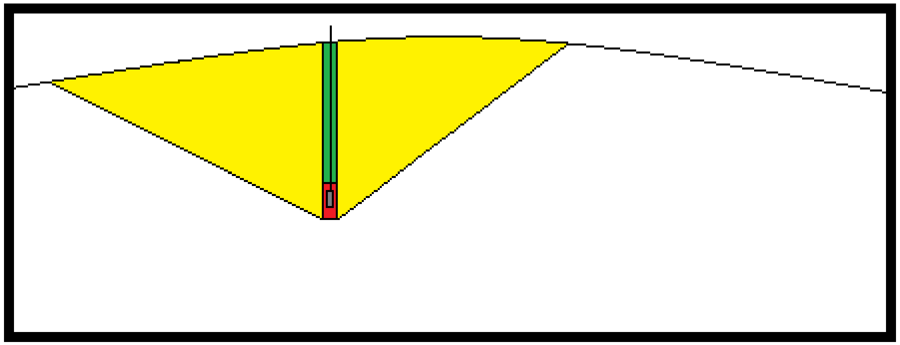


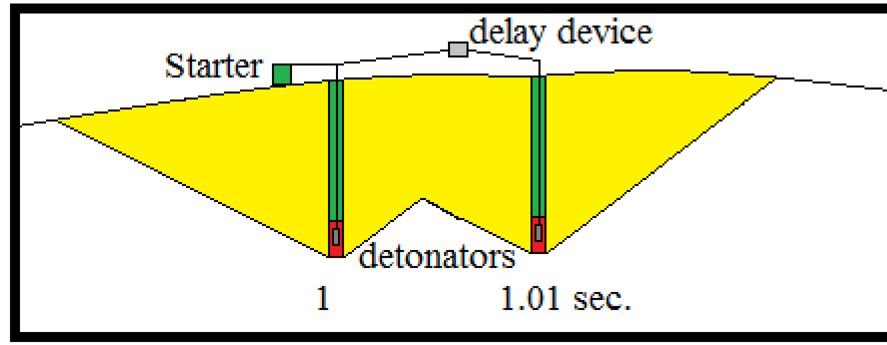
•**Secondary Blasting** – Blasts that may be required to remove or reduce material that wasn't adequately fractured in production blasts (i.e. trimming blasts or removing the high bottom.) Also the blasting of boulders or other specialized blasts whether or not production blasting was conducted.

•**Powder Factor** – The ratio between the weight of explosives detonated and the volume of material blasted, usually defined in pounds per cubic yard for construction blasts. In mining, the powder factor is usually expressed in pounds per ton (or tons per pound of explosive). When discussing powder factors, it is important to know whether one is using the "shot powder factor" or "pay (or yield) powder factor". The shot powder factor includes the material in the sub-drilling zone in the calculations, while the pay powder factor does not. Most blasters use the shot powder factor because it more accurately describes the amount of work that the explosive is supposed to accomplish. Accountants tend to use the pay powder factor because it more closely describes the amount of yield or saleable material generated by the explosives in the shot.



•**Detonator** – The devices, either electric or non-electric, that are inserted in the explosives and used to detonate them.

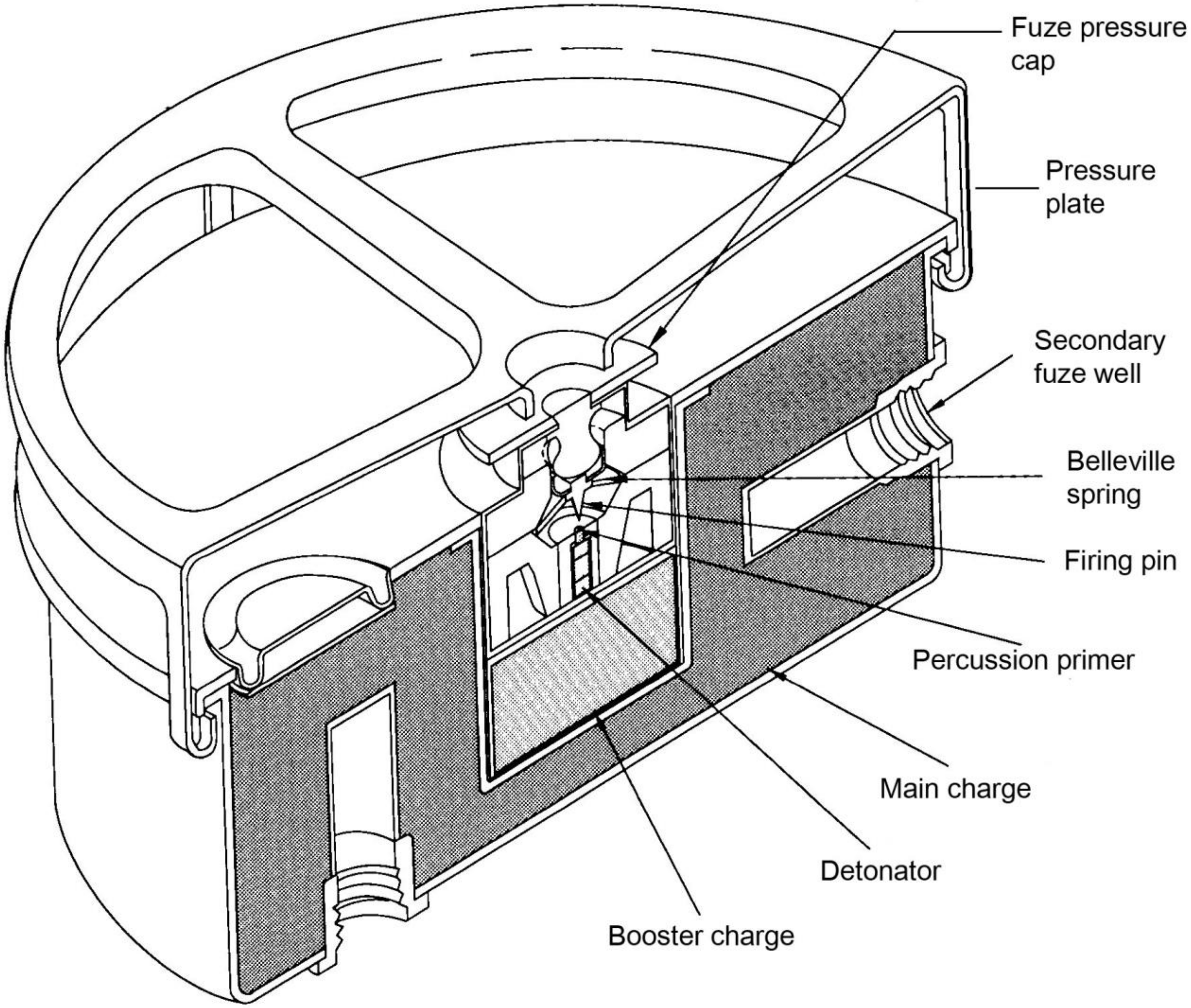




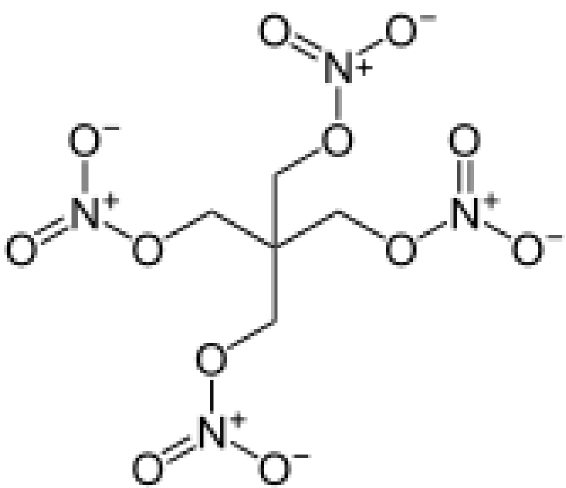
•**Delay** – The time interval between detonators (and their corresponding explosive charges) exploding. Because modern initiation systems provide for further subdividing of the delay times in conventional detonators, the delay times can be tuned for specific blasting needs.

•**Initiation System** – The entire system for initiating the blast is including the blasting machine or starter, detonators, delay devices, and their interconnecting parts.

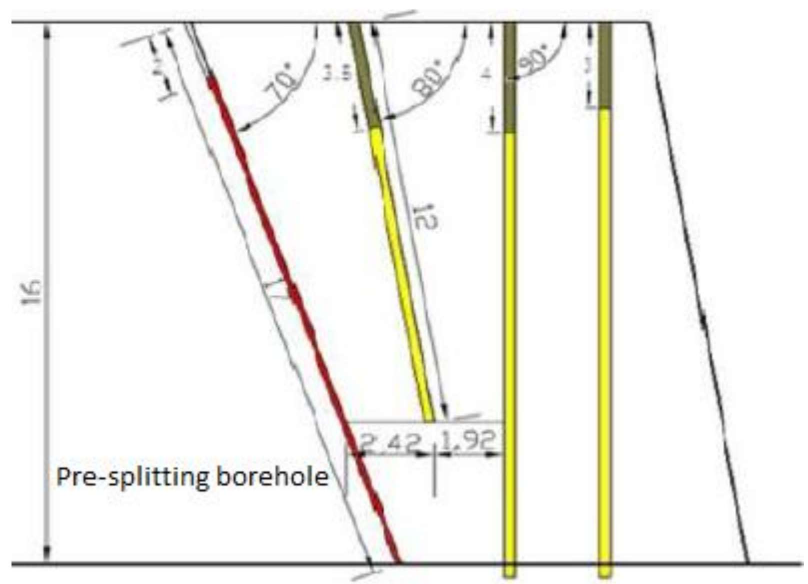
•**Booster or Primer –** A fairly sensitive charge that is used to initiate less sensitive explosive charges. Boosters are in a cast form with a detonator well and/or detonating cord tunnel, but Primers can also be a cartridge products.

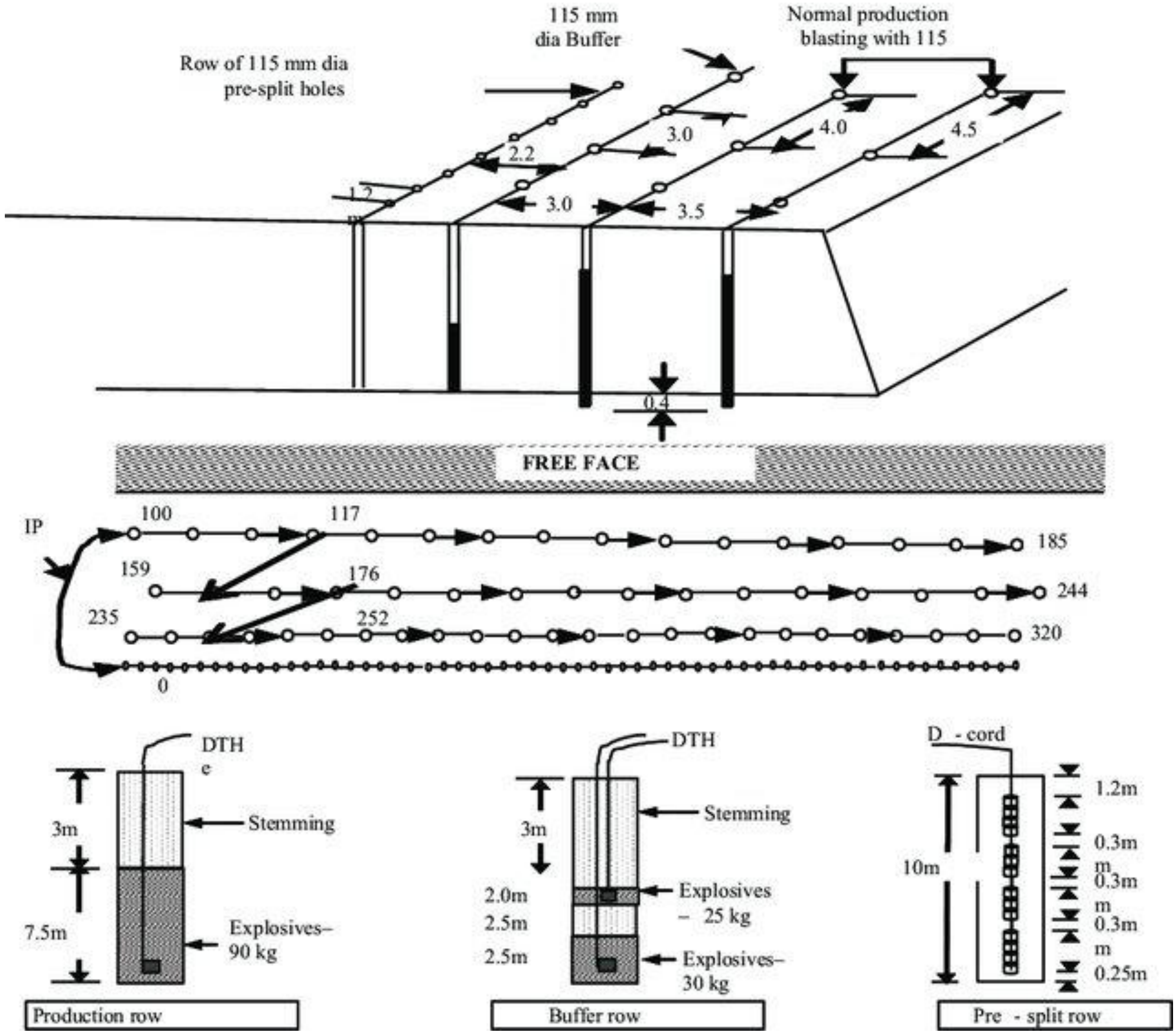


•**Detonating Cord** – A cord consisting of a core charge of pentaerythritol tetranitrate (PETN) overwrapped with layers of plastics and textiles. It is available in various core loadings and detonates at approximately 23,000 feet per second. Originally developed as an initiation system, it has also been used in specialized blasting situations as the primary charge. Detonating cord is sometimes referred to as Primacord, which is the brand name of one specific product. (PETN is also the base charge in most detonators and is an ingredient in most cast boosters.)



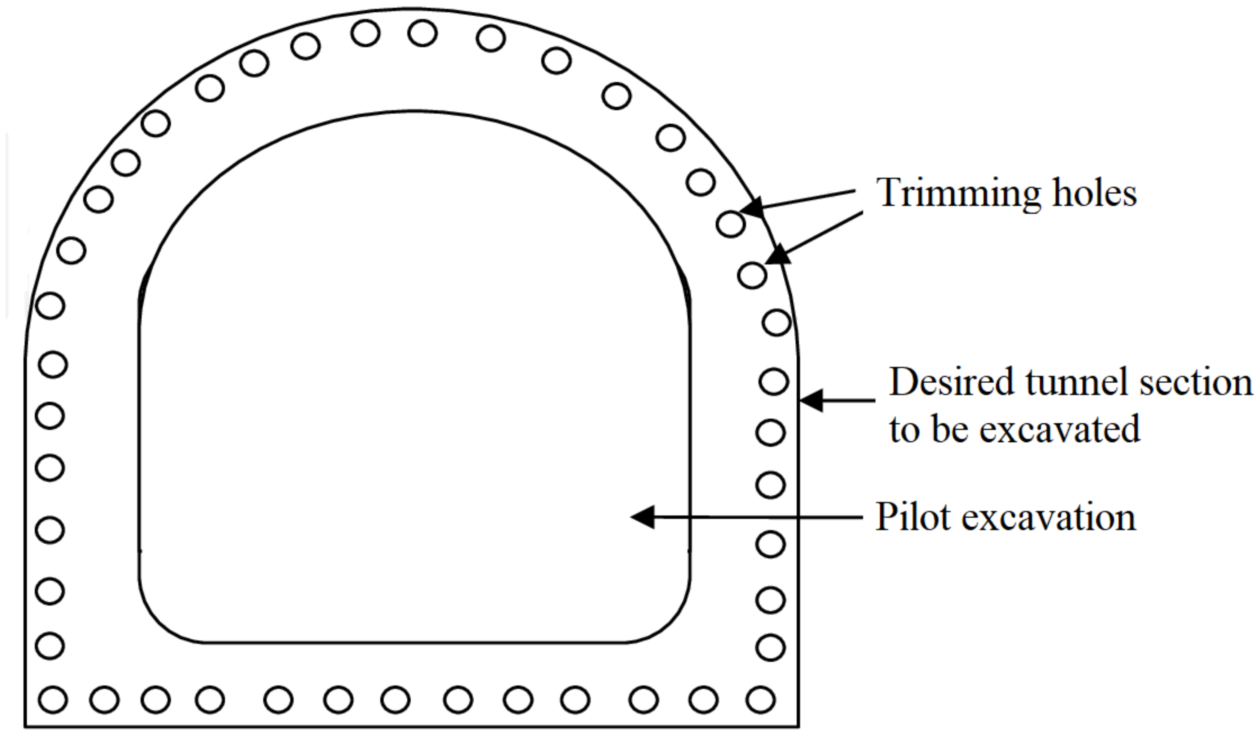
•**Pre-splitting** – A cautious blasting procedure where a row of lightly-loaded perimeter holes is detonated ahead of the main production blast and propagates a crack along the row of holes. This crack is intended to protect the final perimeter wall by allowing expanding gasses to vent and by intercepting cracking (back-break) from subsequent detonating production holes. NOTE: A pre-split crack has little or no effect in reducing vibration from subsequent blasts and, in fact, the pre-splitting blast creates more vibration per unit of explosive weight than many other forms of blasting.



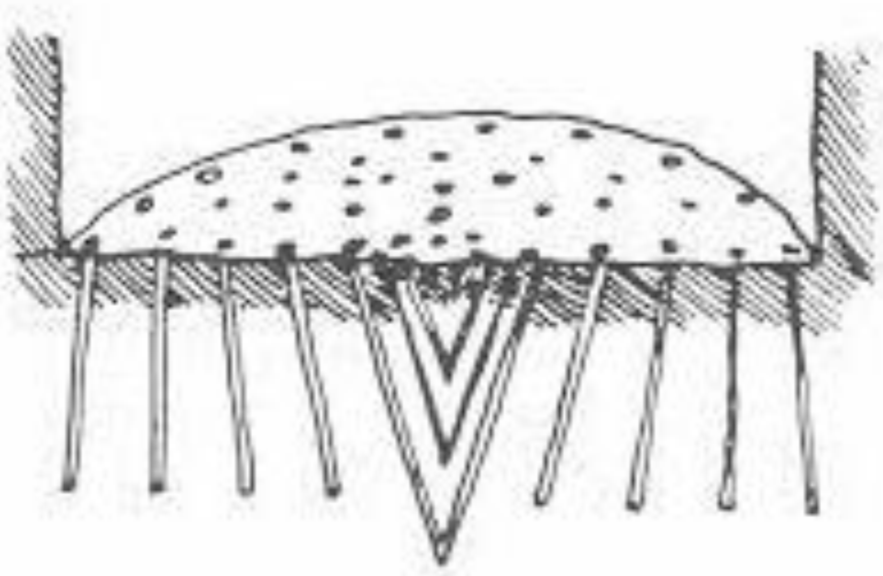


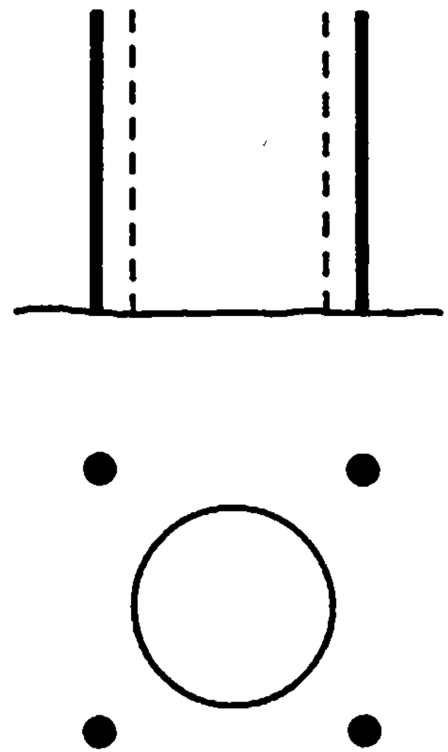
115 mm
dia Buffer
Normal production
blasting with 115
Row of 115 mm dia
pre-split holes
3.0
4.0
4.5
2.2
1.2
m
3.0
3.5
0.4
FREE FACE
IP
100
117
185
159
176
244
235
252
320
0
DTH
e
3m
Stemming
7.5m
Explosives–
90 kg
Production row
DTH
3m
Stemming
2.0m
2.5m
2.5m
Explosives
– 25 kg
Explosives–
30 kg
Buffer row
D - cord
1.2m
10m
0.3m
m
0.3m
m
0.3m
m
0.25m
Pre - split row

•**Smooth-blasting** – A cautious blasting technique similar to pre-splitting, except that the holes are detonated after the production holes in the main blast. The intent is not to form a crack, however, but to blast lose the remaining burden with the lighter charges without causing excessive damage to the perimeter wall. Often the charge weights in the nearest production holes are reduced to assist in preserving the perimeter.



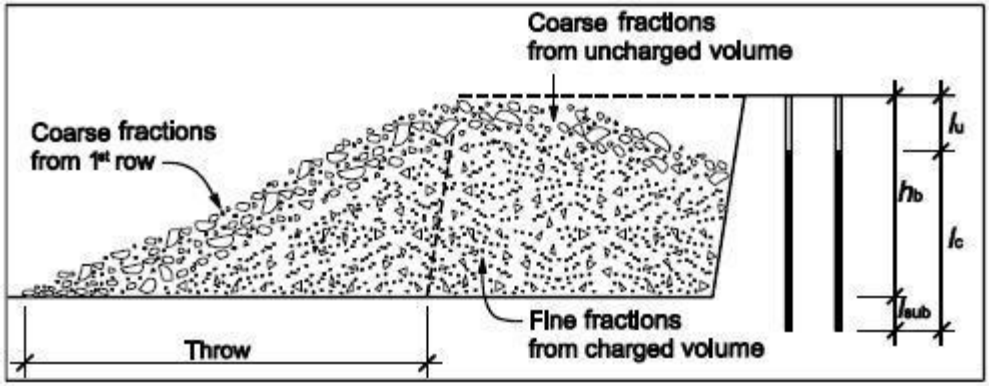
•**Sinking Cut** – a blast where no free vertical (or sloped) face exists and it is necessary to ramp down into a horizontal surface. In this type of blast a portion of the blasted material must be expelled upward to make room for the expanding material from subsequent holes detonating. Some flyrock will necessarily occur and must be taken into account in designing such blasts.





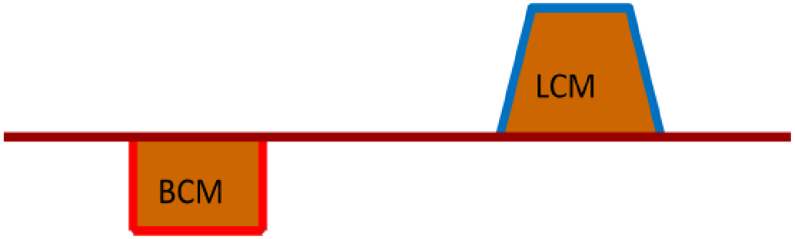
Parallel large-hole burn cut

•**Throw or Heave -** Movement or shifting of the blasted material at an intended distance and direction by the force of the blast.



Typical profile through a rock pile from a surface blast, indicating the main fragmentation sections

•**Flyrock** - Material that is expelled from the blast and travels farther than expected or intended.

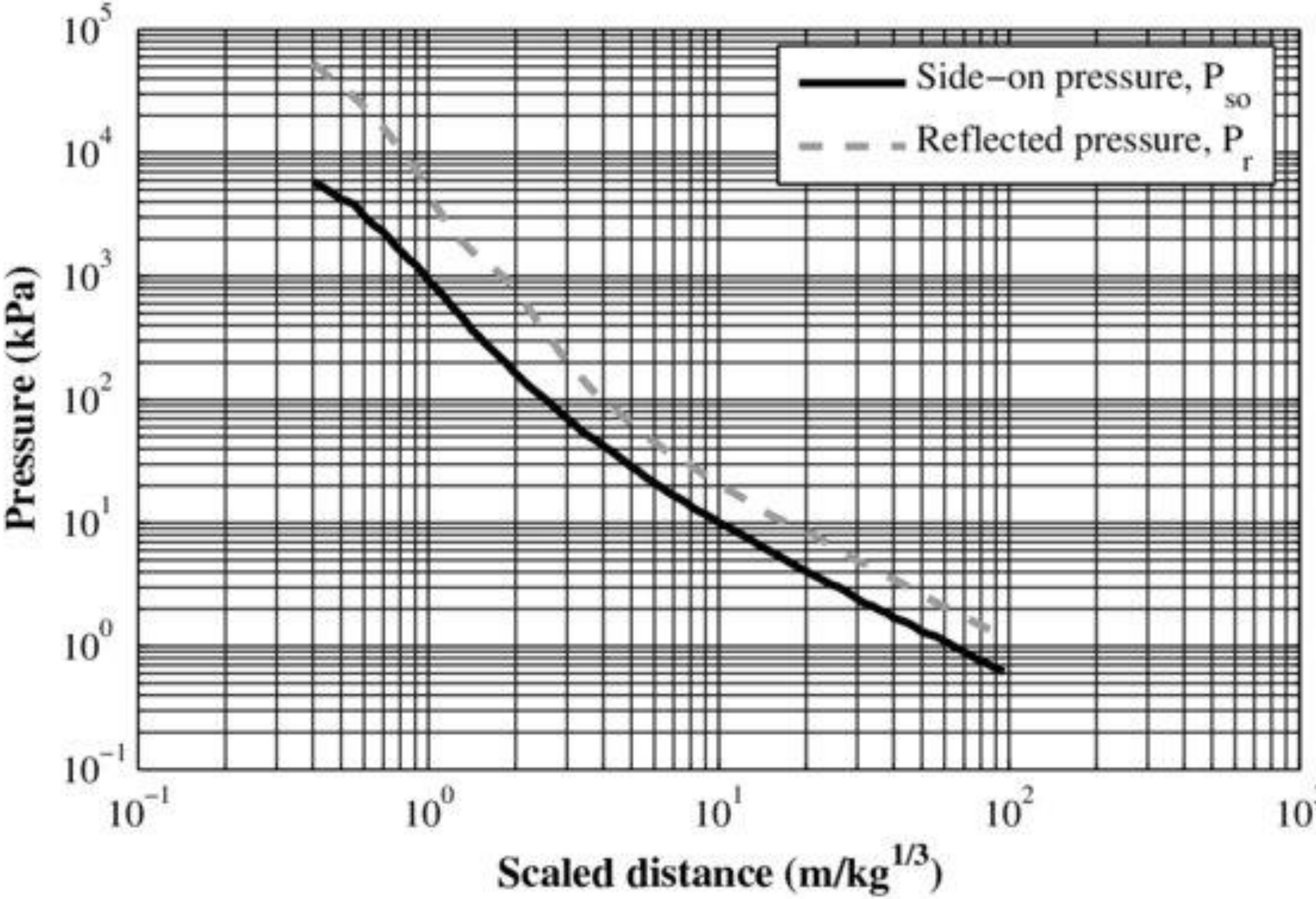


$$\frac{\text{Loose cubic volume (LCM)}}{\text{Bank cubic volume (BCM)}} = \text{Swell Factor}$$

•**Swell** – Because blasted rock occupies a greater volume than before it was blasted, the resulting increase in volume is referred to as "swell". Swell can be accounted for by vertical mounding or by displacement along a free face.

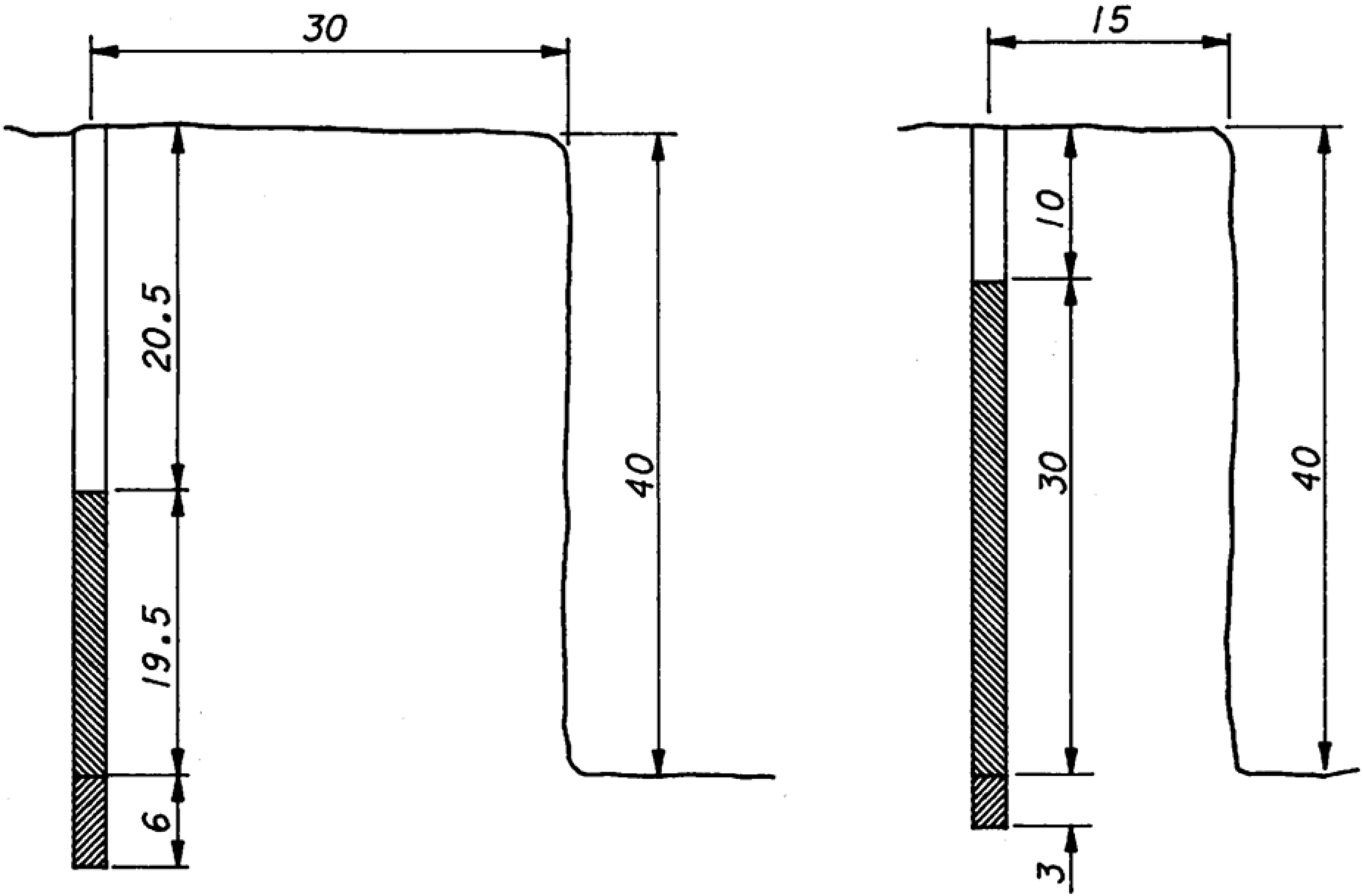
•**Blasting Mats –** Mats used to cover a blast in an urban situation where flyrock cannot be tolerated and the situation dictates that explosives are loaded fairly high up in the holes. Note that it is not practical to cover large blast areas, and prevention of flyrock is best addressed in blast design for those situations. Blasting mats are usually fabricated from sections of rubber tires, manila rope, used conveyor belting, or other similar materials. Many contractors opt to cover the blast with soil, sand, or other fine material. This can be successful, but it is necessary that a sufficient amount is used and that it contains no rocks or other projectiles. Covering the blast with any of these materials or devices must be accomplished carefully so that the initiation system is not damaged in the process.

•**Scaled Distance** (square root or cube root) – In order to compare the adverse effects of blasts of various sizes, a means of combining distance and charge weight to a common base is necessary. This combined number is Scaled Distance and is derived by dividing the distance to the blast by either the square root or the cube root of the maximum charge weight per delay. For conventional blasts using linear charges, it is common to use a square root. For spherical charges (the length of the charge is less than four times the diameter), it is common to use cube root scaling. It is also common to use cube root scaling for comparing air pressures or water pressures from blasting. Either scaling method can be correct for its application, but the two methods should not be mixed.



Side−on pressure, P_{so}
Reflected pressure, P_r
Pressure (kPa)
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
Scaled distance (m/kg$^{1/3}$)

•**Critical Diameter** – <u>That diameter below which an explosive may fail to propagate</u>. For example, AN/FO, depending upon formulation accuracy, density, and grain size may fail to maintain an explosive reaction if the charge diameter is somewhere near 7/8" or less. Manufacturers package products in cartridge sizes and containers that should be well above critical diameter. Pumped or poured products, however, could have problems if loaded in holes that are too small. For most explosives, decreasing the diameter also reduces the detonation velocity or the speed at which the explosive reaction proceeds through the explosive. Detonation velocity plays an important part in maintaining this reaction, so it must be maintained at a level high enough so that the reaction does not fail.



Comparison of a 300-mm diameter blast hole (stiff burden) on the left with a 150-mm diameter blast hole (flexible burden) on the right in a 12-m bench.

•**Critical Density** – Similarly, most explosives have a specific density above which detonation can possibly fail. Again, properly manufactured products would be safely below critical density for normal conditions. A problem could exist, however, if conditions cause an explosive product to be compressed to a point above its critical density. This could occur with an extremely deep hole where the weight of the explosive column compresses itself at the bottom of the hole. The density could also be increased by some outside agency. An example of this might be AN/FO in a small diameter hole (say less than 3"), with detonating cord extending down the length of the hole to a booster. Under normal conditions, the cord would not initiate the AN/FO but would cause a tunnel to be formed in the AN/FO. The AN/FO immediately surrounding the tunnel would probably be compressed above its critical density and would have little, if any, contribution to the shot. It should be noted that, in explosives that are affected by them, Critical Diameter and Critical Density are interactive and each can have an adverse impact on the other. In other words, as the density of such explosive approaches the critical point, its critical diameter may also be increased, resulting in a failure to detonate.

THANK YOU