WUHAN UNIVERSITY OF TECHNOLOGY

《Blasting Engineering》

Chapter 8 Blasting for Rock and Soil

The main contents:

1.1 Open-pit deep hole bench blasting

1.2 Open-pit shallow hole bench blasting

1.3 Deep hole blasting in underground mining, works

1.4 Shallow hole blasting of underground stops

1.5 Collision blasting

1.6 Springing shot and secondary blasting（ ellipsis ）

1.7 Mechanization of gun propellant （ ellipsis ）

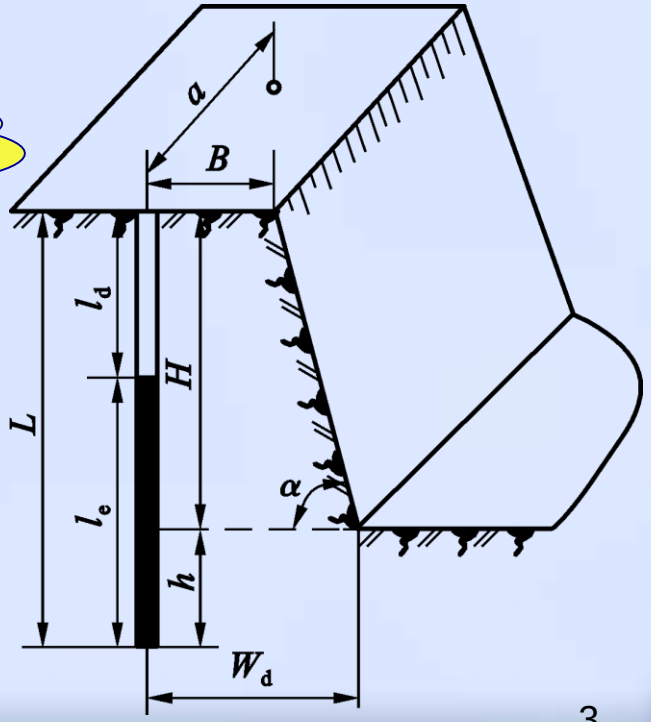
Section 1 Deep Hole Bench Blasting in The Open Air

Bench blasting

- **Bench blasting is the working face advance blasting method in step form 。**

Drilling hole depth is greater than 5 m called long hole ,otherwise it is called a shallow hole

The step elements



W_1 Toe burden

l_c Charging length

l_d Block length；

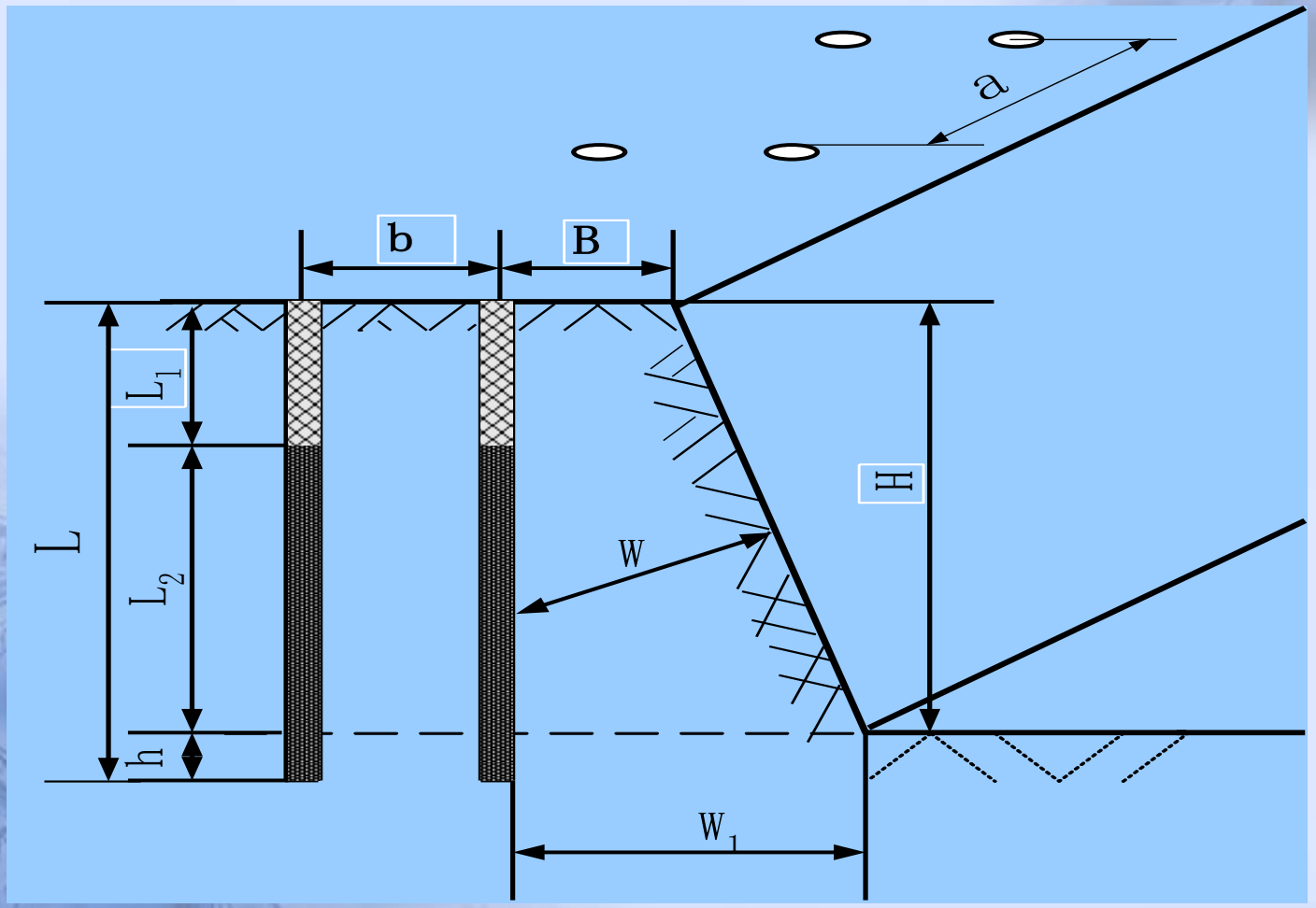
h Subdrilling

L **Drilling depth**

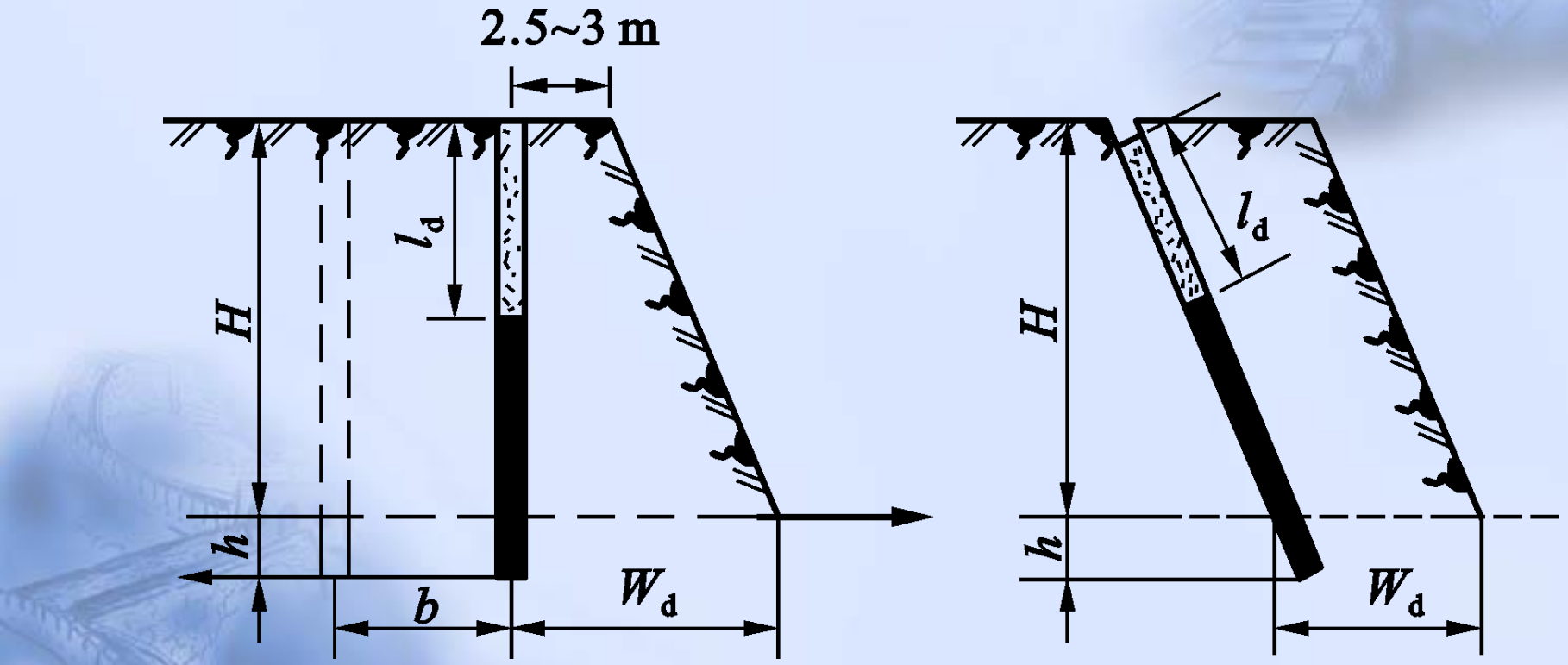
b Row spacing

B is a safe distance from the drilling center to the top line on the steps 。

Bench factors



Drilling



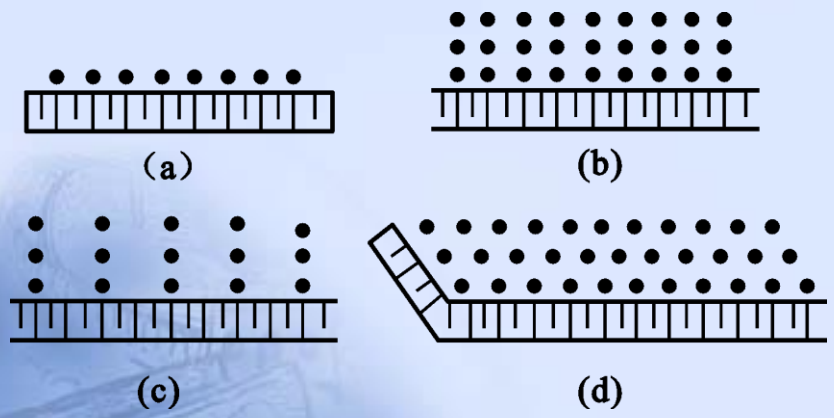
Arrangement of open-pit deep hole

H—Bench height； h—The subdrilling； W_d—Chassis resistance line； l_d—Block length； b—Row spacing

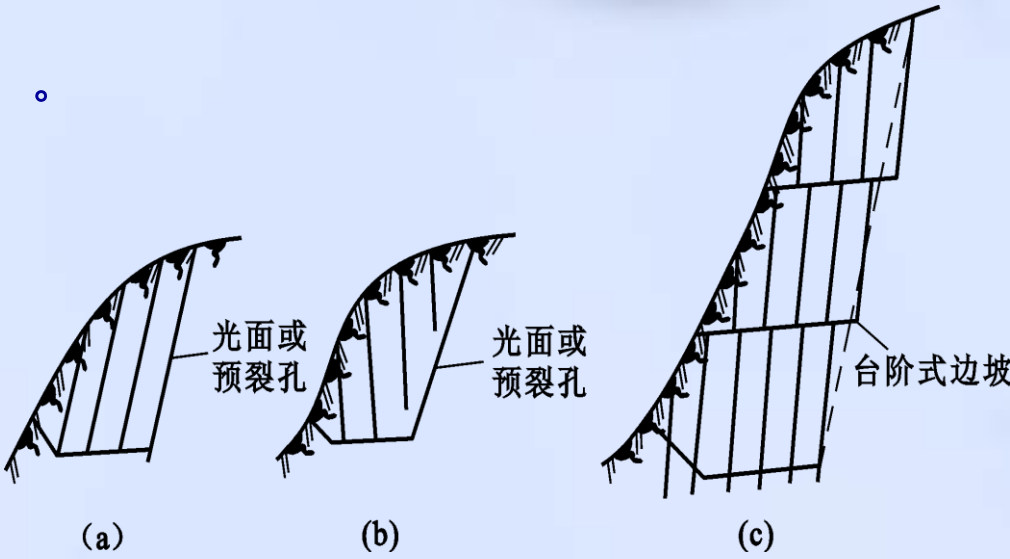
Hole Arrangement Form （1）

1 Deep hole bench plane hole arrangement

Hole way have single bore configuration and arrangement of the two More configuration holes is divided into square, rectangle and triangle (plum blossom)



***a*—Single hole ；**
***b*—Square holes；*c*—Rectangular holes ;**
***d*—Triangle holes**

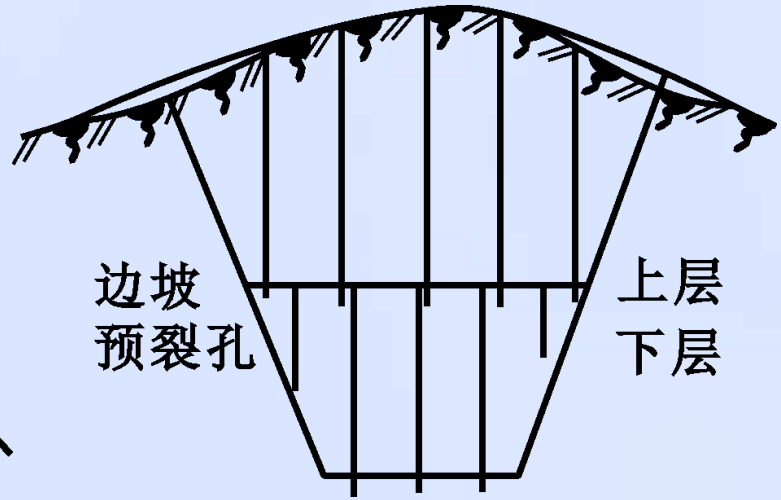


***a*—Inclined hole ； *b*—The vertical hole ； *c*—Tiering hole**

Hole Arrangement Form （2）

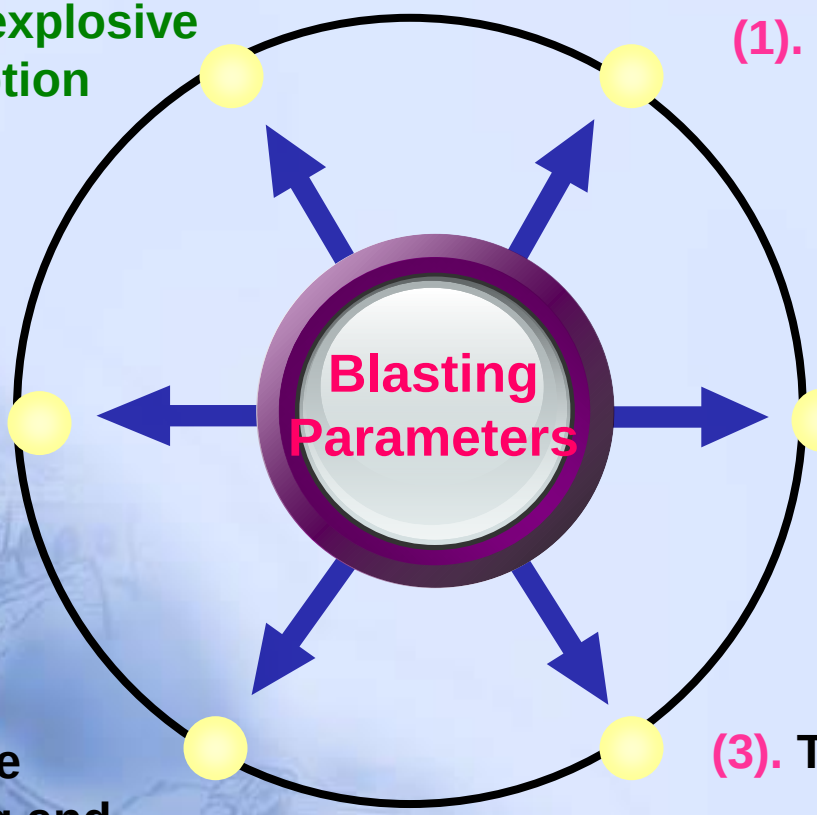
2、Hole distribution of all cutting excavation

double track expansive cutting



single line all cutting by layer

Blasting Parameters



(6). Unit explosive consumption

(1). Hole diameter

(5). Stemming length

(2). Hole depth and subdrilling

(4). Hole spacing and row spacing

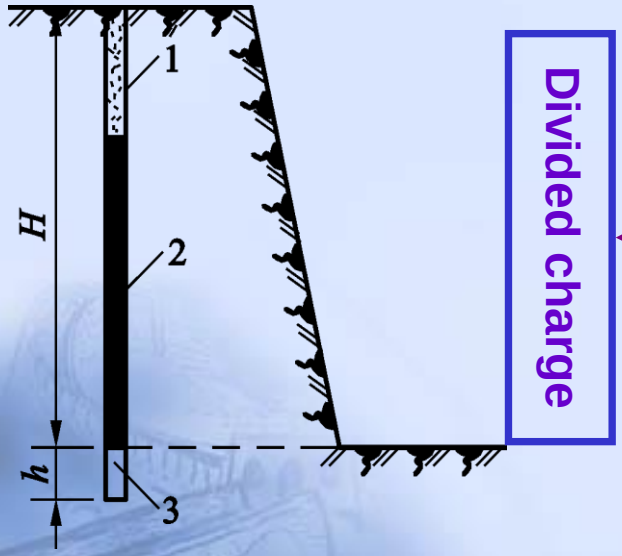
(3). Toe burden

1）According to the safety conditions of drilling operation

2）According to the calculation of bench height and hole diameter

3）According to the condition of charge per hole

Charging Structure



Divided charge

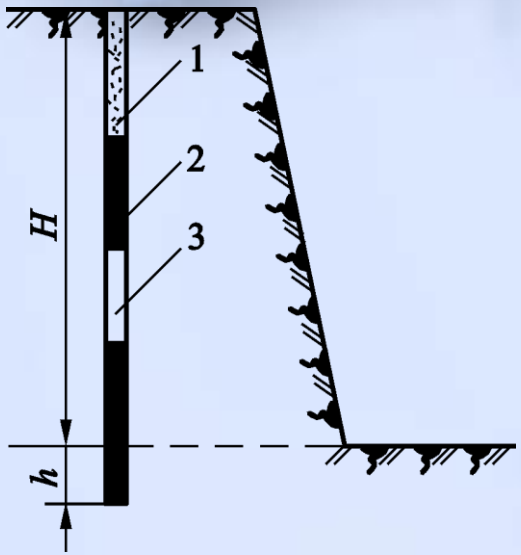
Column charge

Divided charge

Base spacing charge

Mixed charge

Base spacing charge



Charging structure

1 —Blocking
2— Explosive
3 — Air

1 —Blocking
2— Explosive
3 — Air

Detonating Sequence『1』

（1） Row order detonation

（2） Row parity-Order Detonation

（3） Wave-Order Detonation

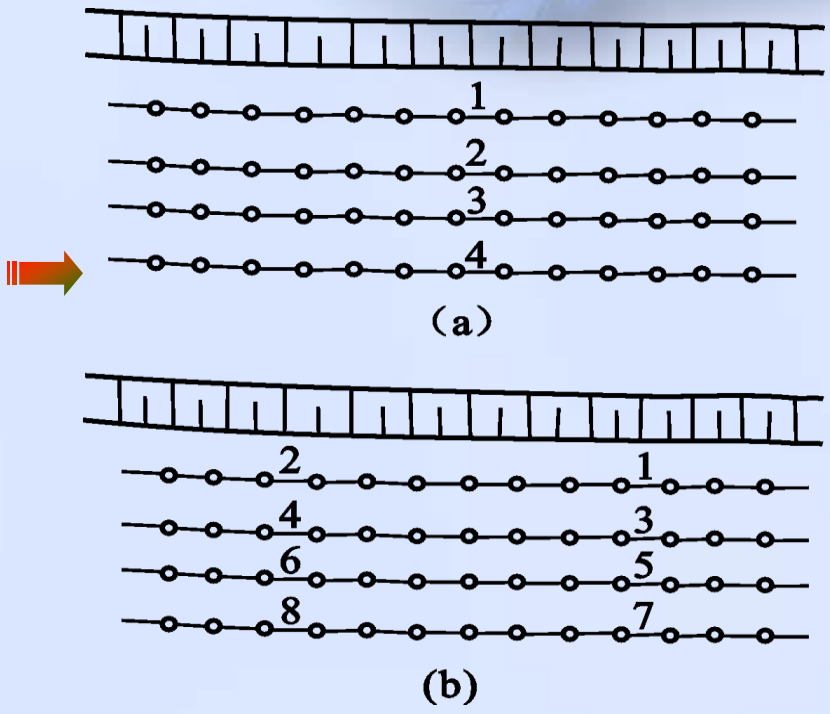
（4） V-shaped order detonation

（5） Trapezoidal Order Detonation

（6） Diagonal order detonation

（7） Radial Order Detonation

（8） Combined Order Detonation



Row order detonation

Detonating Sequence『2』

（1） Row order detonation

（2） Row parity-Order Detonation

（3） Wave-Order Detonation

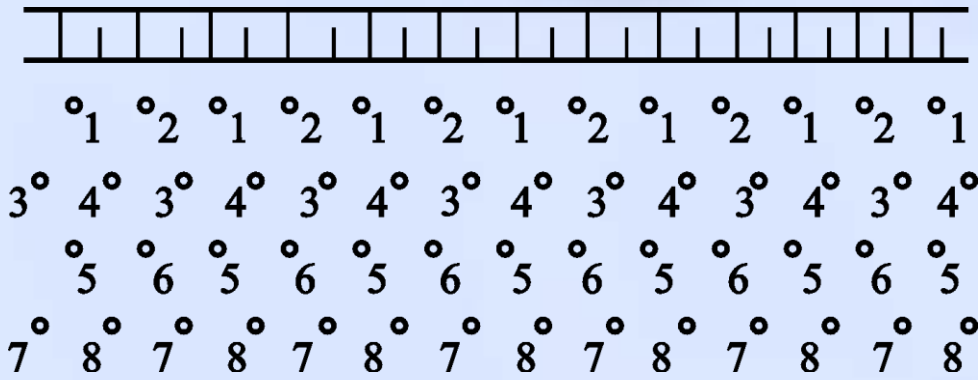
（4） V-shaped order detonation

（5） Trapezoidal Order Detonation

（6） Diagonal order detonation

（7） Radial Order Detonation

（8） Combined Order Detonation



Row parity-Order Detonation

Detonating Sequence 『3』

（1） Row order detonation

（2） Row parity-Order Detonation

（3） Wave-Order Detonation

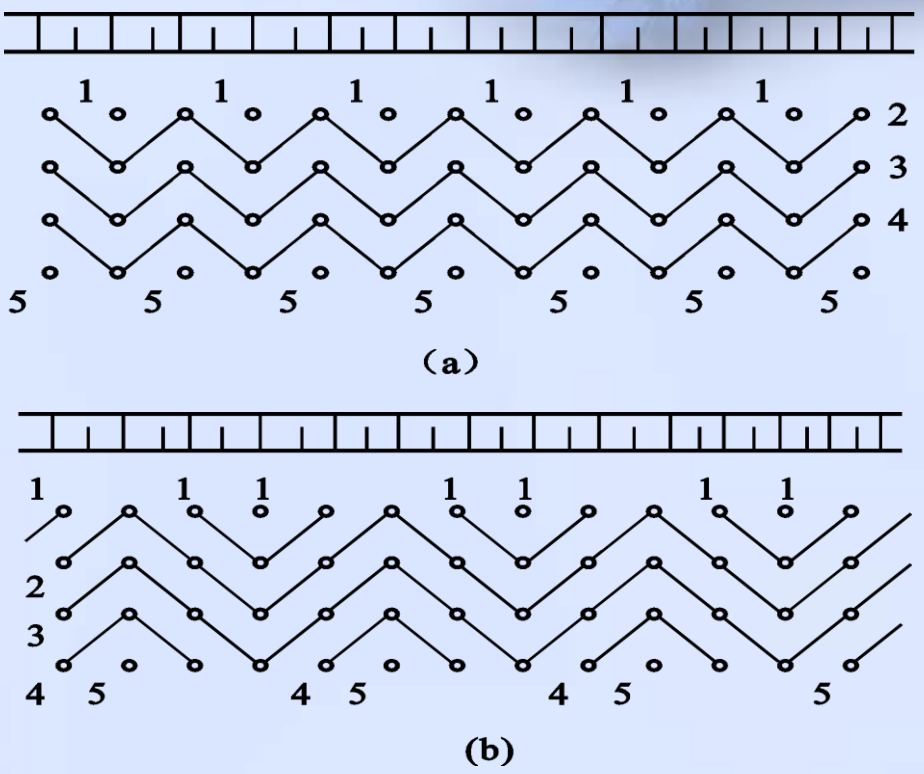
（4） V-shaped order detonation

（5） Trapezoidal Order Detonation

（6） Diagonal order detonation

（7） Radial Order Detonation

（8） Combined Order Detonation



Wave-Order Detonation

Detonating Sequence『4』

（1） Row order detonation

（2） Row parity-Order Detonation

（3） Wave-Order Detonation

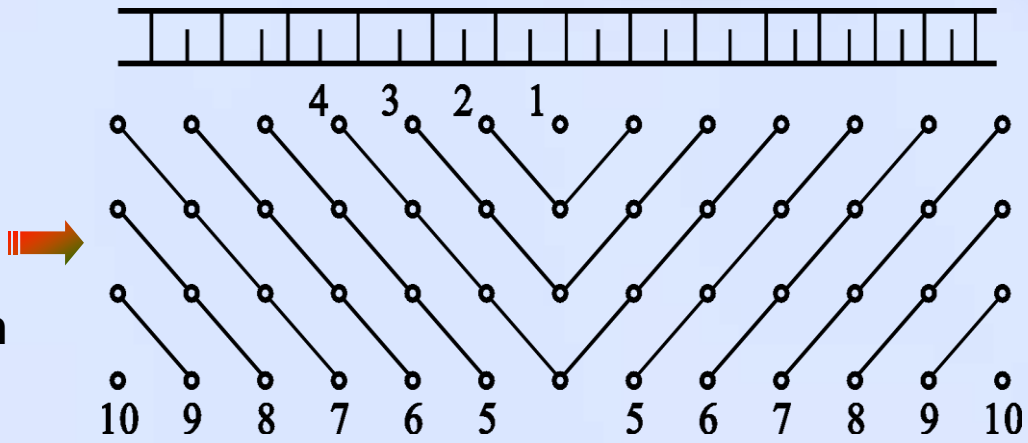
（4） V-shaped order detonation

（5） Trapezoidal Order Detonation

（6） Diagonal order detonation

（7） Radial Order Detonation

（8） Combined Order Detonation



V-shaped order detonation

Detonating Sequence『5』

（1） Row order detonation

（2） Row parity-Order Detonation

（3） Wave-Order Detonation

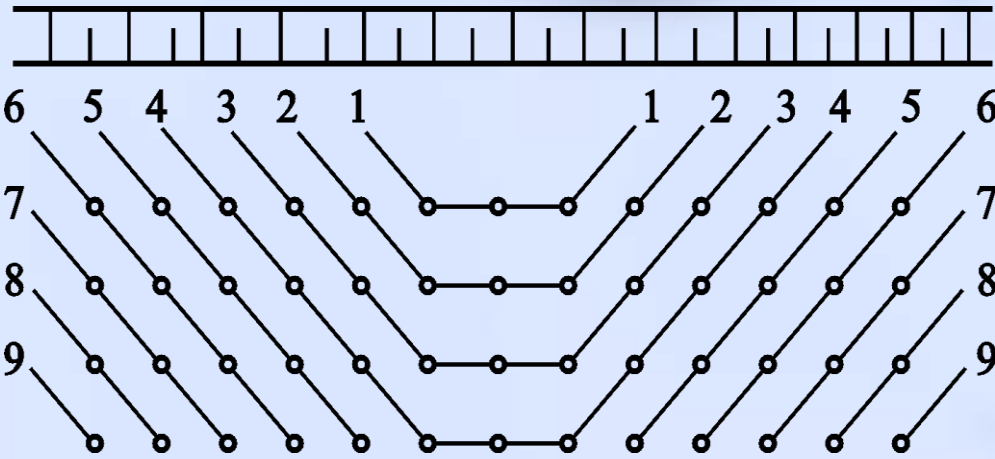
（4） V-shaped order detonation

（5） Trapezoidal Order Detonation

（6） Diagonal order detonation

（7） Radial Order Detonation

（8） Combined Order Detonation



Trapezoidal Order Detonation

Detonating Sequence『6』

（1） Row order detonation

（2） Row parity-Order Detonation

（3） Wave-Order Detonation

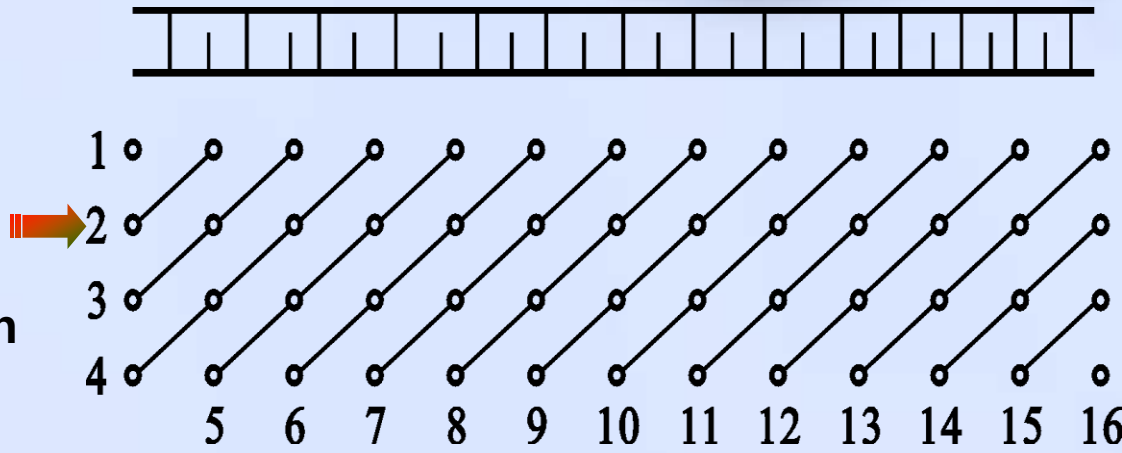
（4） V-shaped order detonation

（5） Trapezoidal Order Detonation

（6） Diagonal order detonation

（7） Radial Order Detonation

（8） Combined Order Detonation



Diagonal order detonation

Detonating Sequence 『7』

（1） Row order detonation

（2） Row parity-Order Detonation

（3） Wave-Order Detonation

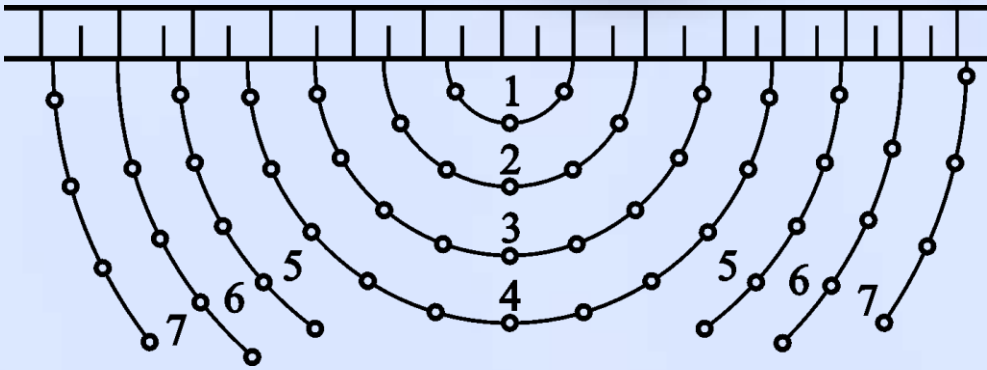
（4） V-shaped order detonation

（5） Trapezoidal Order Detonation

（6） Diagonal order detonation

（7） Radial Order Detonation

（8） Combined Order Detonation



Radial Order Detonation

Detonating Sequence『8』

（1） Row order detonation

（2） Row parity-Order Detonation

（3） Wave-Order Detonation

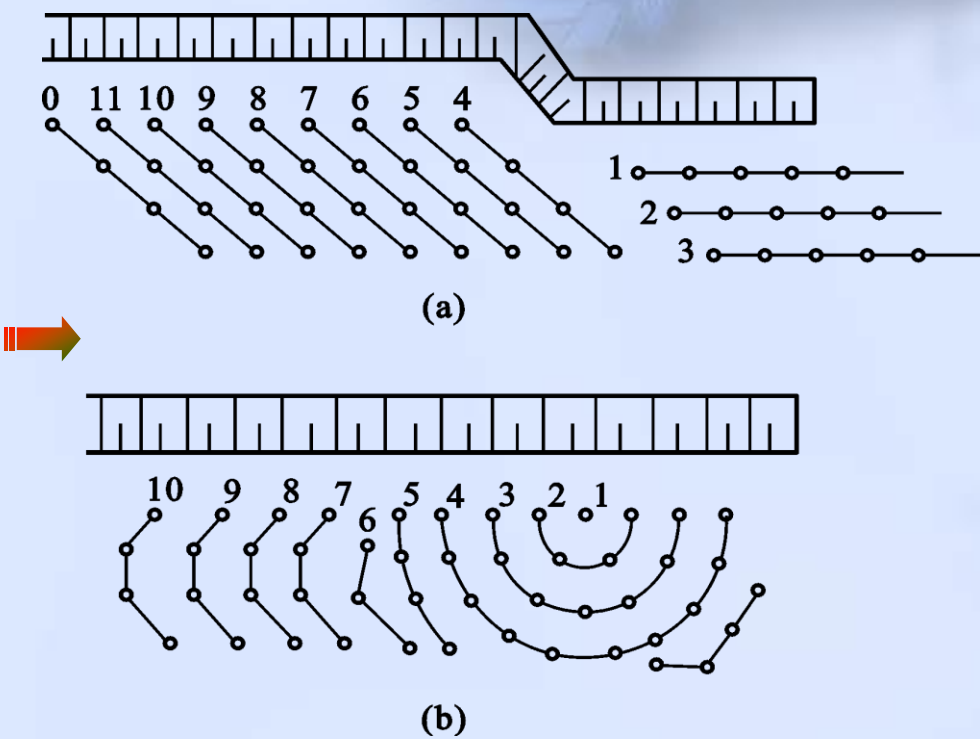
（4） V-shaped order detonation

（5） Trapezoidal Order Detonation

（6） Diagonal order detonation

（7） Radial Order Detonation

（8） Combined Order Detonation



Combined order detonation

Measures to Reduce Chunk and Bedrock Rate

Chunk of the standard depends mainly on the type and size of the shovel mounted equipment and initial crushing equipment, its standard formulation from place to place, time to time

（1）Effects and causes analysis

（2）Measures to reduce chunk and bedrock rate

1. **Correct design**
2. **Strict construction**
3. **Scientific management**

The Multi Blast Hole Area Milliseconds Blasting Technology

Millisec ond blasting

Millisecond blasting: between adjacent blast holes or the rows of holes, with deep-hole millisecond time interval 。

Benefits

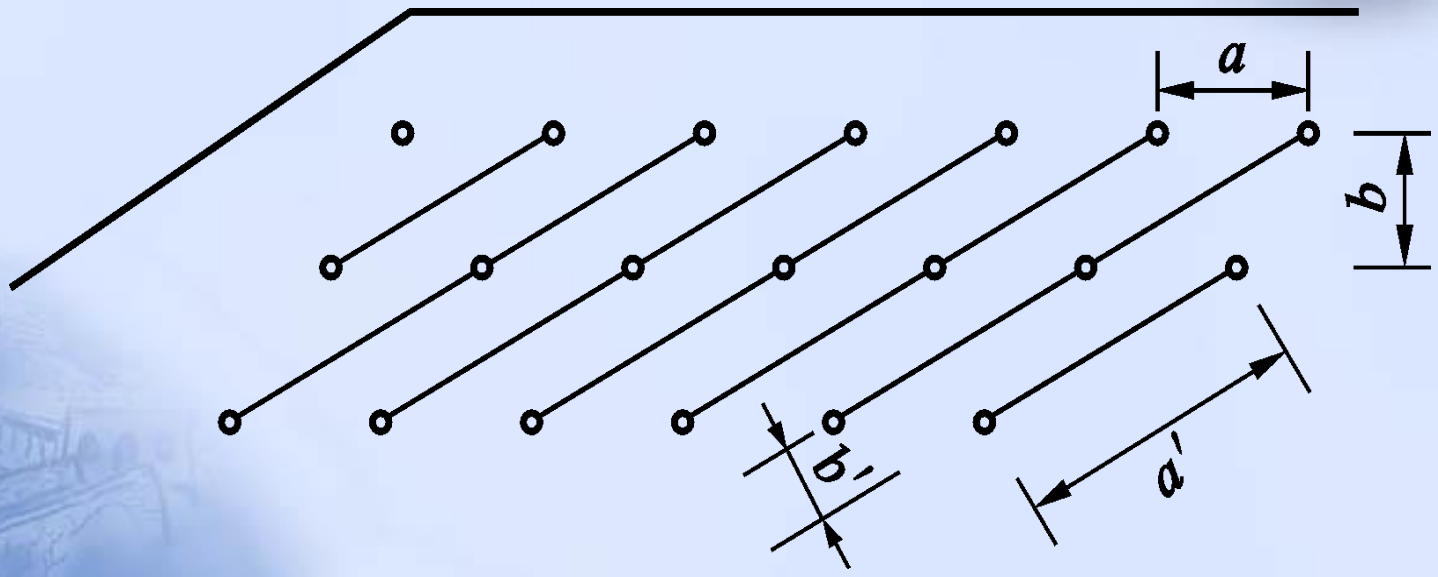
A Enhance secondary crushing effect 。

B Weaken blast hole stress superposition 。

C Prevent explosive gas prematurely discouraged, boost explosive energy utilization 。

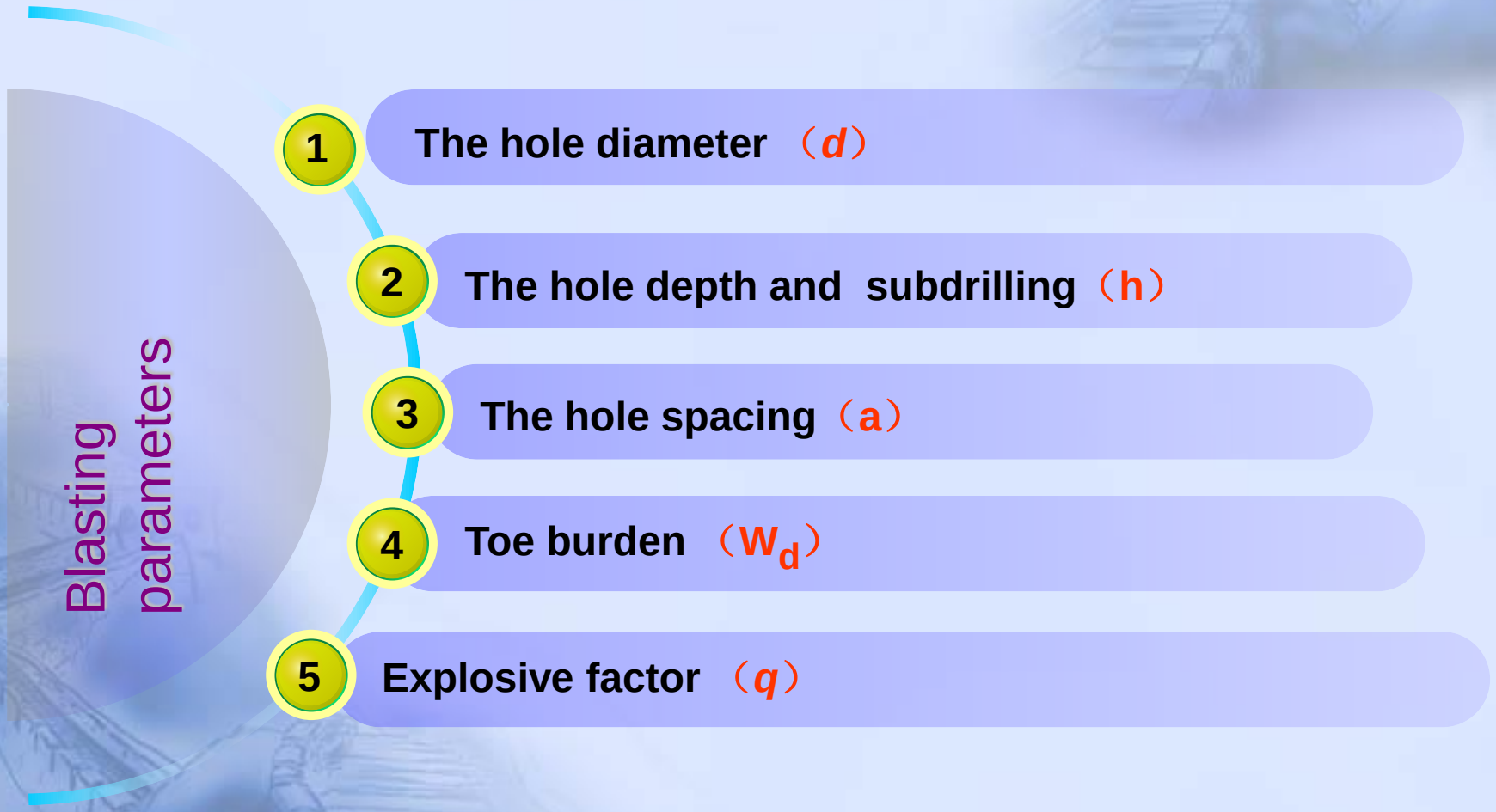
D Increase blasting crater angle, form a curved free surface, to create favorable conditions for the tensile failure of rocks.

Section 2 The Open-pit Short hole Bench Blasting

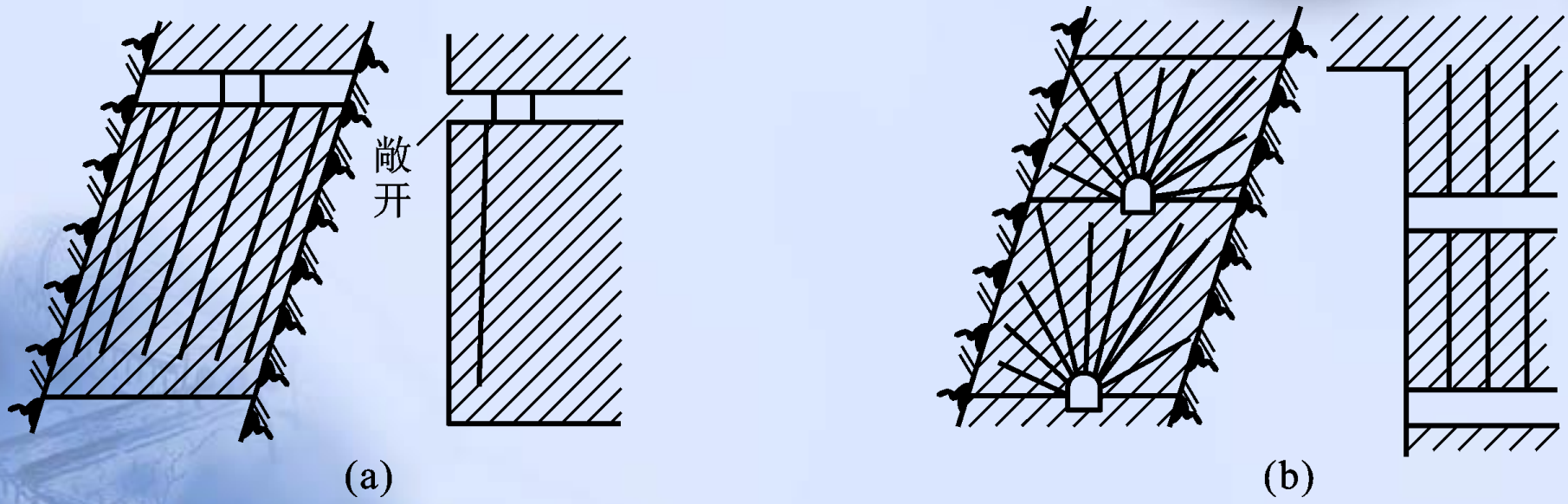


***a*—Blasthole Pitch；*b*—Row spacing；*a'*—*Detonating* Pitch；*b'*—Detonating row spacing**

Blasting Parameters



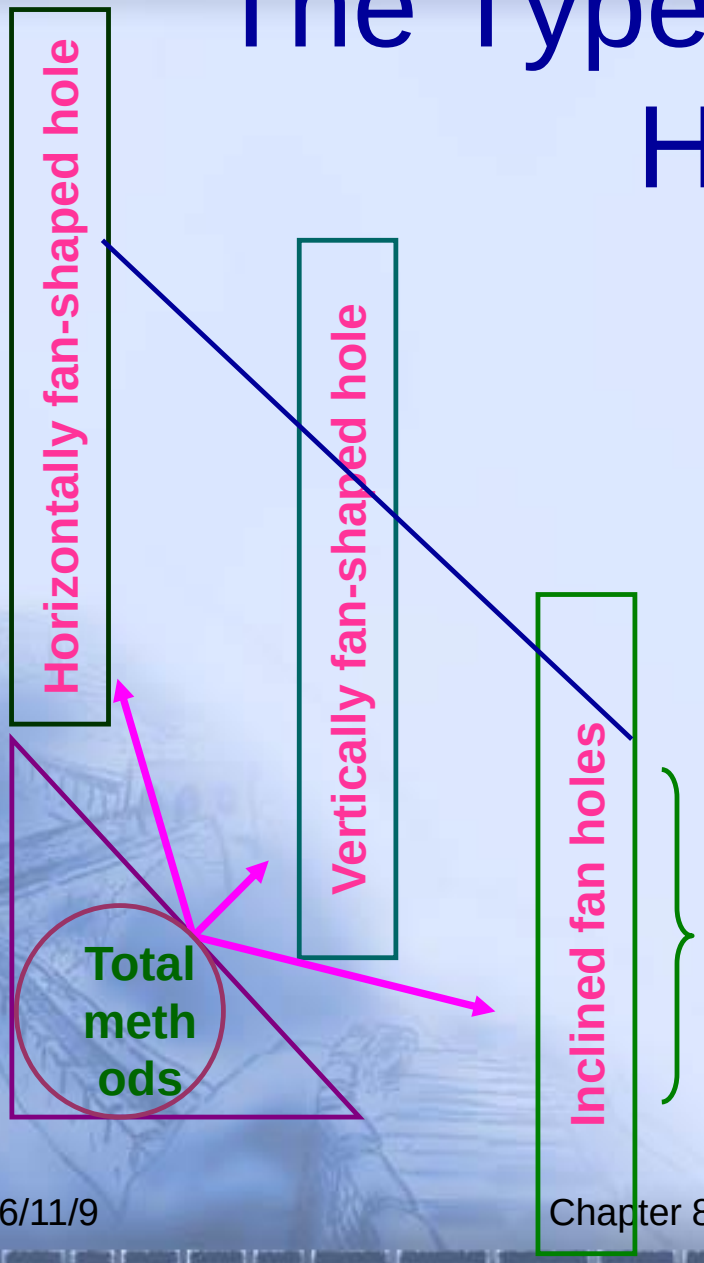
Section 3 Underground Stops Blasting

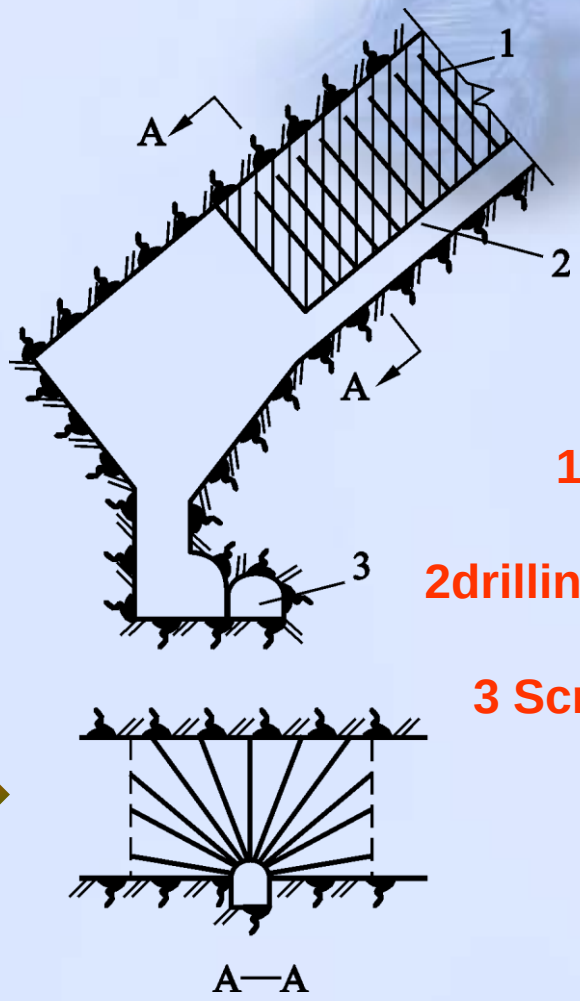


Layout

a—parallel layout；*b*—fan-shaped layout

The Types of Fan-shaped Hole





1depth

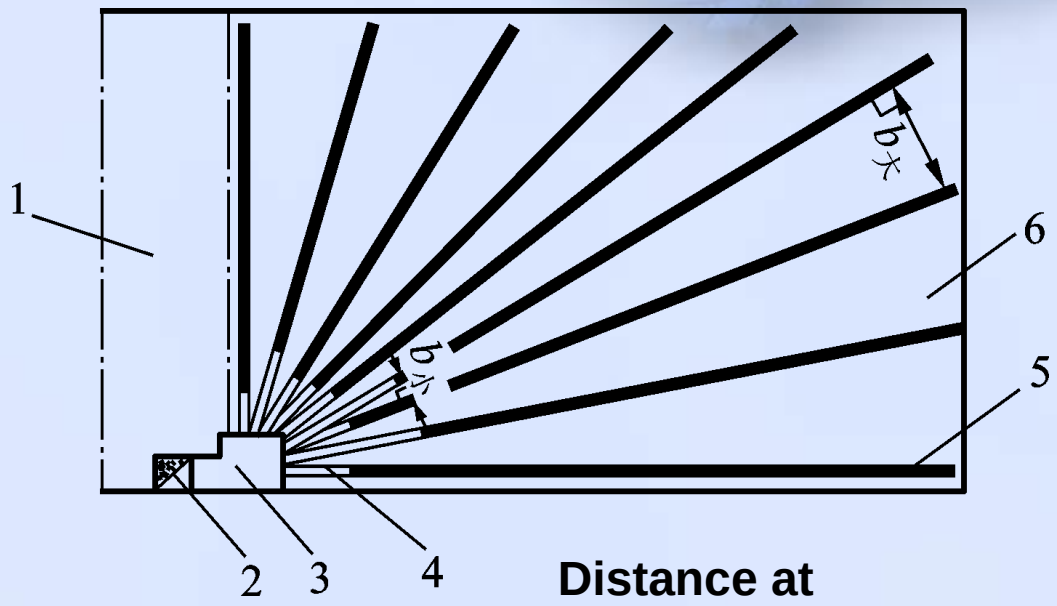
2drilling courtyard

3 Scraper way

Blasting Parameters

（1） deep hole diameter （2）depth （3）minimum burden、pitch of hole and Intensive coefficient

Intensive coefficient



Intensive coefficient is the ratio of the hole spacing and the minimum resistance line.

$$m = \frac{a}{W}$$

Distance at bottom and top

The bottom of the hole density coefficient: The ratio of hole bottom distance and the minimum resistance line

hole density coefficient: The ratio of vertical distance and minimum resistance line.

1—rib pillar；2—courtyard；3—drilling chamber；

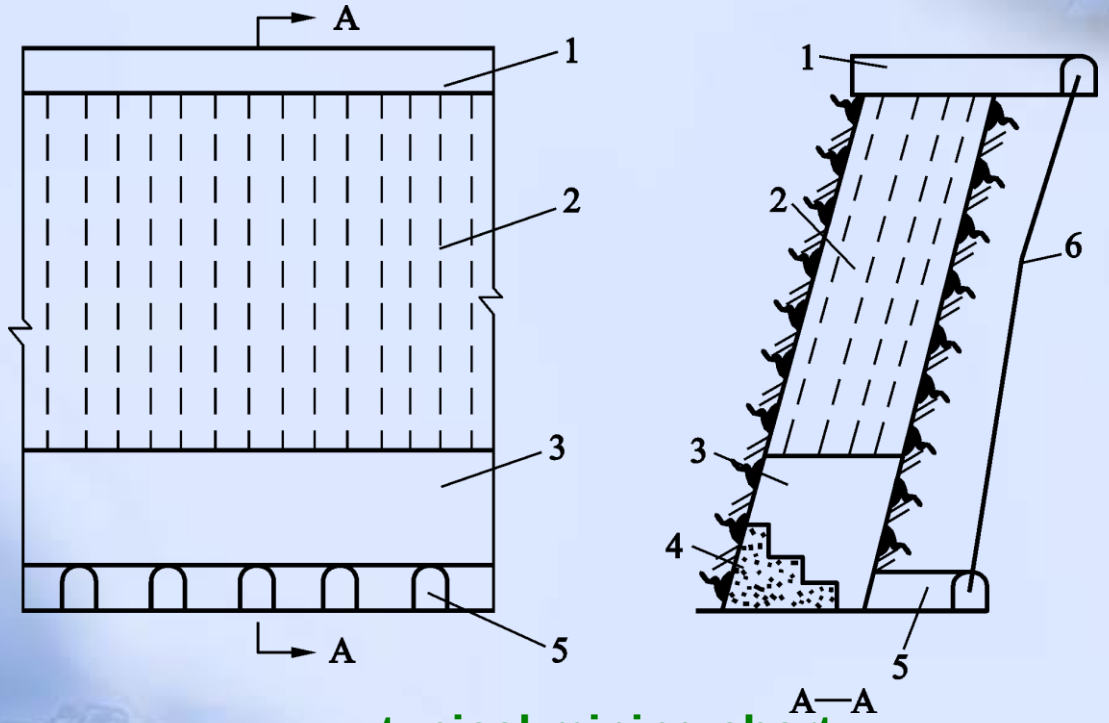
4—Uncharged part；5—charged part；6—chamber

VCR Method

VCR

（Vertical Crater Retreat method）

VCR stands for Vertical Crater Retreat method。



typical mining chart

1—drilling tunnel；2—hole depth for large diameter；3—bottom space；4—stage；5—loading drift；6— haulage way

Section 5 Collision Blasting

collision blasting： for the sake of boosting explosive energy utilization , Improving crush，people create this type of blasting without compensational space。

A

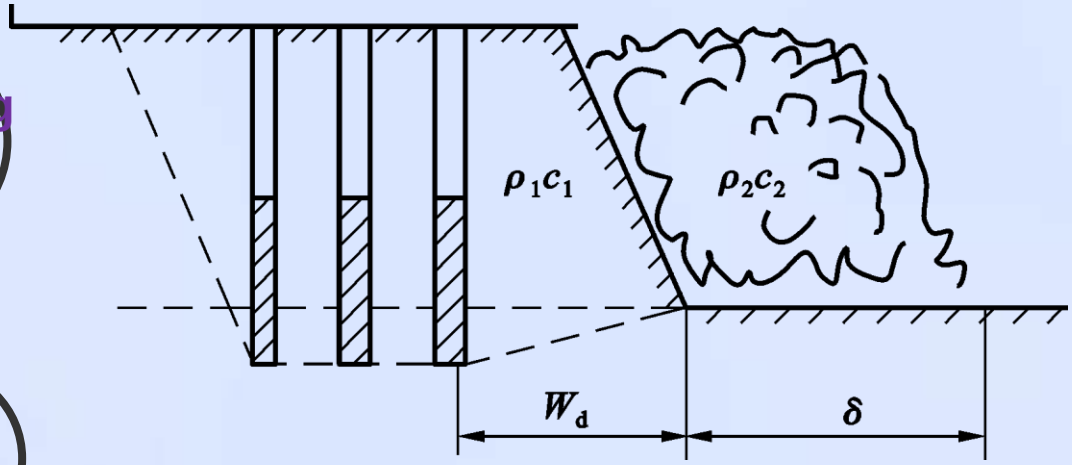
Theory

Because of loose medium (ore) blocking effect, collision blasting compensation space can only be formed by the kinetic energy ,which has the ore impacted, thus prolong the time pressure explosion gas works for, help the development of crack and improve the effective utilization rate of explosion energy

。

B

Underground long hole collision blasting



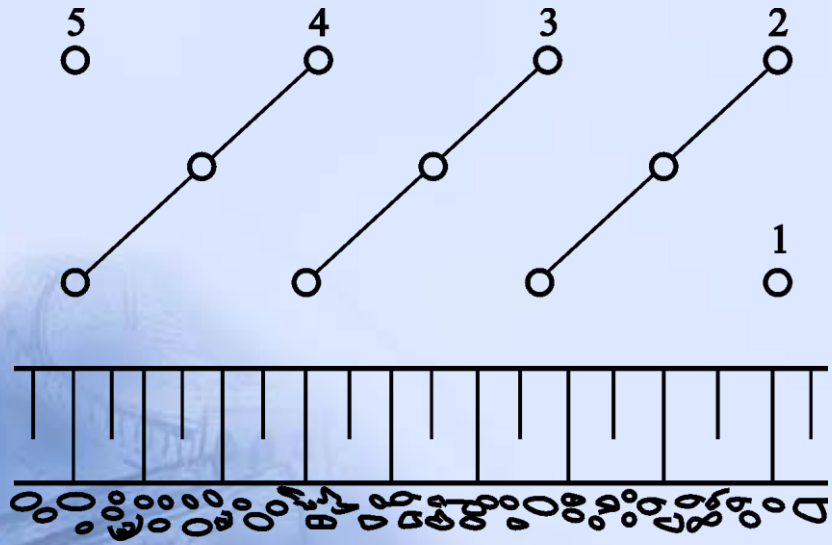
C

collision basting for open-pit mine

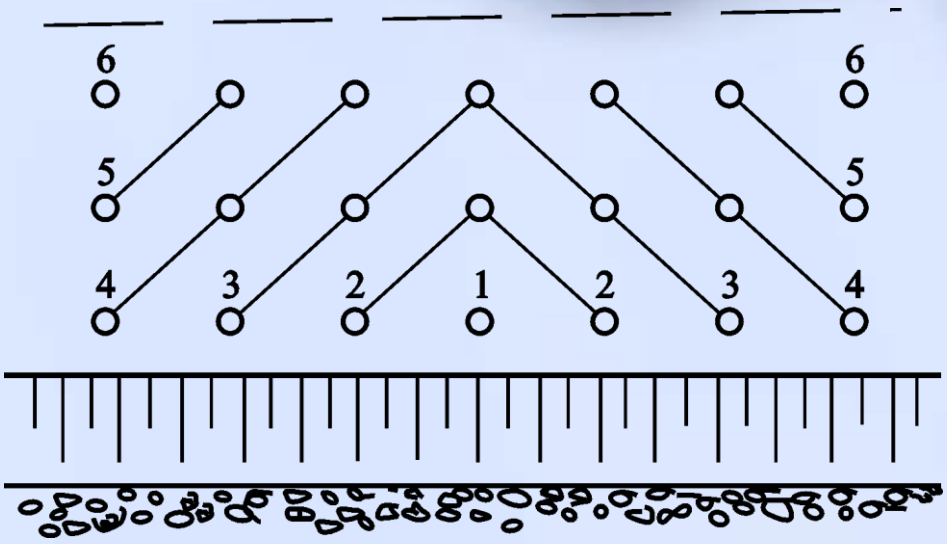
open-pit stage compression blasting

ρc —wave impedence ; δ —thickness of pressed slag; W_d —chassis burden

Two Types of Holes Layout for Open-pit Mine Collision Blasting



Three angular layout， bias blasting



Rectangular layout，V shape blasting


Thank You !