212D6212
TEKNIK PELEDAKAN

Nirmana Fiqra Qaidahiyani
PS Teknik Pertambangan
FT Universitas Hasanuddin

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Subjects

1. Use Forms of Explosives
2. Estimating Properties of Explosives
3. Explosive Selection Criteria
4. Initiation and Priming Systems
5. Qualitative Description of a Shock Wave
6. Fracture Mechanism in Blasting of Rock

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Subjects

7. Rock and Rock Mass Properties and Their Influence on The Results of Blasting
8. Characterization of The Rock Masses for Blast Designing
9. Real Effects in Explosives
10. Theories of Scaling

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Subjects

11. Blasthole Loading
12. Preliminary Blast Design Guidelines
13. Controllable Parameters of Blasting
14. Bench Blasting
15. Drilling Patterns and Hole Sequencing
16. Initiation Sequence and Delay Timing

Subjects

17. Explosives as a Source of Fragmentation Energy
18. Evaluation of Blast Results
19. Blasting in Underground
20. Overbreak Control
21. Perimeter/Contour and Controlled Blasting
22. Environmental Effects of Blasting
23. Blasting Safety

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

References

Cooper, P.W. *Explosives Engineering*. 1996. Canada: Wiley-VCH.

Calvin, J., Konya, and Walter, E.J. *Rock Blasting and Overbreak Control*. 1991. United States: Federal Highway Administration.

Hustrulid, W. *Blasting Principles For Open Pit Mining*. 1999. Netherlands: A.A.Balkema/ Rotterdam.

Jimeno, C.L. et al. *Drilling and Blasting of Rocks*. 1995. Netherlands: A.A.Balkema/ Rotterdam.

References

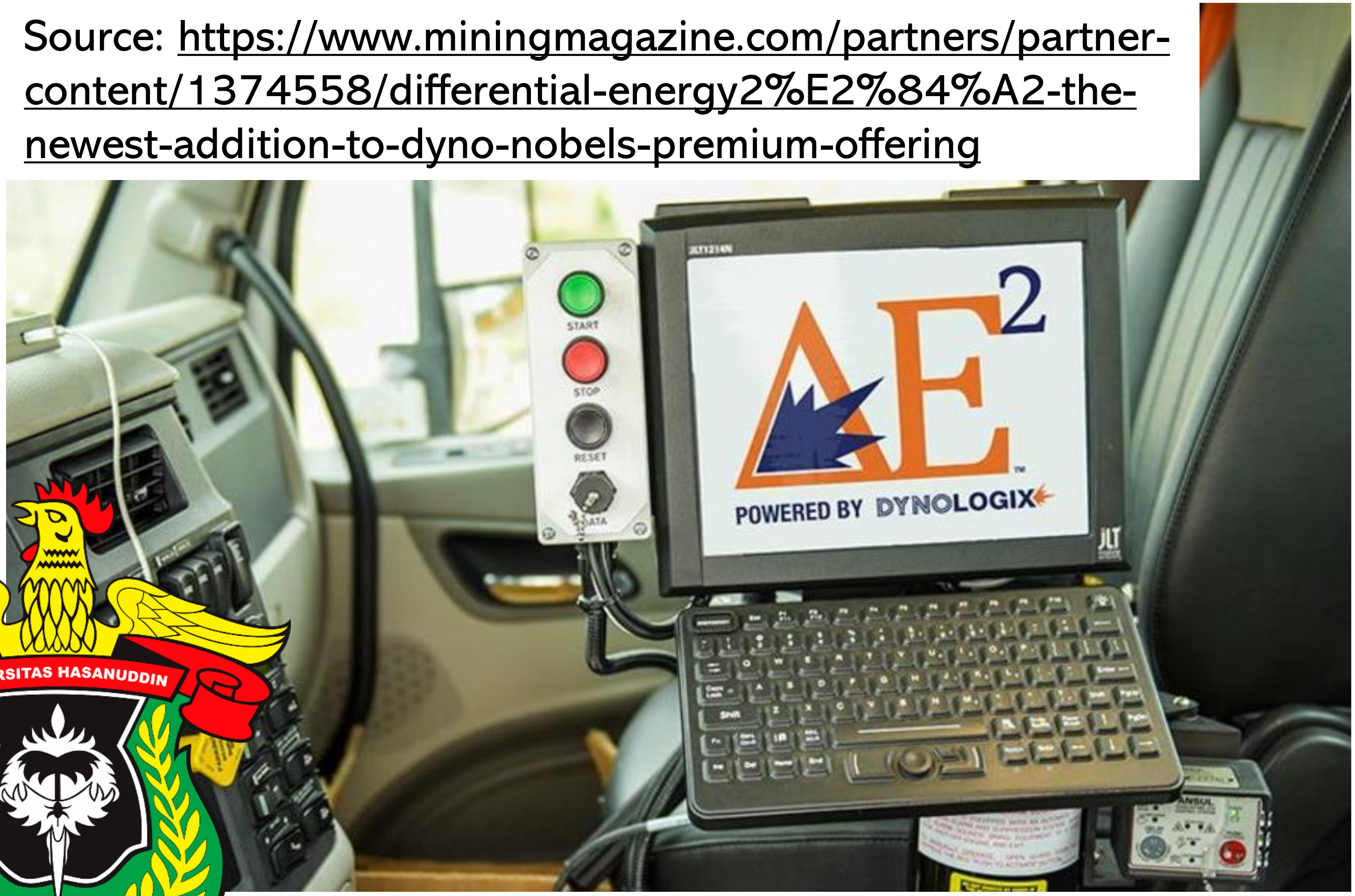
Rustan, A. *Rock Blasting Terms and Symbols*. 1998. Netherlands: A.A.Balkema/ Rotterdam.

Richard, A. et al. *Explosives and Blasting Procedures Manual*. United States: Bureau of Mines.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Initiation and Priming Systems

Source: https://www.miningmagazine.com/partners/partner-content/1374558/differential-energy2%E2%84%A2-the-newest-addition-to-dyno-nobels-premium-offering



Initiation and Priming Systems

1. Initiation of Explosives
2. Initiation Systems
3. Circuit Testing
4. Primers and Boosters

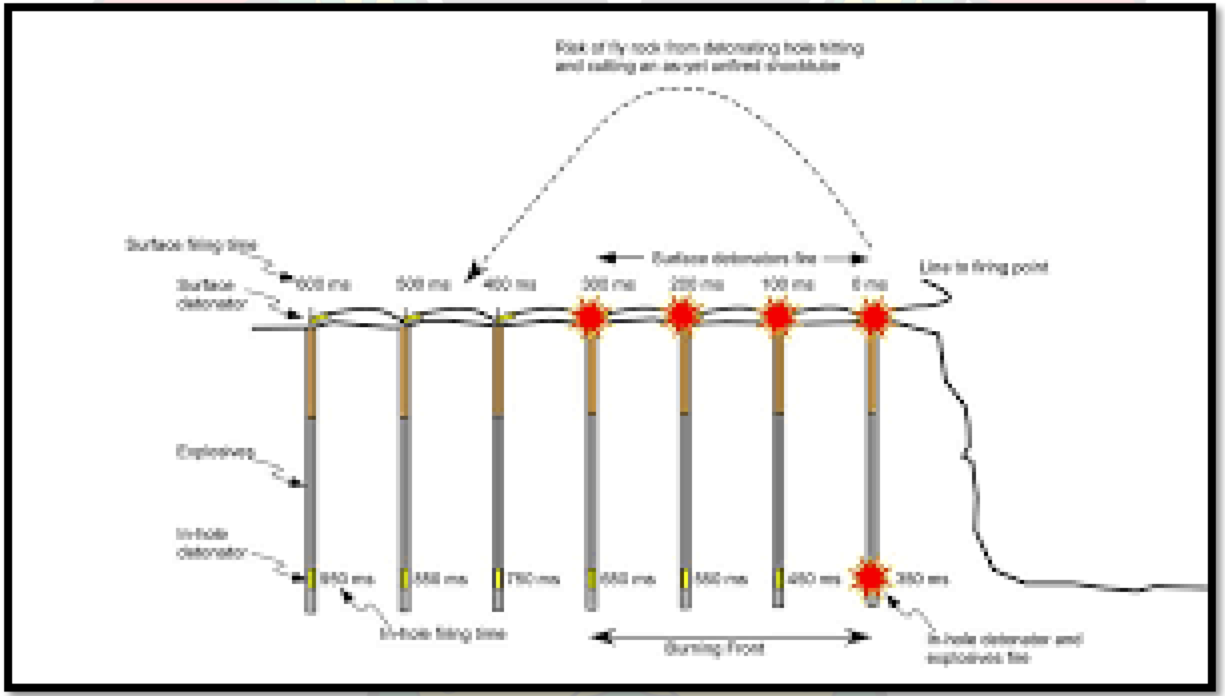
nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

1. Initiation of Explosives

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Introduction

- **The initiation system** <u>transfers the detonation signal</u> from hole-to-hole at a precise time.



Introduction

Initiation system

- ✓ critical for the success of a blast;
- ✓ controls the sequencing of blastholes;
- ✓ effects the amount of vibration generated from a blast, the amount fragmentation produced, and the backbreak and violence which will occur.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Initiation of Explosives

- Explosion and Oxygen Balance
- Connection Between Detonators and Detonating Cord
- Charging Operation
- Sympathetic Detonation
- Desensitization
- Deflagration

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Explosion and Oxygen Balance

- When explosives react, they produce **energy** by oxidation.
- An **oxidation reaction** is the chemical reaction that occurs when a fuel is burning or an explosive is detonating.
- When an explosive is exactly **oxygen balanced**, it produces the maximum energy output per unit weight of that explosive.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Explosion and Oxygen Balance

- Explosion energy: 4 MJ/kg
- Temperature: 1600-3800°C
- Pressure: 1-28 GPa

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Connection Between Detonators and Detonating Cord

- **ANFO** explosives are *detonator-insensitive*, they must be initiated by a primer which consists of a detonator and a booster.
- **Emulsions** may be *detonator-sensitive*. In production blasts, in order to assure a safe initiation, they are usually initiated by primers.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Connection Between Detonators and Detonating Cord

- **Electric detonators**

  There is an electric circuit that can detect any problem in the detonator conection.

Connection Between Detonators and Detonating Cord

- **Nonelectric detonators**

  They are usually tied to a detonating cord which is then connected to an electric detonator that is used to fire the blast by a blasting machine which may be operated far (i.e. kilometers) from the blast sources.

Charging Operation

- Nowadays mechanical charging operation becomes more and more common in loading explosives into blastholes in industry.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Charging Operation

Peru-based Exsa is a major manufacturer and distributor of industrial explosives.

Charging Operation

A truck loading emulsion explosive into blastholes in Kiruna underground mine

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Charging Operation

Mechanical charging operation

- the emulsion directly loaded into the hole through a pipe;
- the feeding and retreat speeds of the pipe can be programmed and well controlled;
- The position where the charging operation starts or ends can be ordered on the opening screen before the charging operation begins.

However, it is necessary to always check whether the feeding speed and pressure are normal regarding the problems in the mechanical feeding system.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Charging Operation

For example, it might happen that a borehole is not fully charged. In other words, some air gaps are left in the explosive charge. When this happens, the explosive in the borehole will not be completely fired due to the gaps if they large enough to stop detonation.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Sometimes blasting is not successful even though the explosive charge is initiated because of

- Sympathetic Detonation
- Desensitization

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Sympathetic Detonation

- When the detonation of one explosive charge induces the initiation of another explosive charge nearby, the detonation in the latter is called **sympathetic detonation**.
- It may happen when the deck is too thin and when structural discontinuities exist surrounding the hole.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Sympathetic Detonation

Sympathetic detonation can cause the blasting results will be impaired;

- fragmentation will be worse
- ground vibrations will be high

*In the majority of industrial explosives, the distances at which sympathetic detonation is induced are **between 2 and 8 times their diameter**, depending on the type of explosive.*

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Desensitization

The **sensitivity** of industrial explosives might **diminish** due to some reasons:

- when the density increases beyond a certain value;
- when a dynamic pressure is applied to the explosive:
  - blasthole with a larger diameter;
  - when an adjacent charge is detonated;
  - when the VOD of an explosive is smaller than the sonic velocity of the rock.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Desensitization

- If a column of cartridge explosives is placed **in a blasthole with a larger diameter**, the detonation of the charge is accompanied by a flow of gases that expands through the empty annular space, compressing the air. At high pressure, the air exerts a lateral force upon the explosive ahead of the detonation front, provoking an increase in density and, in consequence, a desensitization of the explosive, which can cause a drop in the detonation velocity.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Desensitization

- When **an adjacent charge is detonated**, a dynamic pressure is exerted on the explosive, in this case causing the desensitization.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Desensitization

- When **the VOD of an explosive is smaller than the sonic velocity of the rock**, the explosive in front of the reaction zone is compressed by the stress wave from the rock before the detonation occurs. As a result, the explosive which is compressed may not detonate.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Deflagration

- **Deflagration** describes a subsonic combustion propagation driven by heat transfer.
- Deflagration is <u>not expected in normal rock blasting</u>.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

2. Initiation Systems

Initiation Systems

- Initial energy source
- Energy distribution network into the individual blastholes
- In-the-hole component to initiate a cap-sensitive explosive

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Technology of Initiation Devices

- ✓ Energetic initiation of the more modern explosives, which are <u>much more insensitive</u> than the classical dynamites but also **safer**.
- ✓ **The sequence** in which the holes (or portions of the hole) should fire.
- ✓ Control over initiation times to **improve fragmentation**.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Technology of Initiation Devices

- ✓ **Reduction of the vibration levels, air blast, and flyrock** produced in blasts.
- ✓ **Punctual** priming (proper time).
- ✓ More flexibility in breakage operations while **maintaining a high degree of safety** for personnel and installations.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

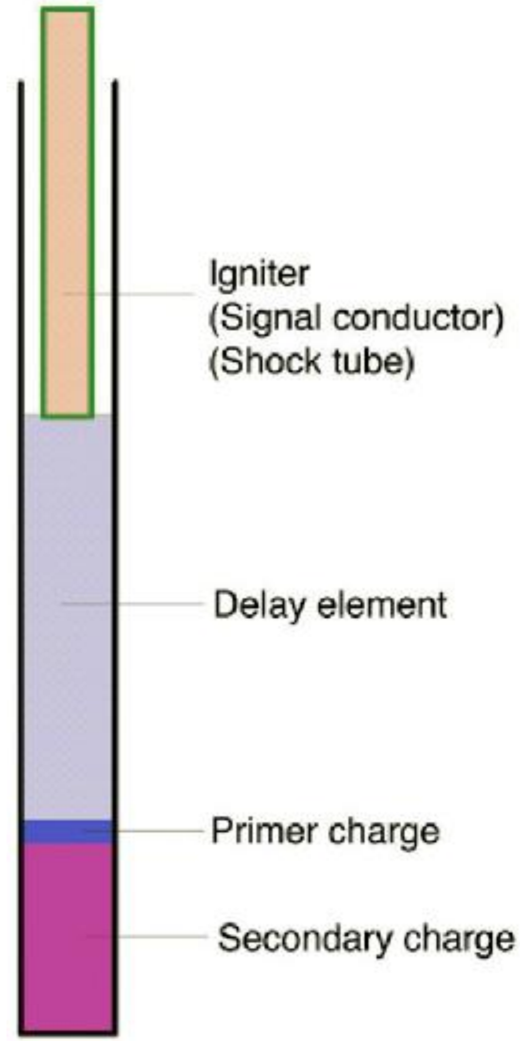
In modern blasting, the initiation of an explosive charge is mainly made by a detonator or a primer. Various types of detonators used in present rock blasting can be divided into three types:

1. nonelectric detonators;
2. electric detonators;
3. electronic detonators.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

1. Nonelectric Detonators

- A nonelectric detonator is initiated by a signal conductor or a detonating cord of low energy type.
- The detonator can be manufactured both with and without delay.



1. Nonelectric Detonators

Advantages

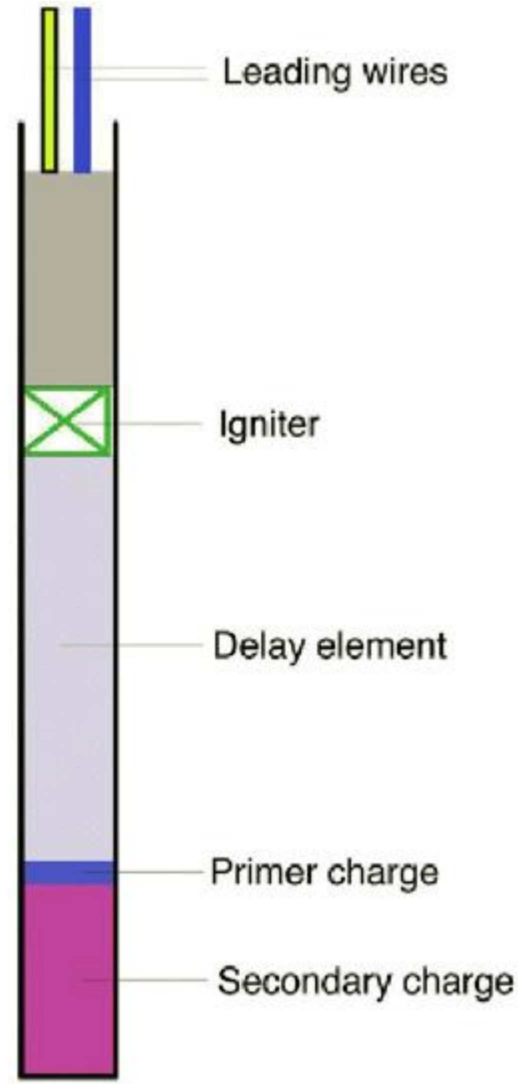
+ Noiselessness
+ Still initiation
+ Down-hole delays
+ Being safe

Disadvantages

- No circuit testing
- Inaccurate initiation time

2. Electric Detonators

- An electric detonator initiates an explosive charge by a current passing through a bridge wire.
- A delay electric detonator includes a delay element (powder). The delay time is based on the length and composition of the delay powder.



nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

2. Electric Detonators

Advantages

+ Circuit testing
+ Availability in coal mines

Disadvantages

- Risk of premature detonation
- Extraneous sources of electricity
- Inaccurate initiation time

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

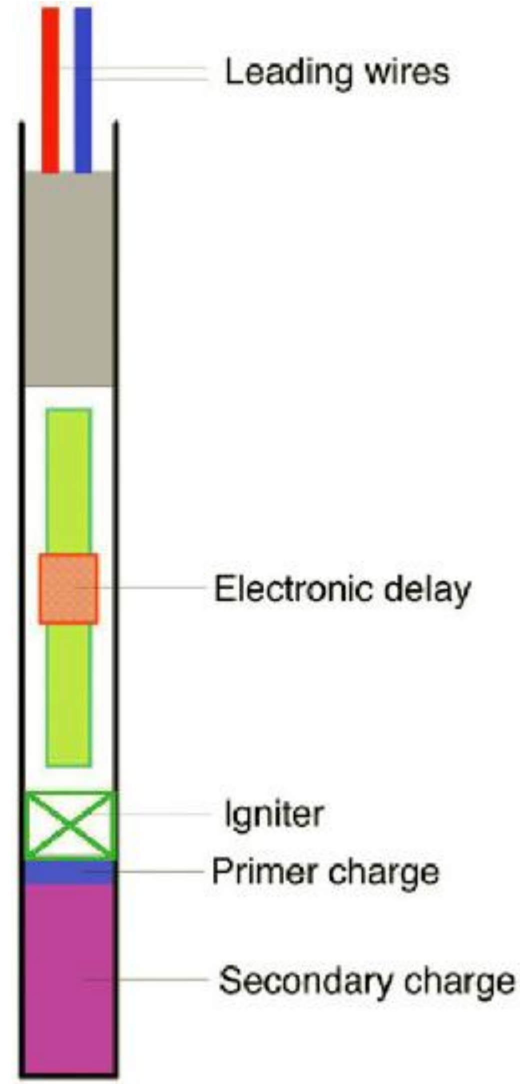
2. Electric Detonators

- Care should be taken when electric detonators are used in some special environments, such as strong radio senders, powerful streamlines over 120 kV, and under lightning weather.
- It should be avoided that electric detonators from different manufacturers are used together in one blast.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

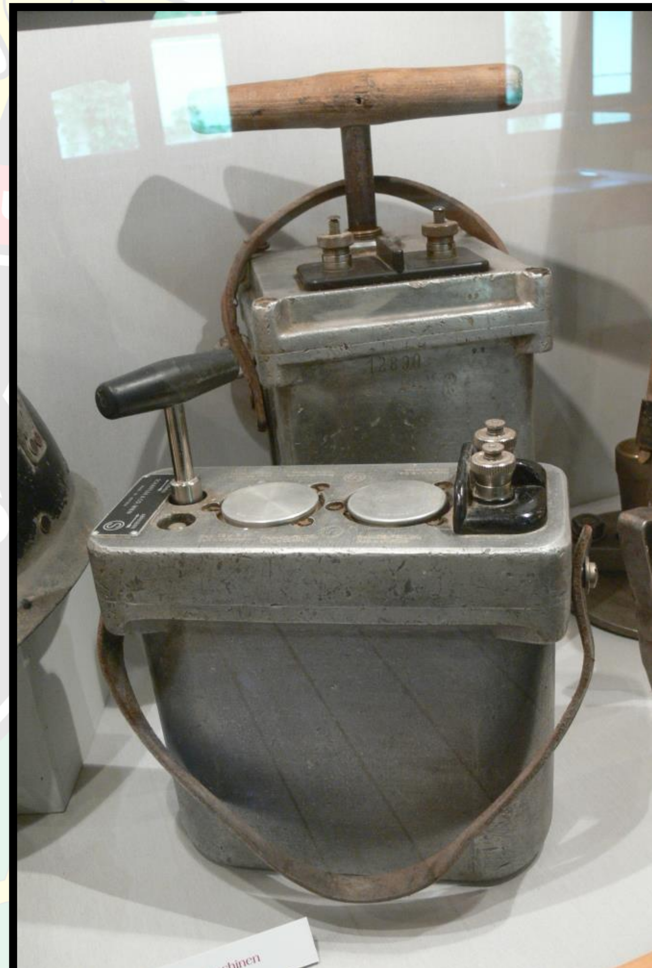
3. Electronic Detonators

- Electronic detonators were developed in the 1990s.
- In an electronic detonator, a <u>computer chip</u> is used to control delay time using electrical energy stored in one or more capacitors to provide power for a timing clock and initiation energy.

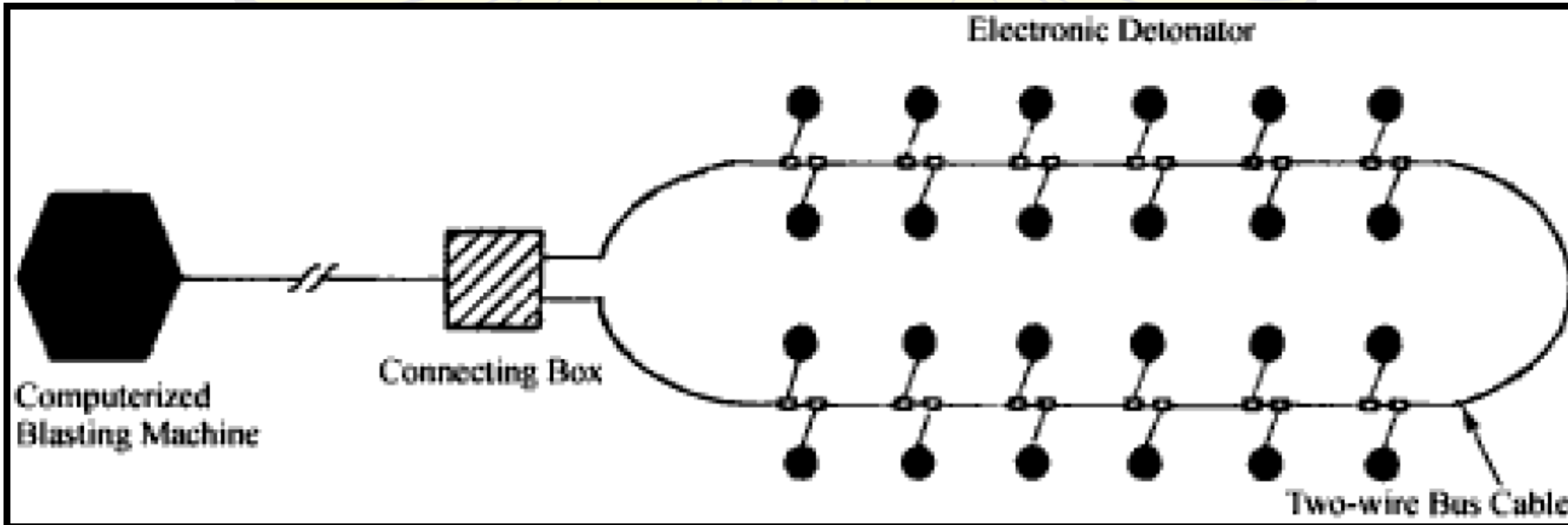


3. Electronic Detonators

- An electronic initiation system consists of **blast machine**, measuring equipment, wire system, and electronic detonators.



3. Electronic Detonators



Electronic detonator circuit, Larsson et al., 1988.

3. Electronic Detonators

Advantages

+ High precision in initiation
+ Good safety in extraneous electricity environments

Disadvantages

- Its price is much higher than other types of detonators

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

3. Circuit Testing

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Circuit Testing

It is important to check the **resistance** of the blasting circuit to make sure that there are no broken wires or short circuits and that the resistance of the circuit is compatible with the capacity of the power source.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Circuit Testing

Blasting Galvanometer

Blasting Multimeter

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Circuit Testing

Blasting Galvanometer (Ohmmeter)

Only to check the circuit resistance

Blasting Multimeter

- ✓ Resistance
- ✓ AC and DC voltage
- ✓ Stray currents
- ✓ Current leakage

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

4. Primers and Boosters

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

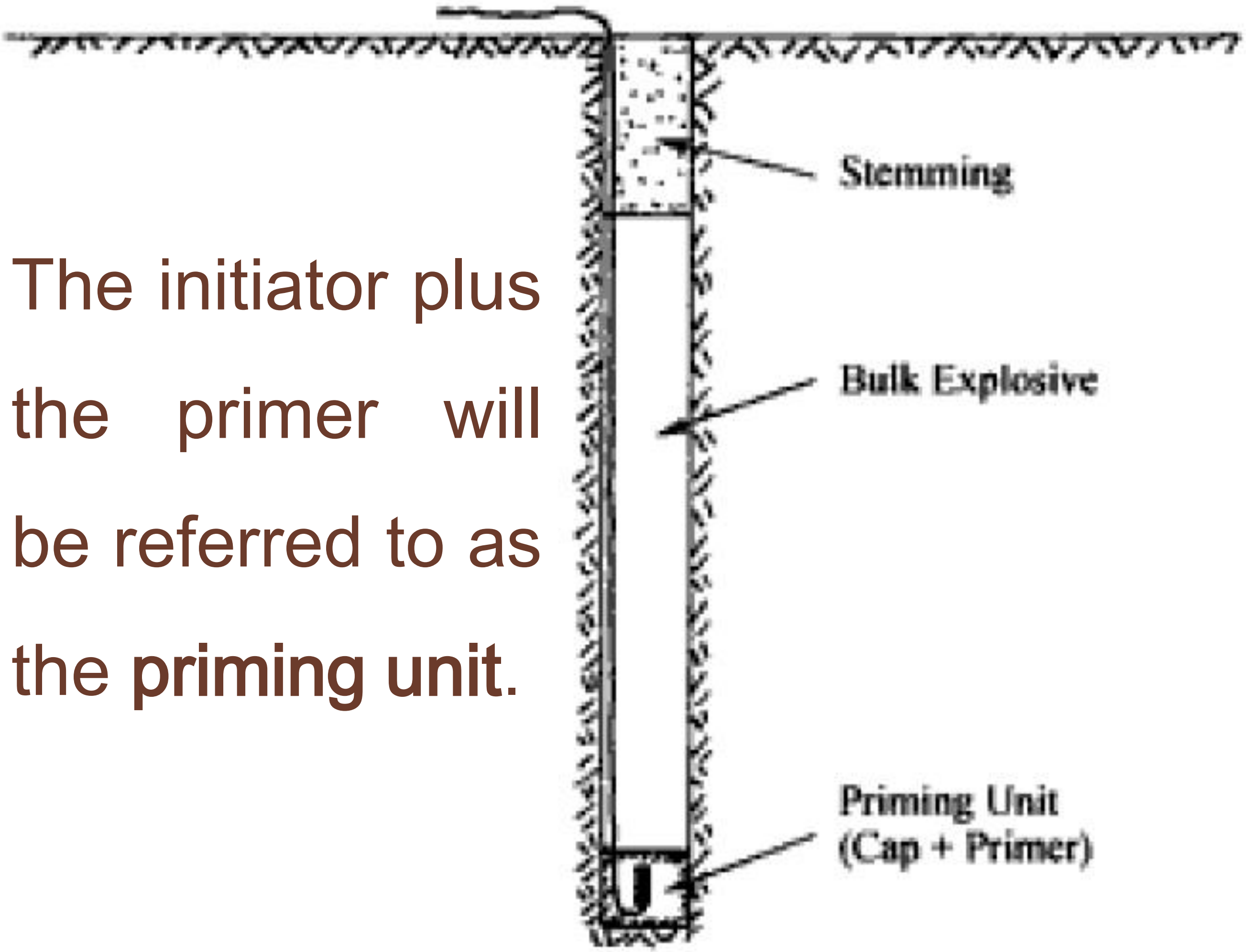
Primers

- The term ‘**primer**’ refers to the explosive charge that initiates the powder column. Caps/detonating cord are always attached to or inserted into the primer.
- A **primer** is a *‘booster’* in the sense that it takes input energy from the cap or detonating cord and boosts or amplifies it to the point where it will effectively detonate the explosive column.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Priming Unit

The initiator plus the primer will be referred to as the **priming unit**.



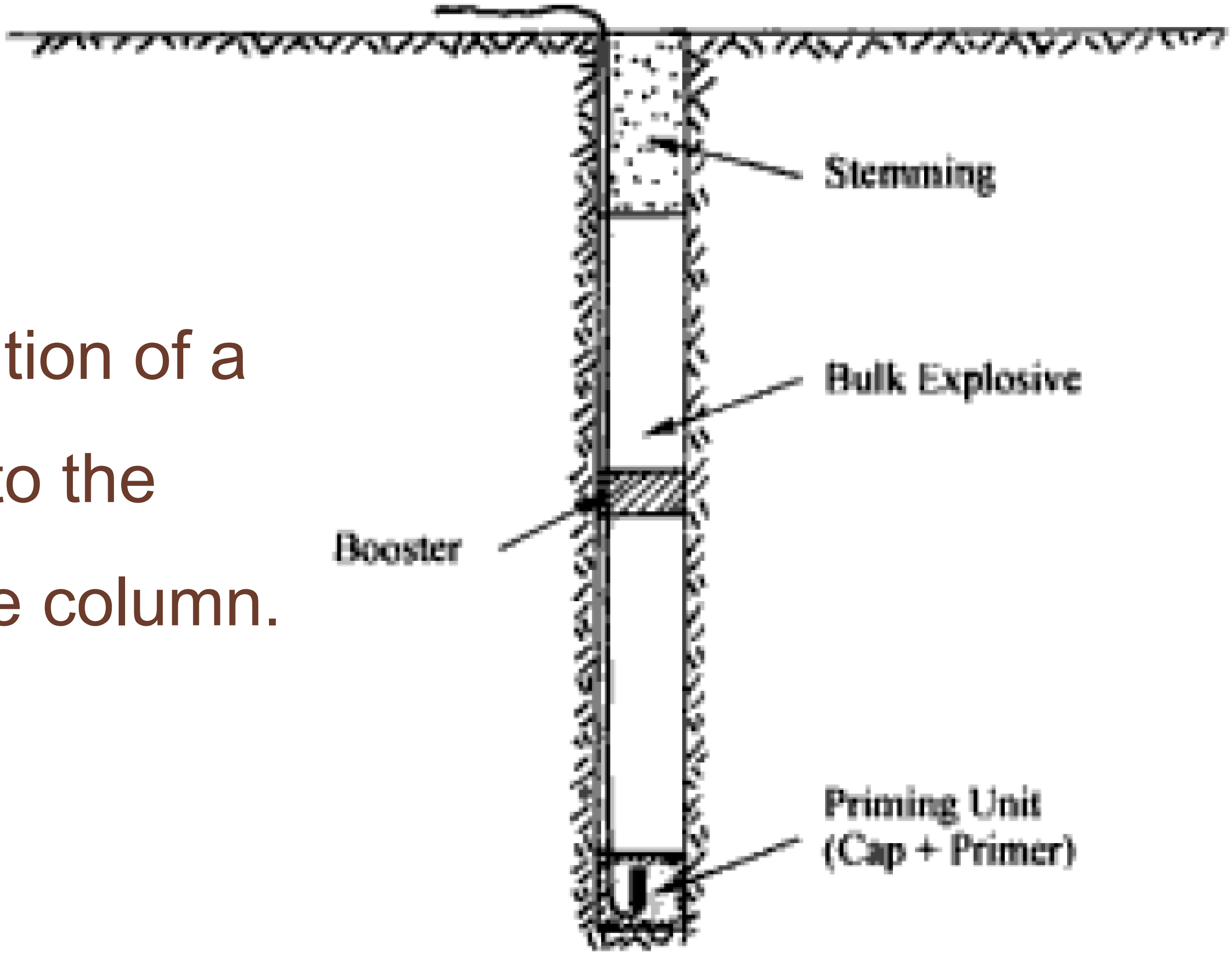
Boosters

- **'Boosters'** are blasting agents/explosives of higher bulk strength than the main primary column charge which, when inserted at various points along the column, increase the energy density (and hence the breaking ability) at those points.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Booster

The addition of a **booster** to the explosive column.



nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Boosters

- Boosting may be of interest at a region where a hard band crosses the borehole or at hard to pull toes.
- Boosters also help to maintain detonation propagation in relatively insensitive bulk explosives.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Secondary Primer

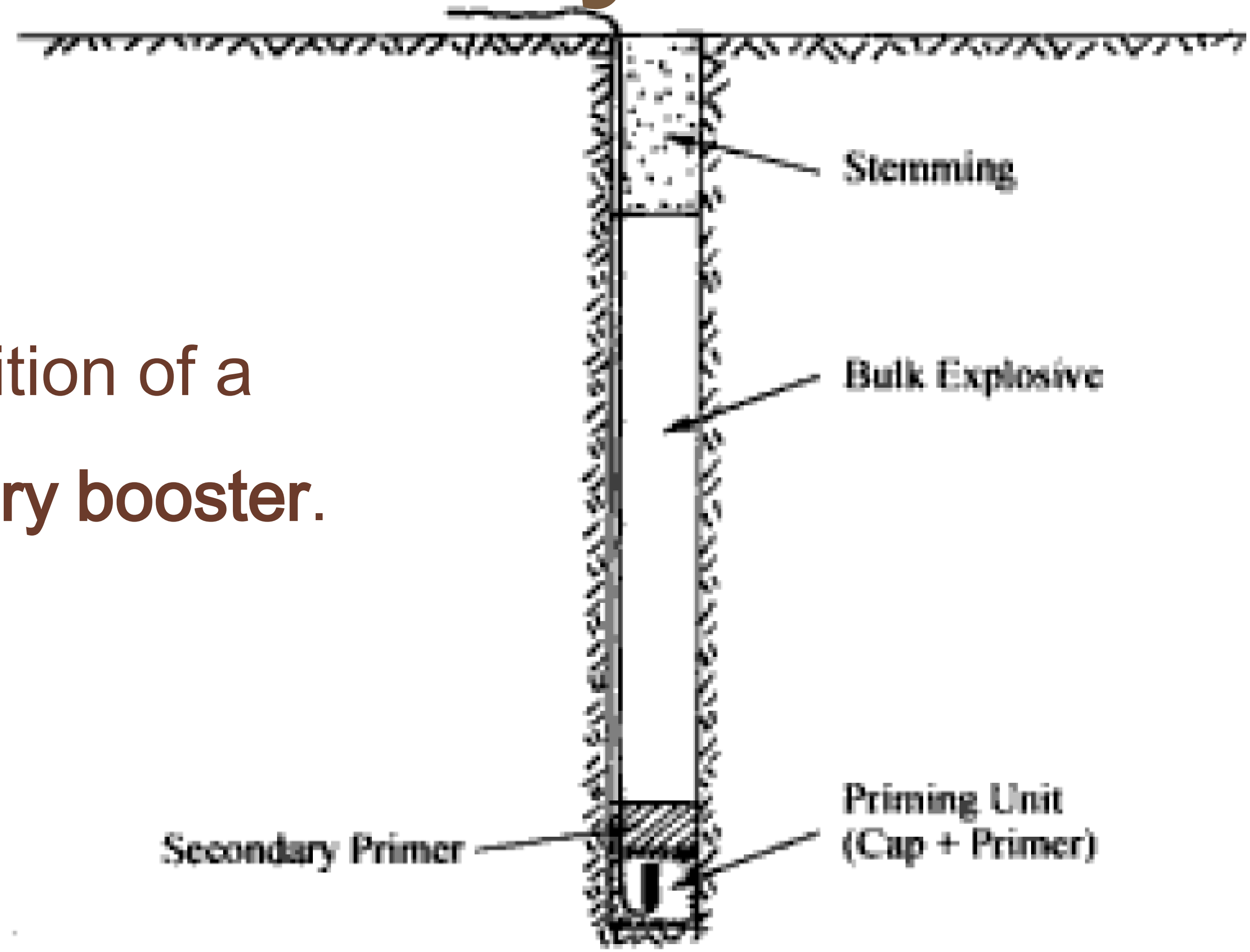
- Here a bag of high VOD watergel/emulsion/ slurry is placed between a smaller primer and the primary bulk explosive. It serves as a **secondary primer**. This is sometimes referred to as ‘**booster priming**’ or ‘**combination priming**’.

nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

Secondary Primer

The addition of a

secondary booster.



nirmana.site123.me nirmana.fiqra.q@unhas.ac.id

THANK YOU

nirmana.site123.me

nirmana.fiqra.q@unhas.ac.id