MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATIONS OF THE REPUBLIC OF UZBEKISTAN

KARSHI ENGINEERING ECONOMICS INSTITUTE

EDUCATIONAL AND METHODOLOGICAL COMPLEX

by discipline:

"MINING INTRODUCTION"

KARSHI 2023

MINISTRY OF HIGHER AND SECONDARY SPECIAL EDUCATION
OF THE REPUBLIC OF UZBEKISTAN

KARSHI ENGINEERING-ECONOMICS INSTITUTE

Registered: № 540
"20" 06 2022

"APPROVED"
Educational Prorector
O.N.Bozorov
2022

SYLLABUS

of the module

«MINING INTRODUCTION»

Knowledge sphere:	100 000 300 000	-	Humanities; Industrial engineering.
Education:	110 000 310 000	-	Pedagogy; Engineering work
Course of Study:	5311600	-	Mining (enrichment of minerals); (open mining) (coal mining); (underground mining).

Karshi-2022

This syllabus of the module has been developed in conformity with the curriculum

Draftsman: Z.Latipov — Associate Professor of the department of "Mining"

The working curriculum of the subject was discussed at the meeting of the Department of Mining № 1 of 28.08 and recommended for discussion by the Board of the Faculty of Geology and Mining.

The working curriculum of the subject is presented in the Methodological Commission of the Department of Mining (Statement _______), the Methodological Commission of the Faculty of Geology and Mining (Statement ______________) and recommended for use in the learning process.

The head of educational-methodical department is SH.Tursiyev

Dean of the Faculty of Geology and Mining T.Yarboboyev

The head of the department is A.Shodiyev

SYLLABUS of the module «MINING INTRODUCTION»

Subject/module code	Academic year	Semester (s)	ECTS
KSK2304	2022-2023	3	4
Subject(module) type	**Language of education**		**Weekly class hours**
compulsory	**English**		4
The name of the science	**Classroom lessons (hour)**	**Independent study**	**Total**
Mining introduction	60	60	120

Teacher information

Name of the department	**Mining**		
Teachers	Name	Phone number	e-mail
Lecturer	Latipov Zuhriddin Yoqub o'g'li	90 425 93 06	Zuhriddin.latipov@mail.ru
Practical training	Latipov Zuhriddin Yoqub o'g'li	90 425 93 06	Zuhriddin.latipov@mail.ru

GOALS AND OBJECTIVES OF DISCIPLINE

"Introduction to the mining industry" - an introduction to the basics of mining affairs, the main activities of specialists in this area. Learning the basic concepts and terms used in the framework of this specialty. Knowledge gained in mastering the "introduction to specialty ", intended to do further training in specialties more understandable and affordable, interest students, and also motivate them for further learning and self-education.

PLACE OF DISCIPLINES IN STRUCTURE

EDUCATIONAL PROGRAM

"Introduction to the mining industry" refers to the variable parts of the professional cycle of the main educational program, is the foundation for the preparation of bachelors in the direction 60721500 - "Mining engineering". "Introduction to the mining industry" is based on such disciplines like: Geology", "Physics", "Chemistry", "Higher mathematics". The knowledge gained during the development of the course "Introduction to the specialty", necessary for the study of disciplines: "Fundamentals of mining", "Mine Surveying and Fundamentals of the Geometry of Subsoil", "Open Mining work", "Processes of underground mining", "Technology of underground mining ", " Technology of open mining", "Design mining enterprises"," Mineral processing".

REQUIREMENTS FOR RESULTS OF DEVELOPMENT OF DISCIPLINE.

The process of studying the discipline is aimed at the formation of students of the following competencies:

- the ability to generalize and analyze information on mining, setting goals and choosing ways to achieve them;

- the ability is logically consistent, reasoned and clear state thoughts, correctly build oral and written speech;

- willingness to cooperate with colleagues, work in a team;

- using regulatory legal and normative documents in their activities;

- the desire for self-development, advanced training and mastery;

- demonstrate the use of a computer as a means management and processing of information arrays;

As a result of mastering the discipline, students should demonstrate the following education results:

DISCIPLINE RESULTS

As a result of mastering the discipline, the student must know: The educational process in high school. Research students work. The history of mining. Basic information about open pit and underground mining, and also enrichment of minerals. Key concepts and definitions used in the framework directions.

Own: The basic concepts and definitions used in the direction.

CONTENT OF DISCIPLINE

Discipline contains a course of lectures, practical exercises, independent work.

COURSE PROGRAM

INTRODUCTION TO THE MINING AND PRODUCING INDUSTRY

Themes of lectures 30 hours.

1. Introduction. Mining and mining terms (4 hours) The Republic of Uzbekistan. Independence. Sovereignty.

2. Mining industry of the Republic of Uzbekistan. (4 hours) Value Uzbekistan for the Central Asian republics. Territorial and spatial features of Uzbekistan.

3. Information on minerals. (2 hours) Minerals and rocks. Mineral reserves

4. Minerals and rocks. Mineral resources. (4 hours) Minerals Rocks and minerals. Useful stocks fossils.

5. Role and role of mining industry in regional development (2 hours) Geographical and geopolitical position. Socio-economic development of the country. The wealth of the subsoil. Place of Birth. Promising ore occurrences. Useful fossils. Capital investment efficiency.

6. Mining enterprises and their structure. . (2 hours) Production units. Shop. Production area. Households. The composition of production units. Production

structure enterprises. The structure of the Navoi and Almalyk mining and metallurgical plants. Central Mining Administration. North ore management. Zirafshan construction department. RU-5. South ore management. Industrial center in the city of Navoi. RU-2.

7. Navoi Mining and Metallurgical Combine and its directions. (4 hours) NMMC. Central Mining Administration. Northern Mining Administration. Southern Mining Administration. Sutine management. 1– hydrometallurgical plant. 2- hydrometallurgical plant. 3- hydrometallurgical plant. 4- hydrometallurgical plant.

8. Almalyk mining and metallurgical plant and its directions. (4 hours) AMMC. Production structure of OJSC Almalyksky MMC. Mining complex. Ore management of Kalmyr. Field distant. Kizil-olmo deposit. Kochbulak deposit.

9. Fundamentals of processes and technology of minerals enrichment. (2 hours) General information about underground mining. The main workings underground mining. Inclined trunk. The vertical trunk. Vertical blind trunk. underground mining technology.

Themes of practical exercises 30 hours

1. Role and value of coal industry in national economy. (4 hours). Underground mining equipment mineral. The composition of the mining extraction complexes. Lifting installation.

2. Mining technology: Underground mining of mineral deposits. (4 hours) General information about the open method of development. Career field and career. Advantages and disadvantages of an open development method.

3. Complex mechanization of underground mining of mineral deposits. (4 hours) The ratio of the volume of stripping and mining operations. Average stripping ratio. Average operating overburden ratio. Layer overburden ratio. Overburden contour coefficient. Operational overburden ratio. Boundary coefficient overburden. Stage of development.

4. Mining technology: Extraction of mineral deposits in an open way. (4 hours). Preparation of rocks for excavation. Excavation and loading operations. Rock mass movement. Waste dumping and unloading mineral resources. Technology and mechanization of mining. Komatsu. Caterpillar. Dressta. Liebherr.

5. Complex mechanization of open cast mining of coal deposits. (4 hours). Excavation operations. Moving quarry cargo. Cyclic-flow technology using steeply inclinal conveyors on the deep career of Muruntau.

6. Traditional methods of mining (4 hours). The essence of an unconventional field development method minerals, its features. Circuit diagram non-traditional way of developing mineral deposits. Advantages of an unconventional field development method mineral.

7. Types and objects of non-traditional mining of mineral deposits. (4 hours). Explosives. Detonation wave. Initiators and blasting explosives. Individual features of explosives. Types
industrial explosives. Powdered and granular Explosives based on dense ammonium nitrate. Waterborne explosives suspension type. Emulsion explosive suspension type. Facilities initiation

8. Explosion and energy in mining. (4 hours). The history of the development of surveying. Surveying Tasks mineral exploration services. Tasks Mine surveying service for the development of mineral deposits. Role and value of research work in the mining industry. (2 hours). The concept of mineral processing. Enrichment processes mineral. Equipment used in the enrichment process mineral.

Self-study content

Familiarization and study of the basic terms of mining science. The study main and auxiliary production processes. Familiarization with technological schemes of drilling and blasting, excavation and loading operations, transportation of rock mass and dumping.

Content independent work.

Independent preparation and study of lecture material.

Familiarization with the literature proposed by the work program.

List of references

Main literature:

1 Howard L. Hartman. Introductory mining engineering. – USA – Alabama, 2002 – 581 p.

2. Sagatov N.X. Kon ishlari asoslari. O'quv qo'llanma. – T.: TDTU, 2005. – 131 b.
3. Norov Yu.D., Zairov Sh.Sh. Vvedenie v napravlenie. – N.:Navoi, 2015. 189 s.
4. Umarova I.K., Solijonova G.K. Foydali qazilmalarni boyitish va qayta ishlash. Darslik. – T.: Cho'lpon, 2009.

5. V.V. Rzhevsky. Open cast mining. Technology and complex mechanization. M.: Book House Librocom, 2010. 552 p.

6. Egorov P.V. other Underground mining mineral deposits (workshop). M.: Moscow State University, 2002. – 217 p.

Additional literature:

1. N.Ya. Repin. Preparation of rocks for excavation. M.: ed. "Mountain Book", 2009. – 188 p.

2. N.Ya. Repin , L.N. Repin. Mining and loading work. M.: ed. The Mountain Book, 2010. - 267 p.

3. N.I. Kuchersky. Modern technologies for development of primary gold deposits. M., ed. "Ore and Metals", 2007.

4. Mineral deposits. M.: ed. Moscow State University 2004

5. W. Scott Dunbar. American school of mines: Basics of mining and mineral processing. University of British Columbia. USA, 2012.

Internet sites:

http://www.elibrary.ru/menu/info.asp – scientific electronic library

http://msmu.da.ru - Moscow State mining University.

http://www.mining-journal.com/ru/MJ/ru.htm - Mining Journal

http://info.tuwien.ac.at/e28/e813 - Institute of Geotechnical and Tunnel Engineering.

http://www.rsl.ru - Russian state biblioteka,

http://www.infomine.com - Mining companies

http://www.agmk.uz - Almalyk mining and metallurgical plant,

http://www.ngmk.uz - Navoi Mining and Metallurgical Combine

http://www.uz/ru/industries/min.htm -Mining industry of Uzbekistan.

http://www.uz/ru/industries/gold.htm -Gold mining industry

«APPROVE»
Chief of the department "Mining"
________ A.Shodiyev
«__» ________ 2022y.

CALENDAR PLAN OF THE STUDY PROGRAM
(Lectures, practical and laboratory exercises)

Faculty: "Geology and Mining" Specialty: Mining introduction Akad. Group –KI-
Discipline: Introduction in specialty
Lecturer: Latipov Z.Y.
Teacher of practical exercises: Latipov Z.Y.
Advisor for assignments and ind. hours: Latipov Z.Y.

Lectures: 30
Practical exer.: 30
Independent k.: 60
Total: 120

№	The title of the topic and its summary	Hours	Execution note		Signature of the teacher
			day and month	number of hours	
1	2	3	4	5	6
	Lectures				
1	Introduction. Mining and mining terms.	4			
2	Mining industry of the Republic of Uzbekistan.	4			
3	Information on minerals.	2			
4	Minerals and rocks. Mineral resources.	4			
5	Role and role of mining industry in regional development.	2			
6	Mining enterprises and their structures.	2			
7	Navoi Mining and Metallurgical Combine and its branches.	6			
8	Almalyk Mining and Metallurgical Combine and its branches.	4			
9	Fundamentals of processes and technology of minerals enrichment.	2			
	Total:	30			
	The title of the practical exercises and its summary				
1	Role and value of coal industry in national economy.	4			
2	Mining technology. Underground mining of mineral deposits.	4			
3	Complex mechanization of underground mining of mineral deposits.	4			
4	Mining technology. Extraction of mineral deposits in an open way.	4			

5	Complex mechanization of open cast mining of coal deposits.	4			
6	Traditional methods of mining.	4			
7	Types and objects of non-traditional mining of mineral deposits.	4			
8	Explosion and energy in mining.	2			
	Total:	30			

Leading teacher   Z. Y. Latipov

MINING

Mining is branch of industry. It is the search for exploitation and dressing of economic minerals and rocks.

Many minerals and rocks are today basic raw materials for various branches of industry: coal and oil are most important sources of heart energy; metals produced from ores form the building materials for machines, bridges and other constructions; other minerals give the raw materials for the chemical industry, others are used in building; salt is a foodstuff, etc.

The miner has two main tasks: to break out and to transport to the surface the economic mineral.

Before any mining enterprise can begin its nature, the properties of the mineral mined, richness (amount in percent), thickness and a real extent of the deposit and thus the reserves of the overlying and underlying beds, especially of the immediate roof and floor of the deposit, the inflow of water, the presence of firedamp or other gases, the necessity for and manner of ore dressing, etc. It's on all these various factors that the size of the proposed mining, the cost of installation and the profitableness of the enterprise. This primary work is called prospecting and exploration.

MINING ENGINEERING

Mining engineering is a field that involves many of the other engineering disciplines as applied to extracting and processing minerals from a naturally occurring environment.

The need for mineral extraction and production is an essential activity of any technically proficient society. As minerals are produced from within a naturally occurring environment, disturbance of the environment as a result of mineral production is a given. Modern mining engineers must therefore be concerned not only with the production and processing of mineral commodities, but also with the mitigation of damage or change to an environment as a result of that production and processing.

The two primary types of mine are underground mines and open pit mines. Minerals that exist relatively deep underground (ex., some coal seams, gold and some ferrous metals ore) are generally recovered using underground mining methods. Minerals like iron ore, shallow coal seams and bauxite are usually recovered from the surface by open pit mining.

Engineering disciplines that are closely related to mining engineering are:

- Civil engineering
- Environmental engineering
- Geotechnical engineering
- Hydraulic engineering
- Electrical engineering
- Structural engineering

MINING INDUSTRY

Mining is the extraction of valuable minerals or other geological materials from the earth, usually (but not always) from an ore body, vein, or (coal) seam. Materials recovered by mining include bauxite, coal, gold, silver, diamonds, iron, precious metals, lead, limestone, nickel, phosphate, oil shale, rock salt, tin, uranium, and molybdenum. Any material that cannot be grown from agricultural processes, or created artificially in a laboratory or factory, is usually mined. Mining in a wider sense can also include extraction of petroleum, natural gas, and even water.

The oldest known mine in the archeological record is the "Lion Cave" in Swaziland. At this site, which by radiocarbon dating is 43,000 years old, Paleolithic human mined for the iron – containing mineral hematite, which they ground to produce the red pigment ochre. Sites of similar age where Neanderthal may have mined flint for weapons and tools have been found in Hungary.

Ancient Egyptians operated malachite mines at Wady Maghareh on the Sinai Peninsula and at Timna in the Negev. At first, the bright green stones were used for ornamentation and for pottery glaze, but approximately 1,200 BCE, Egyptians discovered that malachite could be converted into copper by the application of intense heat and air.

NAVOIY MINING & METALLURGY COMBINE

Today NMMC is a large multi profile industrial complex that in addition to exploration, mining and production of uranium, gold, flour-spar, construction materials and phosphorites includes into its activity production of marble goods, sulfuric acid, jewelry, knitted and textile goods, machines and household equipment. NMMC's successful development is a result of step by step providing the production facilities with modern equipment for mining, excavating, transporting, metallurgy, drilling, prospecting, construction, machine building, metal-working and analytical measurements. They are also equipped with computers, checking and measuring apparatus, automatic machinery, automated quality control systems, designing control systems and mining works preparation control systems. Construction of Navoiy Mining & Metallurgy Combine (NMMC) commenced at the end of the fifties exactly in the heart of Central Kyzyl Kum, one of the largest deserts on our Planet. Nowadays NMMC is among the ten largest uranium and gold producers in the world. Its products of highest quality are well known all over the world and have a lot of International Awards and Prizes.

Forty five years is not the long period of time but it is rich in highly significant events. NMMC's history has been created against the background of the history of great country and it is inseparably linked with foundation of the new sovereign state - the Republic of Uzbekistan. NMMC is one of the founders of American - Uzbek Chamber of Commerce. Founded in September 1993 it represents non-commercial organization including companies interested in development of bilateral commerce and investments between the United States and Uzbekistan.

In 1996 presentations of mineral base and sources of raw materials of Uzbekistan took place in the U.S.A. and Japan where foreign companies showed the enormous interest towards NMMC.

CLASSIFICATION OF METALS

The metals divide on black and colour. To black metals concern iron (Fe) and his(its) alloys , and also manganese Mn, V) and Cr, to colour - all others (33).

The colour metals are subdivided into four groups:

1. Heavy metals;
2. Easy metals;
3. Noble metals;
4. Rare metals.

The classification of colour metals is made on the basis of their various attributes: density (heavy and easy), chemical inertness (noble), limited prevalence both scales of manufacture and application (rare), high temperature (refractory), (absent minded), radio activity (radioactive).

Heavy colour metals. Copper (Cu) and nickel (Ni) in industrial classification of metals form together with lead (Pb), zinc (Zn) and tin (Sn) group of heavy basic colour metals. The antimony (Sb), mercury (Hg), cadmium (Cd), cobalt (Co) and arsenic (As) - only 11 concerns also bismuth (Bi), to same group under the name younger (small).

To group of easy colour metals concerns metals, at which density does not exceed 5. Into group enter aluminum (Al), magnesium (Mg), and also alkaline metals: natrium (Na), potassium (È) and alkali element: calcium (Ca), Sr, barium (Ba) - only 7.

To noble metals concern silver (Ag), gold (Au), platinum (Pt) and platinum: (Ru), radium Rh, Pd, Os, Ir - only 8.

Others 57 metals form group rare, which in the turn, subdivide into five subgroups:

1) Refractory rare metals;
2) Absent-minded rare metals;
3) Easy rare metals;
4) Less-common metal;
5) Radioactive rare metals.

To refractory rare metals concerns titanium Ti, Zr, Hf, V, Nb, Ta, Mo and W - only 8.

Subgroup of absent minded rare metals forms Ga, In, Tl, Ge, Se, Te, Re - only 7. These metals do not form, as a rule, own minerals, and is as impurity in minerals of other elements and are taken in passing from ores of other metals or minerals.

Li, Rb, Cs and Be makes a subgroup of easy rare metals (only 4).

To less-common to metals concerns elements which are included in a collateral subgroup of 3-rd group: Sc, Y, La and: Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu - only 17. Their characteristics are the affinity of physic-chemical properties and joint presence (finding) in raw material.

Subgroup of radioactive metals form (Hardware), Fr, Ra, Ac, Th, Pa, uranium (U) and elements: Np, Pu, Am, Km, Bk, Cf, Es, Fm, Md, No, Lr, Ku, Ns - only 21. From them of radioactive metals and the uranium is natural (natural) radioactive elements, and all others is artificial are received at nuclear reactions.

METALS AND ALLOYS

Everybody knows that metals and alloys play important part in any branch of technique as well as in our everyday life.

From earliest times man has made things of materials obtained from the earth. For thousands of years of the Stone Age for making tools he used mostly stone. Then came the discovery that metal can be produced from certain types of stones when they were treated with fire. By heating stones to very high temperatures man made the metal the stones contained melt and run out of them. Sometimes, as we know it now, man had to add some carbon to produce compounds of metals. We know also copper (Cu) and tin (Sn) to be two of the earliest metals obtained this way. Then man noticed that the two metals, when melted together, produced a new material that was much harder and stronger than either of them had been. Scientists think this discovery opened a new period in man's development. Since the discovery the period to continue for about seven hundred years is considered to be the age of bronze. That's why the scientists gave it the name of the Bronze Age. It had lasted for about 700 years, when came the time when man learned to produce iron, which became one of the most important metals for him. It marked the beginning of a new age — the Iron Age.

Since then man has learned how to produce a lot of other metals and how to obtain thousands of alloys from them. To produce an alloy man melted together two or more metals. As the time passed many different types of alloys were discovered. Now we know some alloys to contain not only metals but also non-metals, such as carbon, sulphur (S), phosphorus (Ph), etc. Generally speaking, it is in the form of alloys that one considered metals to be the most useful. A lot of metals are converted into alloys of much importance and scientists and metallurgists want much more new alloys to serve man's needs.

We want you to know that only about as little as 30 metallic elements serve modern needs of man, but there are over five thousand alloys, hundreds of which are in common use. So many different alloys have been elaborated because modern industry requires metals to be used for different purposes.

We know scientists to classify all the alloys into some types or classes according to their chemical composition and physical properties. According to composition, all the alloys are to be classified as ferrous alloys (those containing iron) and non-ferrous ones (those containing no iron or only a small quantity of it). The classes of alloys based upon their physical properties include light-weight alloys, low-melting point alloys and others.

SOME IMPORTANT PROPERTIES OF METALS

Why are metals of such importance for man's life?

The answer to this is to be found in their characteristic properties. The most important of this is strength, which means that metals can withstand weight without bending or breaking, and are also corrosion-resistant and may be formed into different shapes, which distinguishes them from many other classes of materials. Some metals also have other special properties, two of which are conductivity and the property to be magnetized.

Strength is of great importance for most industrial purposes. That is why steel is widely used in modern industry. We know steel constructions to be used not only for building ships, planes and engines but in building industry too. Steel is also used for producing tubes, pipes, etc. For this purpose, engineers often use special kinds of steel.

As iron and steel are used more often than any other metal, we usually divided metallurgical materials into two classes: ferrous metals and non-ferrous ones. Where the requirements for strength are combined with the requirements for resistance to rusting, such non-ferrous metals as aluminum, bronze or brass (an alloy of copper and zinc) may be used.

We know engineers to use copper and aluminum for conducting electric current since these metals offer less resistance to it than ferrous metals do. A copper wire offers less resistance to current than an aluminum wire of the same size does. But due its lighter weight aluminum offers less resistance per unit of weight.

When current passes through a conductor, resistance results in giving off heat; the greater the resistance, the greater is the heat for a given current. That's why metals with high electric resistance are used for electric heating. This property is found in the alloys; among the best for the purpose are alloys of nickel and chromium.

NAVOIY MINING & METALLURGY COMBINE

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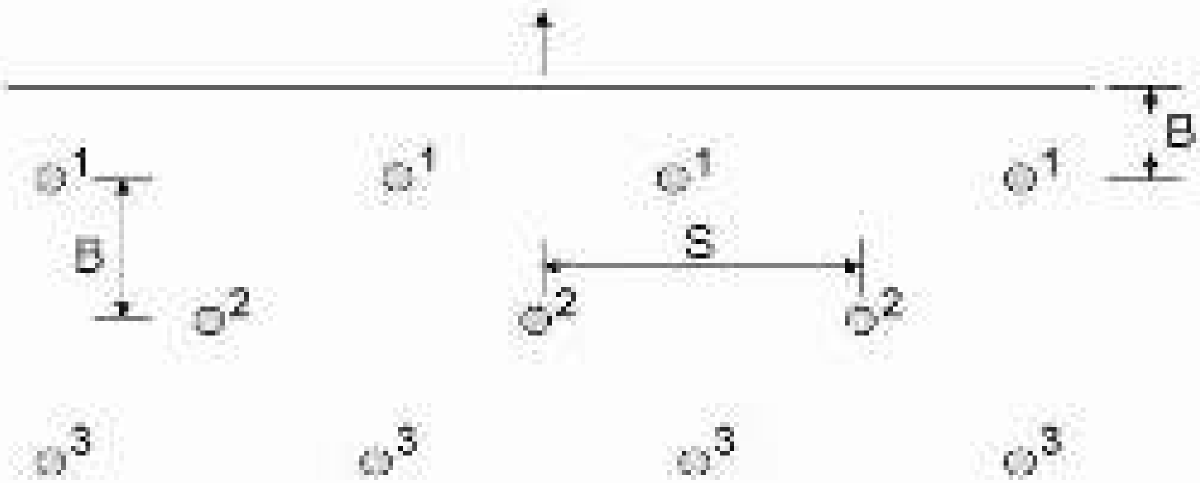
Surface-Blast Design



This blaster-training module was put together, under contract, with Federal funds provided by the Office of Technology Transfer, Western Regional Office, Office of Surface Mining, U.S. Department of the Interior, located in Denver, Colorado.

The module is an example of the technical assistance the Federal government furnishes States to assist them in meeting the requirements of the Surface Mining Control and Reclamation Act of 1977, upon which their State surface coal-mine regulating programs are based. In particular, the module was requested and will be used by the Sheridan District Office, Wyoming Department of Environmental Quality, Land Quality Division.

A word of caution: please note that this module is not intended to stand alone, nor is it a self-training type module. Rather, the information the module provides **MUST BE SUPPLEMENTED** by information given by a certified blasting instructor.

DISCLAIMER

The technologies described in the module are for information purposes only. The mention herein, of the technologies, companies, or any brand names, does not constitute endorsement by the U.S. Department of the Interior's Office of Surface Mining.

Surface-Blast Design

This module presents recommended blast-design practices for surface-mine and quarry blasting.

Blast-Design Overview

Objectives in blasting:

- Fragmentation
- Highwall stability
- Movement:
  - Buffer blasting
  - Cast blasting

Blast theory:

- Stress waves
- Crack propagation

Timing:

- Millisecond delay blasting:
  - "V" (chevron) pattern
  - Echelon pattern
  - Row-by-row pattern

Types of blast patterns:

- Square
- Rectangular
- Staggered

Blast-Design Overview

Blast parameters:

- Burden
- Spacing
- Bench height
- Powder column:
  - Hole diameter
  - Hole depth
  - Powder factor
  - Subdrilling
  - Stemming

Controlled blasting techniques:

- Line drilling
- Presplitting
- Smooth blasting
- Cushion blasting

Measurements and calculations:

- Loading density
- Face profiling
- High-speed photography
- Fragmentation distribution
- Velocity of detonation

Objectives in Blasting

The primary objectives in rock blasting are to optimize blast performance and ensure the safety of everyone by implementing safe practices in and around the blast site.

Secondary objectives include:

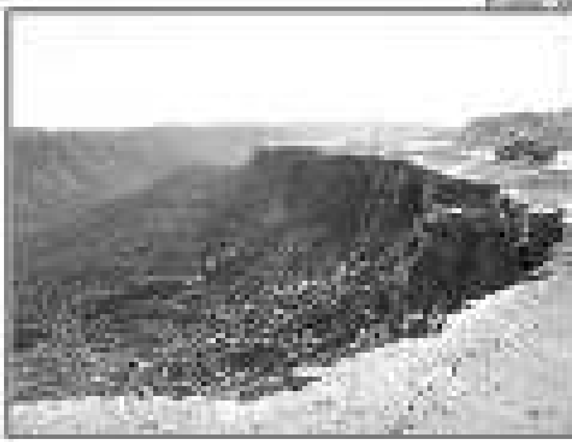
- Maintaining the stability of highwalls, so that men and equipment working on and under them are safe;
- Fragmenting rock masses to reduce their downstream hauling and crushing costs; and
- Moving rock masses to facilitate their load-out by site-specific equipment.

Safety

Weekly or monthly safety meetings that include the blast crew, drill crew, and production crew keep employees posted as to (1) all site-specific safety procedures and (2) what is expected of them daily.

Fragmentation and Moving

A proper blast design will yield adequate fragmentation, which will lower downstream costs related to hauling, equipment maintenance, and crushing.



Highwall Stability

A safe and stable highwall is critical to virtually all aspects of a blasting operation. Equipment—drills, draglines, and dozers—relies on highwall stability, as do blasting crews loading interburden (parting shots) and shovel operators loading trucks in the pit. Maintaining a stable highwall at your operation requires a good understanding of geology and water conditions, as well as slope and blast design. In addition, you must maintain quality control over the blast design. The strength of a rock mass under shear, tensile, and compressional loading will dictate the overall stability of a highwall.

Rock Failure

Compression failure is caused immediately around a charge when the rock is crushed by extremely high borehole pressures.

Tensile failure occurs when reflecting stress waves rip the rock apart. The damage from such failure is much greater, because rocks are much weaker in their tensile strengths than in their compressive strengths.

Shear failure is controlled by the shear strength of the rock mass, the duration of the blast, and blast induced vibration levels. Repeated blasting can reduce the shear strength of adjacent rock masses.

Highwall Stability

Blast design will influence the stability of highwalls, in that it affects:

- Horizontal relief away from the wall,
- Energy concentration adjacent to the wall, and
- Blast size and duration.

Modified production blasts are blasts that use reduced charge loads in the rows nearest to the proposed crestline of the new highwall. This reduces the explosive energy adjacent to the highwall and may reduce overbreak beyond the crestline.

Some controlled blasting methods used to reduce **overbreak** and **backbreak** beyond the crestline are discussed in this module.

Movement

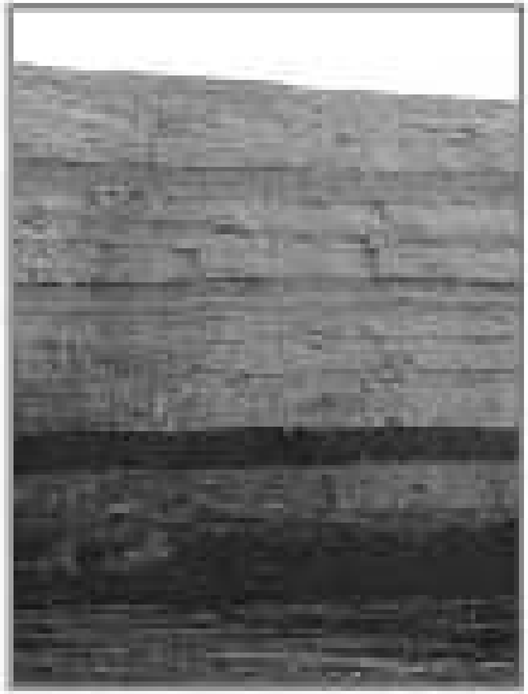
The shape and location of the muckpile is an important element of shot design. Requirements range from a need for extreme throw—for example, to cast overburden under a coal-stripping scenario—to buffer shooting, where the muckpile is confined to a certain area by rock that has been previously blasted. The confined muckpile provides a high bank of shot material that will increase shovel productivity. Mines with a high face that use front-end loaders will often blast for a low muckpile for the sake of safety considerations on the ground. Bench height, powder factor, burden, timing, and buffers all must be considered when movement modifications are made.

Click on the image above to play a buffer-shot blasting clip.

Click on the image above to play a cast-blast blasting clip.

Controlled Blasting

Controlled blasting techniques are used to efficiently distribute explosive charges in a rock mass, thereby minimizing the fracturing of rock beyond the crestline of the highwall or designed boundary of main excavation areas. Such over-fracturing, commonly called **overbreak**, is typically more of a problem in soft or unconsolidated, incompetent overburden formations.



There are several techniques that a blaster can use to minimize overbreak, but trials should be conducted to determine whether any given technique can be applied successfully, as well as to determine the proper hole spacing for the given geology. Modern blasting professionals group controlled blasting techniques into four categories:

- Presplitting,
- Smooth blasting,
- Line drilling, and
- Cushion blasting.

Presplitting

Presplitting is a technique that involves loading a single row of holes that have been drilled along a desired highwall crest or excavation line with small decoupled charges. Such charges reduce the crushing effect around the borehole and are shot before the main production shot. The idea is to minimize or eliminate overbreak from the primary blast and to produce a smooth rock wall. Presplitting will add a large drilling cost to an operation.

Borehole Diameters

Normally, the diameter of a borehole is limited by the capabilities of the drill used to create it. As a rule, open-pit and coal strip mines using large drills will drill presplit holes that range from 9 to 12 ¼ inches in diameter. Quarry and construction presplits are much smaller, generally ranging from 2 to 4 inches in diameter. Presplit holes may be drilled on an angle if the geology and drill allow for it.

Spacing

Presplit spacing will vary, depending upon rock characteristics, size of the operation, and bench height. Trials should be conducted to determine the optimal borehole spacing. On average, Western coal strip-mine operations use presplit spacings of from 10 to 12-½ feet, whereas soft-weathered formations at small projects may require presplit spacings of 15 inches or less.

Explosive Charge

Depending upon the rock characteristics and spacing used for the presplit, charge loads will vary; however, powder factors will normally range from 0.1 to 0.3 lb/ft^2. Many times, detonating cord (25 to 400 grains/foot) is used either as the primary charge in a presplit hole or in conjunction with a small primer. This decoupled charge reduces the amount of explosive energy that is transferred to the rock mass.

Limitations

Results of presplitting cannot be determined until after the excavation has been removed to the presplit line.

Controlled Blasting

The term "*smooth blasting*" refers to lightly loaded holes that have been drilled along excavation limits and are shot after the main excavation is removed. Typically, such holes are shot instantaneously or with little delay, leaving a smooth wall with minimum overbreak. Smooth blasting is the most widely accepted method for controlling overbreak in underground headings and stopes. however, it is is not widely preferred over presplitting in surface mining.

"*Line drilling*" provides a plane of weakness to which a primary blast may break; it may also protect a highwall by reflecting some of the shock wave created by a blast. This plane of weakness is created by drilling a line of closely spaced (3- to 12-inch), small-diameter (1.5- to 3-inch) holes along the excavation line. The distance from the back row to the line drill is normally 50 to 75 percent of the production burden. Line drilling is normally limited to construction projects, dimension stone quarries, and rock sculpting where any overbreak at all can be considered detrimental.

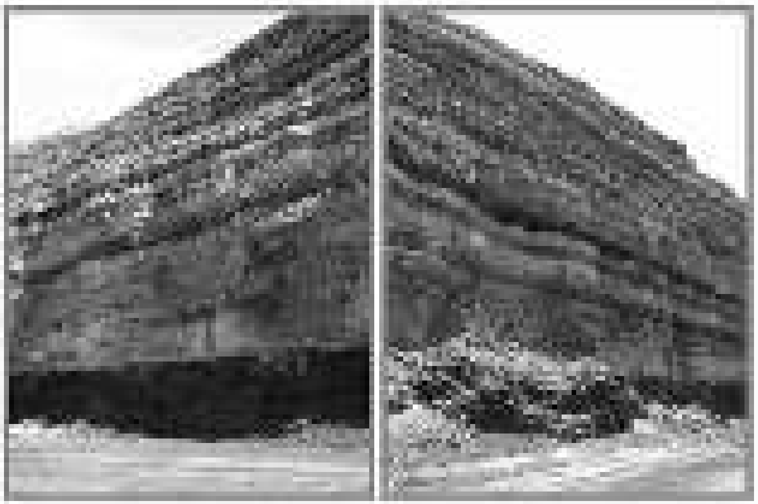
"*Cushion blasting*," or trim blasting, is similar to smooth blasting in that the holes are shot after the main production shot. Cushion blasting involves backfilling the entire borehole with crushed stone to cushion the shock from the finished wall. This technique is rarely used today, because air decking with good quality gas bags or hole plugs can achieve the same results will less loading time.

Hole Diameter and Depth

The choice of the hole diameter depends upon the geology of the blastsite, primarily the jointing and bedding of the formation. The desired fragmentation, the face height, and economics must also be considered.

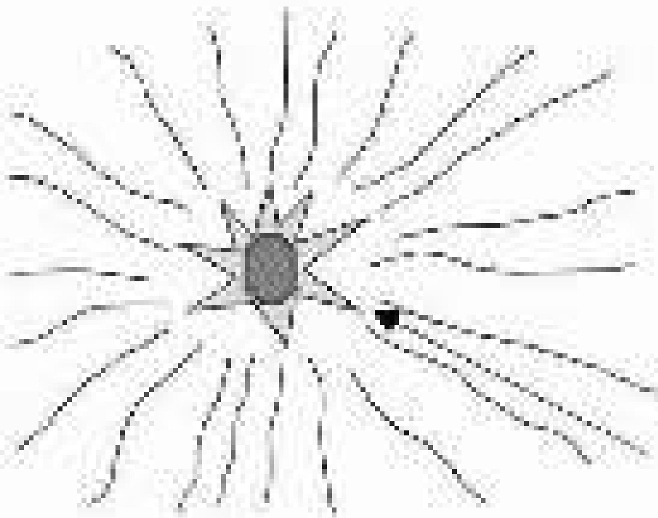
The geology is the only factor in the blast design that cannot be changed. Accordingly, given the geology, the method of operation and the cost of equipment are determined based upon the desired fragmentation, which in turn is a function of hole diameter and the explosive being used.

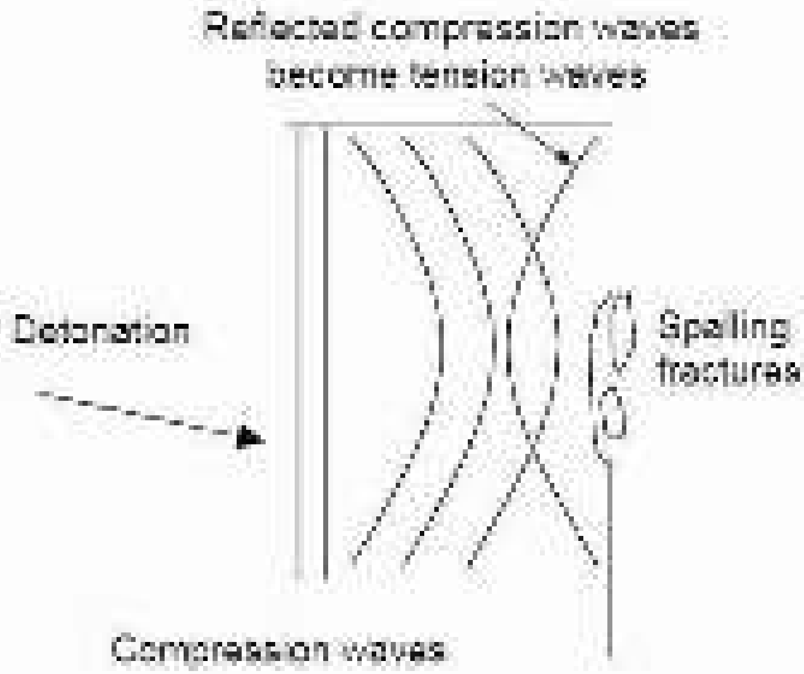
The bench height is usually designed around the safety of the workers and equipment that will be on top of and under the highwall. Proper blast design will optimize use of the inherent stability of the geological formation in question.



Blast Theory

When explosives detonate in a blasthole, a stress wave moving at 10,000 to 20,000 ft/s (depending upon the rock type) propagates out from the hole. These stress waves cause radial fracturing of the rock mass at 1.5 to 8 feet per millisecond.





When using burdens from 6 to 20 feet, initial face movement will occur within 15 milliseconds. The crack network will establish and rock movement will begin after 1 millisecond per foot of burden on the hole.

Blasting Measurements

The fundamental principle of blast design is most often the distribution of an explosive in the rock, where "distribution" is considered to be a combination of blast pattern and explosive density.

Powder factor is the relationship between a rock mass and the explosive used to fragment it. The term "powder factor" can be used to describe either the weight of explosive per unit volume (lb/yd^3) or the weight of material blasted per weight of explosive (tons/lb). The weight of explosive can be determined using the column-rise formula, as follows:

***Loading density = K x explosive density x (column diameter)^2*,**

where

- loading density is measured in pounds of explosive per foot of borehole;
- K = 0.3405;
- explosive density is measured in grams per cubic centimeter; and
- explosive column diameter is measured in inches.

The total weight of explosive per hole is determined by multiplying the loading density (calculated using the column rise formula) by the length of the powder column. The volume of material to be blasted is calculated by the rock volume formula, as follows:

***Volume = burden dimension x spacing dimension x (hole depth – subdrill length)/27*,**

where

- hole depth – subdrill length = bench height[1]; and
- burden dimension, spacing dimension, and bench height all are measured in feet.

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[1]Technically, the equation "hole depth – subdrill length = bench height" is correct. However often, bench height alone equals hole depth, especially at surface coal mines, where subdrilling is not a common practice (subdrilling is more prevalent at quarry operations).

Blast Design

The powder factor for a single borehole is calculated as:

$$PF = \frac{PC \times (0.34\ \rho) \times d^2}{B \times S \times H/27}$$

where PF = powder factor, pounds of explosives per bank cubic yard of rock;
PC = Powder column, feet of explosive charge*;
ρ = density, in g/cm³, of the explosive;
d = charge diameter[†] in inches;
B = burden dimension in feet;
S = spacing dimension in feet;
H = bench height (or hole depth) in feet[‡].

Typically, blasters will round the powder factor to the nearest tenth or hundredth.

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*Powder column = hole depth (or bench height, H) – stemming – backfill.

[†]Charge diameter = hole diameter, when using bulk ANFO or other pumped explosives.

[‡]Again, note that, especially at surface coal mines (as distinguished from quarry operations), not all benches are subdrilled. In cases where subdrilling is used, "H = bench height in feet," where "bench height = hole depth – subdrill length."

Review Question

1. A surface coal mine currently in operation plans to undertake additional blasting loading ANFO with a density of 0.8 g/cm^3. Additional relevant parameters with respect to this proposed shot are:

   - Burden = 28 feet,
   - Spacing = 33 feet,
   - Bench height (or hole depth) = 135 feet,
   - Hole diameter = 11 inches,
   - Stemming = 30 feet, and
   - No. of holes = 200.

   In pounds of explosives per bank cubic yard of rock, what will the powder factor for a single one of these boreholes?

   a. 0.25
   b. 0.5
   c. 0.75

Answer

5. c. is correct. Powder factor for a single borehole is calculated as:

$$PF = \frac{PC \times (0.34\,\rho) \times d^2}{B \times S \times H/27}$$

where PF = powder factor, pounds of explosives per bank cubic yard of rock;
PC = length, in feet, of the explosive charge;
ρ = density, in g/cm³, of the explosive;
d = charge or hole diameter in inches;
B = burden dimension in feet;
S = spacing dimension in feet; and
H = bench height or hole depth in feet.

Remembering that PC = bench height – stemming, and using the parameters in our example,

$$PF = \frac{105 \times (0.34 \times 0.8) \times 11^2}{28 \times 33 \times 135/27}$$

or 0.7491 (rounded to 0.75) pounds of explosive per bank cubic yard of rock at our surface coal-mine shot.

Blast Measurements

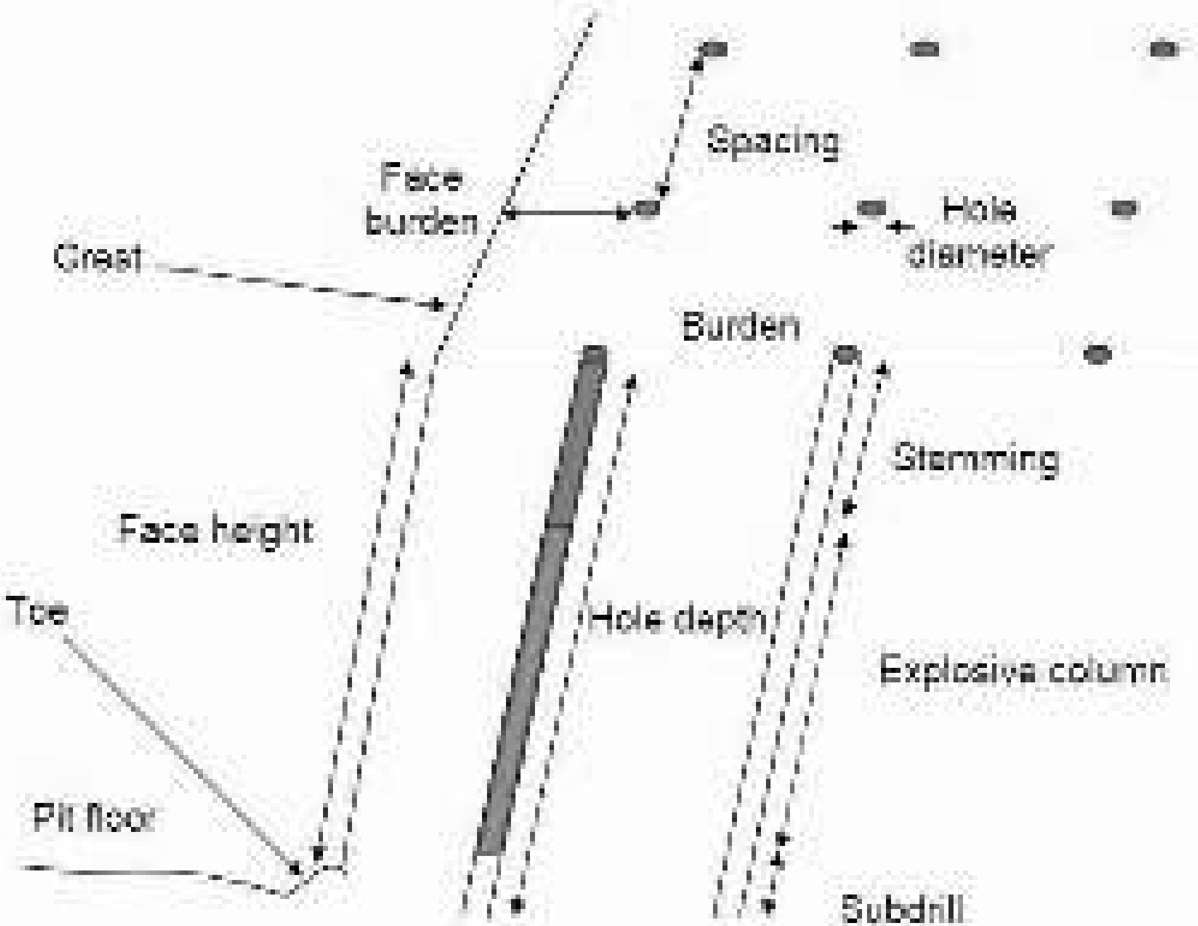
It is important for the blaster to know the face height and toe burden of a shot. In cast blasting, knowing the face burden can allow you to accurately calculate the placement and angle of the face holes and to set any remaining rows of holes. These parameters can be determined by surveying the face in one of many ways. Modern laser transits are available for detailed 2D and 3D face profiling.

High-speed photography can be used to evaluate the movement or flexing of the face and top of the shot and to determine the velocity of rock moving away from a highwall.

Fragmentation distribution can be calculated by running a particle distribution on the muckpile. Computer software exists to aid in making distribution calculations.

Velocity of detonation in any borehole can be calculated by placing a gage inside the borehole. This gage is wired to an oscilloscope that logs the speed of the detonation wave in the borehole.

Blast-Pattern Parameters



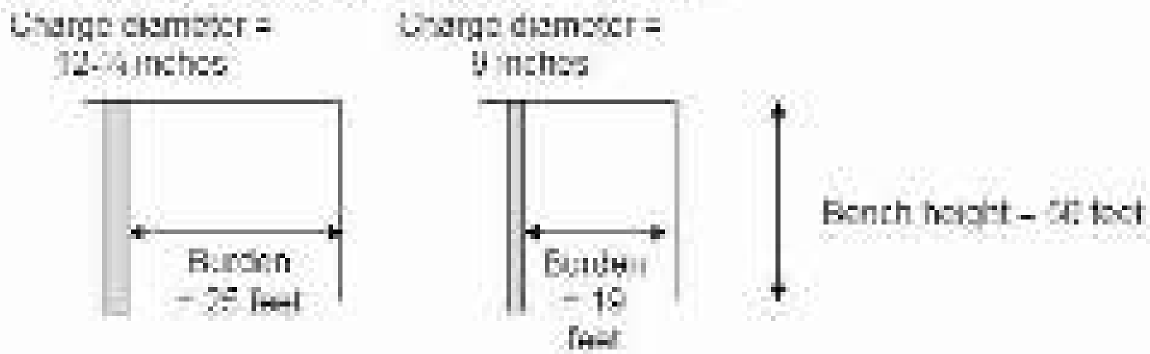
Blast Design

Burden

The proper burden dimension to use in any given individual blast can be calculated by taking into account hole diameter, relative rock density, and the explosive that will be used in the blast. Too small a burden can result in excessive airblast and flyrock; on the other hand, too large a burden can result in improper fragmentation, toe problems, and excessive ground vibrations. The burden, in turn, is the basis for calculating spacing, stemming, and subdrilling.

Field testing gives a better idea of the exact burden to use in an operation; however, lower burden-to-charge diameter ratios should be used as a first approximation when the blasthole diameter is large in comparison to the bench height.

The assumption of 25 times the charge diameter is a good starting point for determining the burden dimension to use when shooting with ANFO (0.85 g/cm^3) in rock with a density of near 2.7 g/cm^3. When shooting with a denser emulsion or blend product (1.2 g/cm^3), the burden can be increased to from 30 to 35 times the charge diameter. Thus, if an operation plans to shoot ANFO in 9 inch holes in a 50 foot bench, a good starting point would be a 19 foot burden. In a hole with a 12-3/4-inch diameter, the burden can be increased to 25 feet.[1]



ANFO shot

[1]Note that both these assumptions with respect to charge diameter are first approximations. A blaster can modify the charge diameter/burden ratio based upon his or her experience and knowledge of the explosive being used, the rock type, and the specifics of the operation.

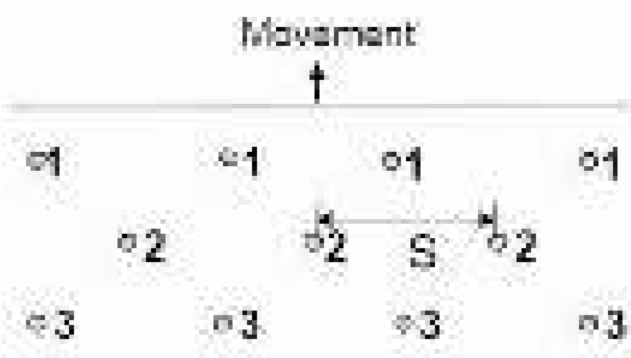
Blast Design

Spacing

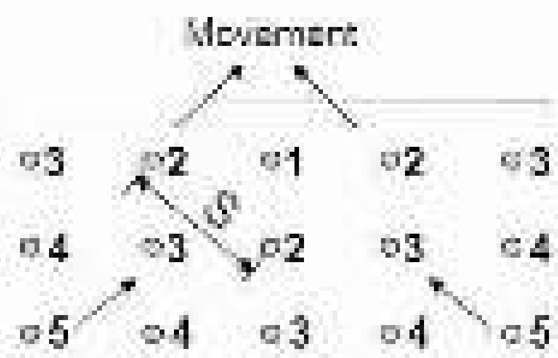
Spacing is the distance between adjacent blastholes in a row, measured perpendicular to the burden. In row-to-row shooting, spacing is measured between holes in a row. When the shot progresses at an angle to the free face, the spacing is measured at that angle.

Spacing may be somewhat dependent on the timing, but is most often a function of the burden. Close spacings cause crushing and cratering between holes, boulders, and toe problems. Holes spaced too far apart will result in inadequate fragmentation.

The assumption of from 1.5 to 2 times the burden is a good starting point for determining the spacing of a blast to be initiated simultaneously in holes in the same row. When shooting sequentially down the row in a box cut or "V" pattern, spacing should be from 1 to 1.2 times the burden (or close to a square pattern).



Spacing = 2 x burden



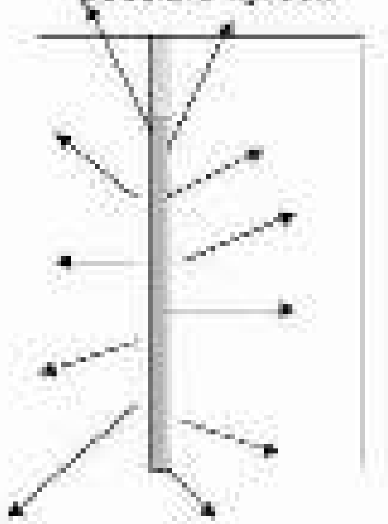
Spacing = burden

Blast Design

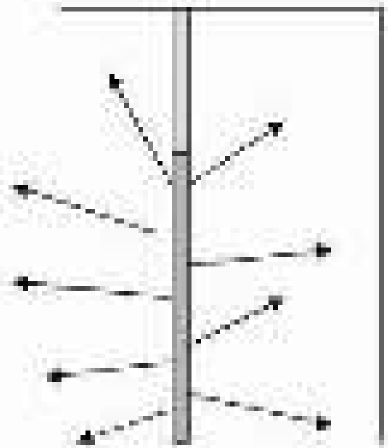
Stemming

Stemming contains explosive energy within a blasthole, so that it will break and move the rock without generating flyrock. Sized crushed stone or drill cuttings should be used as stemming.

Inadequate stemming =
possible flyrock



Adequate stemming =
well-contained explosive energy

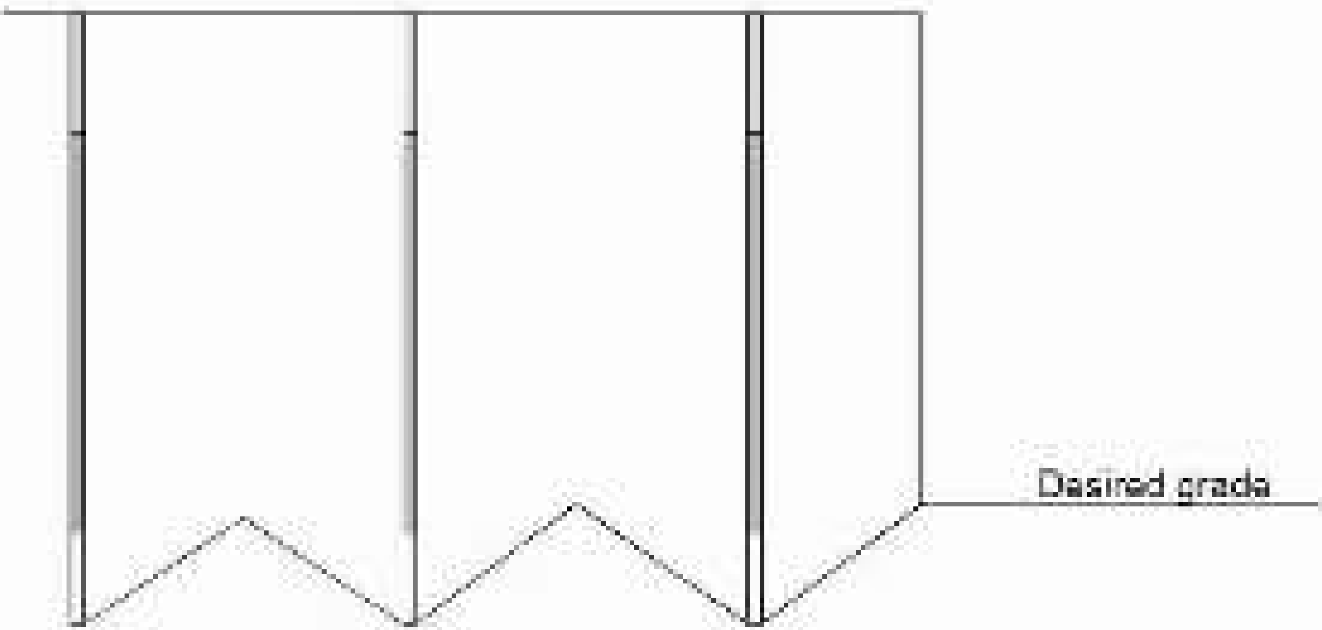


Stemming columns are generally 0.5 to 1.3 times the burden. A good first approximation for stemming column height is 0.7 x burden.

Blast Design

Subdrilling

"Subdrilling" is the distance drilled below the floor level (or actual required blast depth), in order to ensure that the full face of the rock is capable of being removed to the desired excavation limit. Subdrilling may be required to achieve a smooth pit floor. The subdrill portion of a borehole is generally backfilled with drill cuttings or other stemming material. ***DO NOT LOAD EXPLOSIVES INTO THE SUBDRILL!*** Excessive confinement will lead to high peak particle velocity ground vibrations.



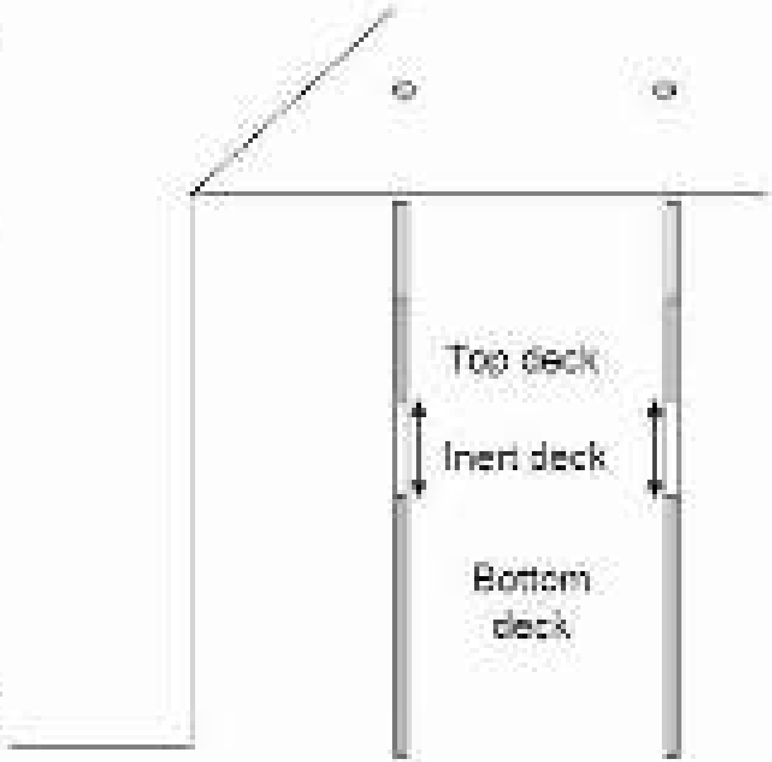
Blast Design

Decking

A process called "decking" is often used to reduce either the charge load per hole, the amount of explosives detonated per delay, or both. Decking is also used to get explosives into harder rock zones or to keep them out of weak zones such as mud seams.

Using the decking process, the top deck in a blasthole is normally shot one delay period after the bottom deck in the hole. The idea is to keep the explosives in the bottom deck from propagating through and detonating the top deck. To achieve this, an air deck or deck of inert stemming is inserted between the top and bottom decks. The length of the inert deck will vary depending upon borehole conditions. Increase the deck length in wet holes to reduce the chances of propagation between decks.*

There are many types of hole plugs commercially available for creating decked charges.



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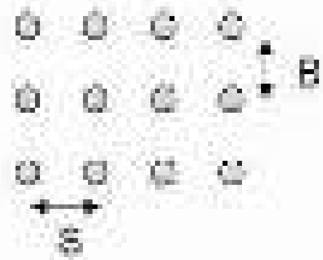
*The minimum stemming between explosive decks should be six times the borehole diameter, and, in wet holes, this amount should be doubled.

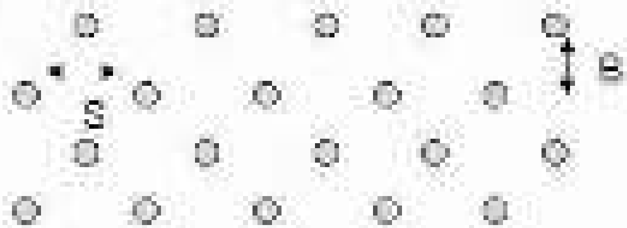
Blast Patterns

A **square blast pattern** has drilled spacings that are equal to drilled burdens.



A **rectangular blast pattern** has drilled spacings that are larger than drilled burdens.

In a **staggered blast pattern**, the drilled spacings of each row are offset such that the holes in one row are positioned in the middle of the spacings of the holes in the preceding row. In addition, the drilled spacings are larger than the drilled burdens.



A staggered blast pattern is used for row firing, where the holes in one row are fired before the holes in the row immediately behind them. The square and rectangular blast patterns are used for firing "V" (chevron) or echelon rounds.

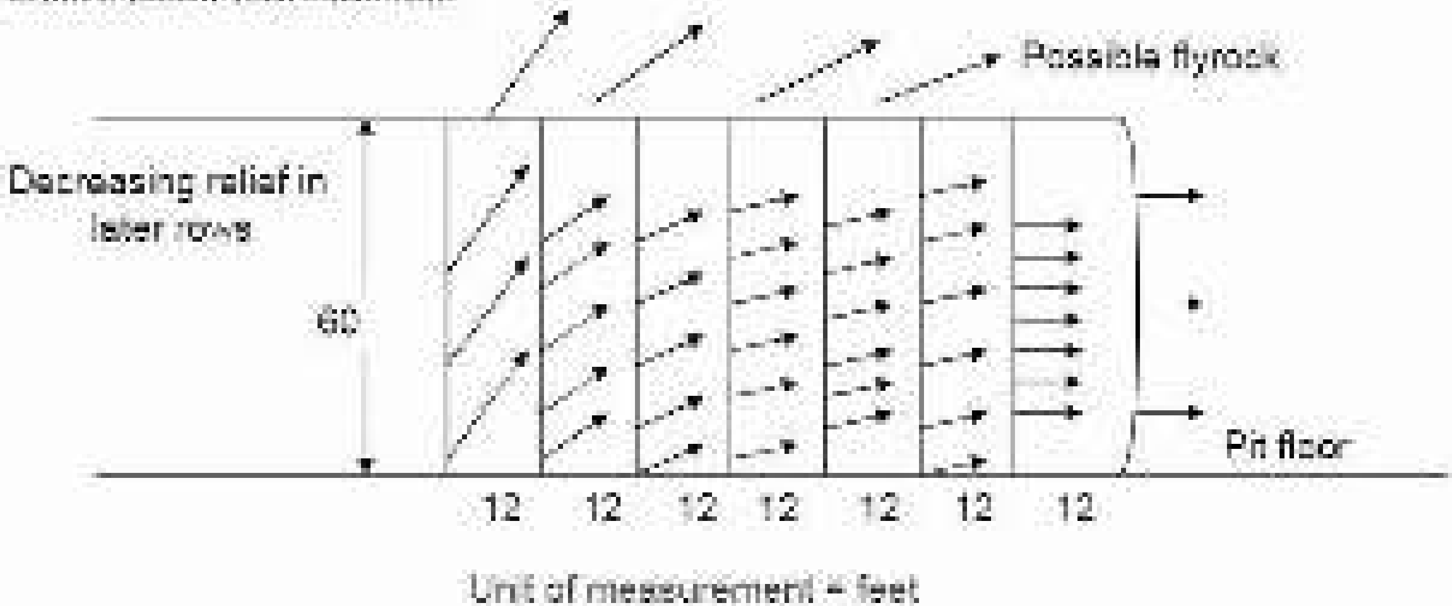
Millisecond Delay Blasting

The timing between holes in a row and between rows in a shot both (1) dictates the movement and fragmentation of the shot and (2) helps prevent cut-offs in the explosive column that are owing to shifting rock. Larger diameter holes on large burdens and spacings require greater delay time to ensure correct movement and to reduce the "dead-pressing" effects of adjacent boreholes (dead pressing can lead to the emission of nitrogen dioxides).

Rock fragmentation occurs within 5 to 15 milliseconds after detonation. The gas pressure created by a blast moves the rock out from the blast face at velocities of from 50 to 100 feet per second. This broken rock is only moving 0.5 to 1 foot in 10 milliseconds. The movement of rock is important with respect to designing a blast that obtains optimal fragmentation.

The general (conservative) rule of thumb is "2 milliseconds per foot of burden" for designing delay times required for maximum fragmentation.

As the number of rows increases, the low velocity of the moving rock causes a reduction in relief toward the free face, leading to more vertical rock movement.



Blast Design

High-Energy Bottom Charges

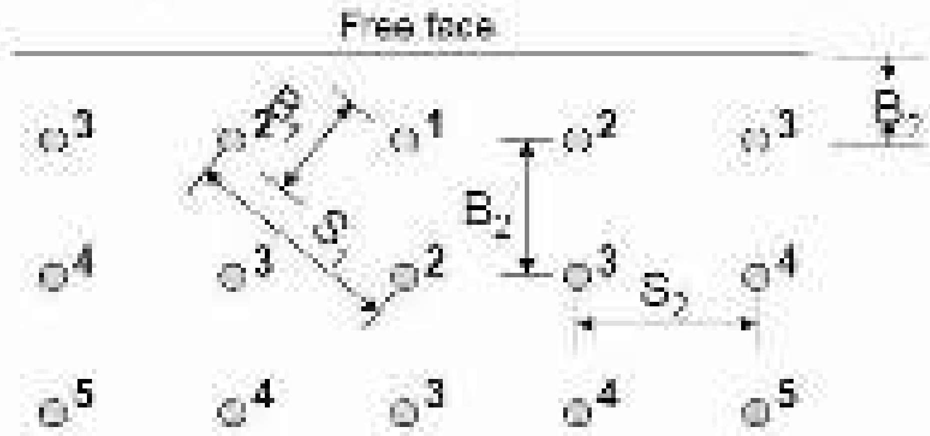
The rock at the bottom of a vertical hole requires more energy to break than does the rock at the top of the same hole. This is the primary reason why most blastholes are bottom-primed. High-density explosive charges may be added to the bottom of a hole to increase fragmentation at the toe or to improve the final pit-floor grade.

Click on the image above to play a quarry-shot blasting clip.

Blast Timing

A **"V"-pattern, or chevron, firing round** is appropriate for most square or rectangular blast patterns; it is not as practical for staggered-pattern loading.

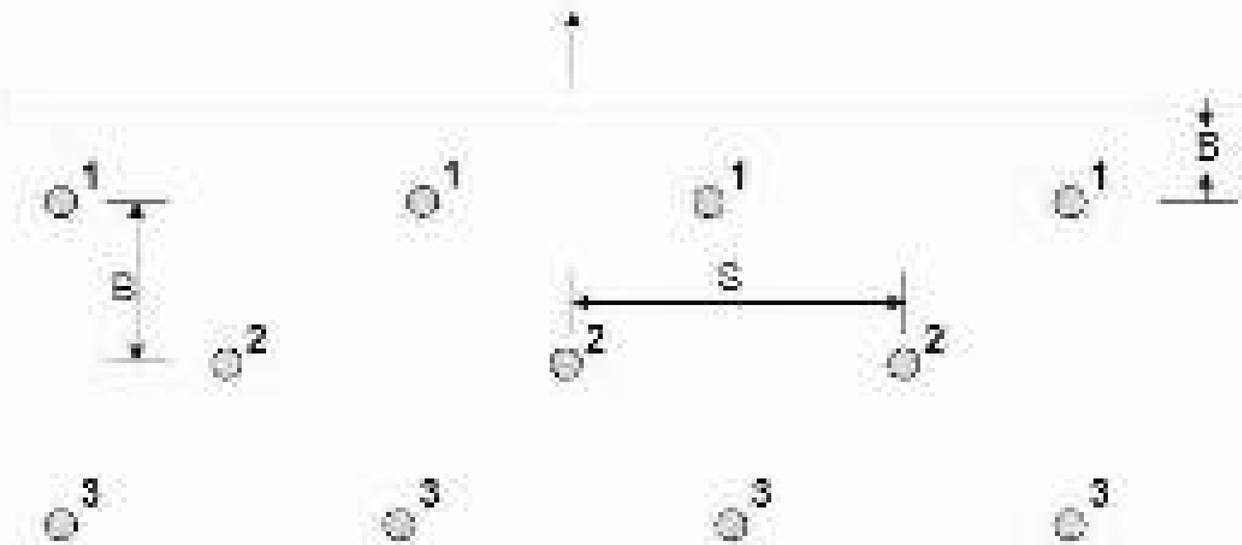
Under any square or rectangular blast scenario that uses a "V" pattern, actual burden and spacing (both of them dependent upon the timing of the shot) will be different from drilled, or apparent, burden and spacing. When a "V"-pattern firing round is used under a square-pattern loading scenario, the rock movement is 45 degrees to the open face. "V"-pattern firing rounds are quite common at surface coal mines that use larger diameter blastholes.



Numbers indicate firing sequence (B_1 = true burden; B_2 = apparent burden; S_1 = true spacing; S_2 = apperent spacing).

Under any "V"-pattern blast scenario, a distinction is made between "apparent burden" and "true burden," such that apparent burden is defined as both the distance between the shot's first row and the highwall or free face and the distance between all subsequent rows running parallel to the face. True burden, on the other hand, is defined as the distance between rows as these are delineated by the drill pattern and the delay timing associated with it. (Note as well that, as the example here shows, a comparable distinction is also made between "apparent spacing" and "true spacing.")

Blast Design



QUARRY, ROW-BY-ROW.

Numbers indicate firing sequence (S = true spacing; B = true burden).*

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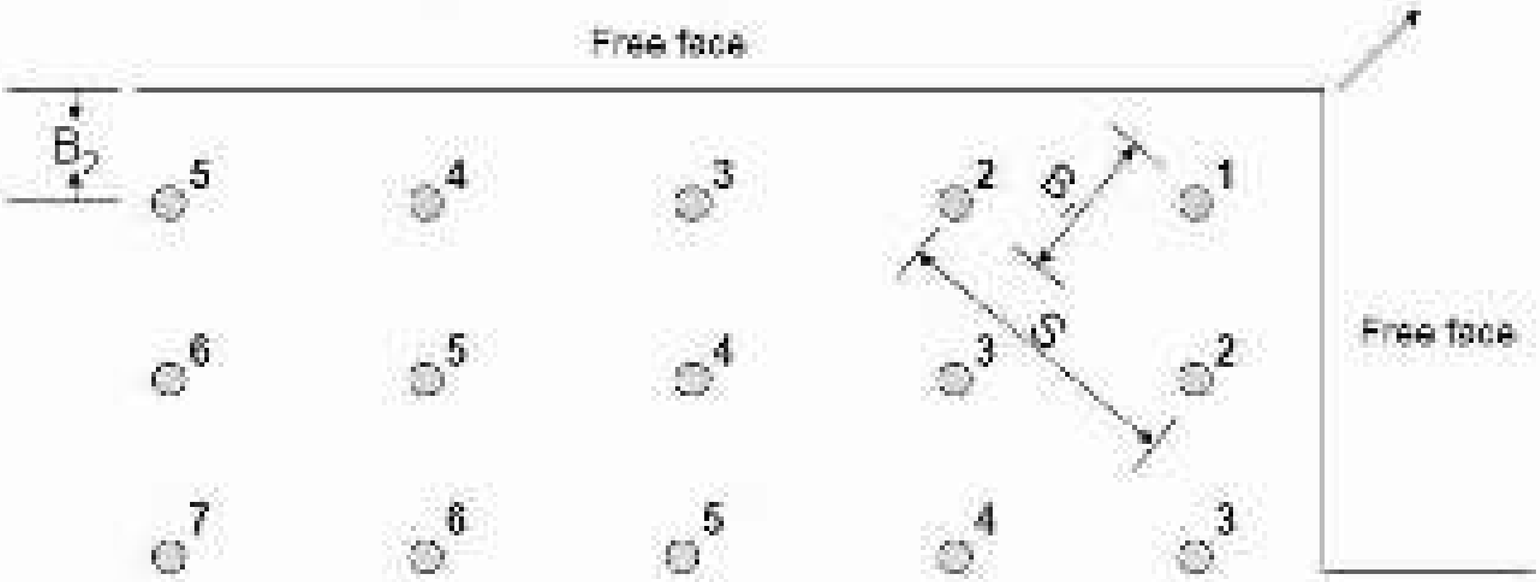
*Note that a quarry, row-by-row blast pattern is shot row by row, the rows shooting parallel to the highwall or free face; that is, the timing of the blast is not defined by a delay pattern (whether a "V," a chevron, or an echelon). Accordingly, there is no distinction in this type of shot between the "apparent burden" of the shot and its "true burden." There is only the "burden" of the shot, which is defined as both the distance between the shot's first row and the highwall or free face and the distance between all subsequent rows running parallel to the face.

Blast Timing

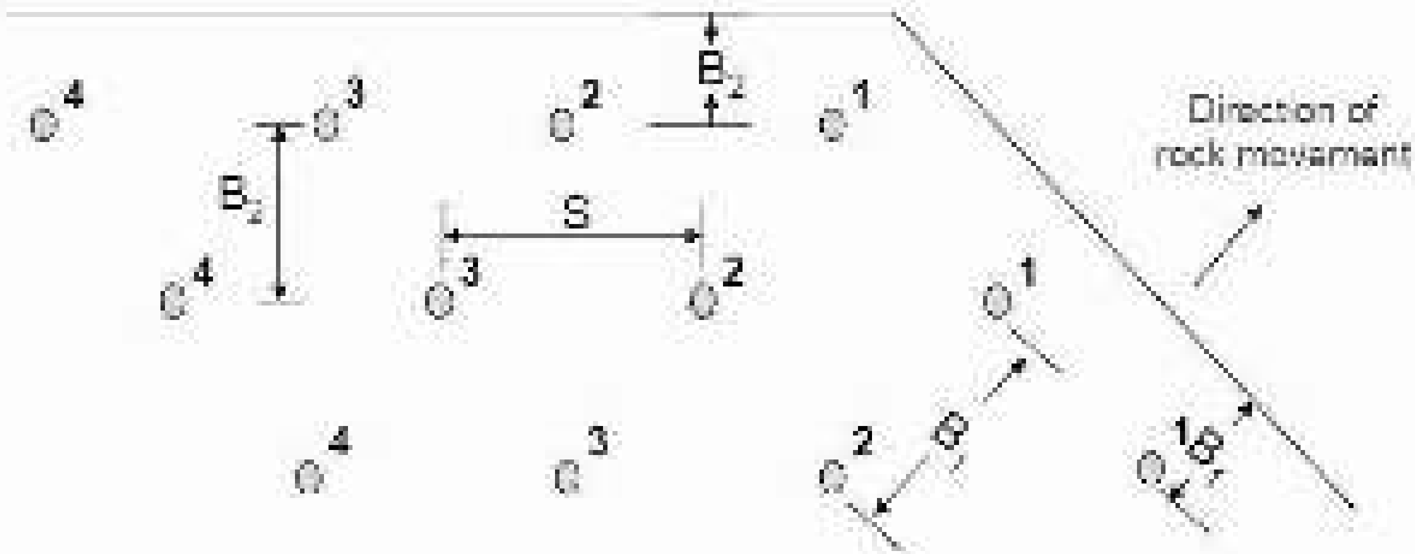
Echelon patterns are normally designed to take advantage of two free faces; they are typically used in large overburden shots (that is, in blastholes with diameters greater than 8 inches), casting operations, and interburden shooting.



Numbers indicate firing sequence (B_1 = true burden; B_2 = apparent burden).*

*Under any echelon-pattern blast scenario, a distinction is made between "apparent burden" and "true burden." (See footnote regarding "V-"pattern blast scenarios.)

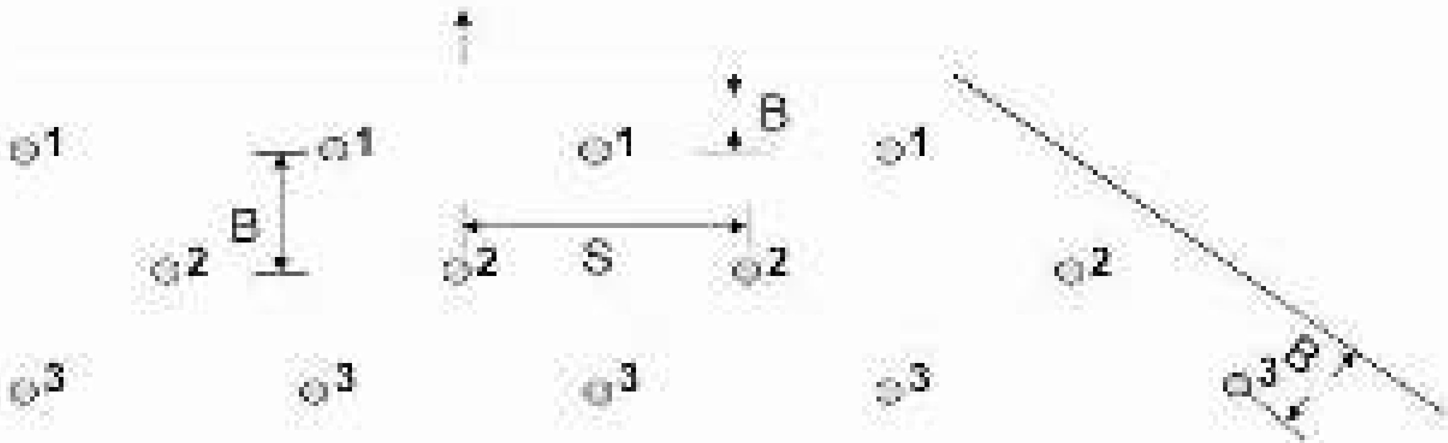
Blast Design



CORNER CUT, STAGGERED PATTERN, ECHELON.

Numbers indicate firing sequence
(S = true spacing; B_1 = true burden; B_2 = apparent burden).

Blast Design



CORNER CUT, ROW-BY-ROW.

Numbers indicate firing sequence
(S = true spacing; B = true burden).

Review Questions and Discussion

1. Why should you avoid loading explosives into a subdrill?
    a. Excessive confinement will lead to high peak particle velocity ground vibrations
    b. Over-confinement could generate toxic fumes
    c. Loading the subdrill could result in poor highwall stability
    d. All of the above

2. How does increasing the fragmentation of blasted rock decrease downstream costs related to it?
    a. Increased fragmentation reduces shovel digging time
    b. Increased fragmentation reduces the wear on haul equipment
    c. Increased fragmentation increases the crushed throughput
    d. All of the above

3. What is a way to reduce the explosive energy adjacent to a highwall on a production blast to ensure the integrity of the highwall?
    a. Reduce the total shot time, thereby reducing the amount of time the highwall is subjected to vibrations
    b. Use a controlled blasting technique (for example, pre-splitting)
    c. Drill on an angle to keep the explosive energy away from the toe

4. What is the purpose of using a decked charge?
    a. To lower the powder factor
    b. To reduce the amount of explosives detonated per delay
    c. To avoid loading a week seam or to bypass a void in the rock
    d. All of the above

Review Questions and Discussion—continued

5. What are some general rules for designing the stemming for blastholes?
   a. Use crushed stone or drill cuttings as the stemming material
   b. Stem at a ratio of from 0.5 to 1.3 times the amount of burden
   c. Design stemming so that it contains explosive energy without generating flyrock
   d. All of the above

6. What is the most important objective(s) of any blasting program?
   a. Fragmentation
   b. Lowering costs
   c. Ensuring the safety of all workers in and around the blast site
   d. a and c

Answers

1. a. is correct
2. d. is correct
3. b. is correct
4. d. is correct
5. d. is correct
6. d. is correct

Glossary

Atama- Термин- Terms	Atamaning o'zbek tilidagi izohi	Комментарии на русском языке	Комментарии на английском языке
Ankerlash- Анкерирование- Bolting	Kon lahimlarini ankerlar bilan mustahkamlash bilan bog'liq bo'lgan ishlar	Работы по креплению горных выработок анкерной крепью, включающие бурение скважин, установку анкеров, опорных шайб и подхватов	drilling a hole and inserting a bolt to strengthen the ceiling and walls of an underground mine
Maydalagich- Дробилка- Crusher	Yirik mineral bo'laklarni maydalash uchun ishlatiladigan mashina	Аппарат, в котором осуществляется дробление крупных кусков минерального сырья	a machine used to crush ore before it is transported
Shtrek Штрек- Drift	Foydali qazilma yo'nalishi bo'yicha o'tilgan yer yuzasiga chiqmaydigan gorizontal kon lahimi	Горизонтальная подземная горная выработка, проведенная по простиранию пласта, залегающего наклонно или при любом направлении при горизонтальном его залегании	a horizontal underground tunnel that follows a vein or ore body
Burg'ilash va portlatish ishlari Буровзрывные работы Drilling and blasting	Mustahkam tog' jinslarida foydali qazilmani qazib olish, kon lahimlari va inshootlarini o'tish uchun burg'ilangan shpur va skvajinalarni portlatish ishlari majmuasi	Совокупность взаимосвязанных и последовательных в цикле бурения шпуров и скважин при добывании полезных ископаемых, проведении горных выработок, строительных сооружений в крепких горных породах	the process of using a drill to create long narrow cylindrical holes in the rock, and filling these holes with explosives which are then detonated to fragment the rock
Burg'ilash dastgohi Буровой станок Jumbo	Yer osti kon ishlari va geologiya qidiruv ishlarida skvajinalarni burg'ilash uchun mo'ljallangan mashina	Машина предназначенная для бурения скважин на открытых, подземных и геологоразведочных работах	a drill which is capable of drilling more than one hole at a time and is especially useful in preparation for blasting
Karyer avtosamosvali- Автосамосвал карьерный – Load Haul Dump	Ag'darma kuzovga ega bo'lgan kuchaytirilgan karyer yuk avtomashinasi	Грузовой автомобиль с усиленным кузовом, опрокидывающимся	a vehicle with a large bucket on the front used for transporting ore to crushing stations and

		для разгрузки при помощи гидравлических питателей.	mucking
Ma'dan- Минерал- Mineral	Fizik va ximik xususiyatlariga tarkibiga ko'ra bir xil tarkibga ega sodda va murakkab jismlar	Простое либо сложное природное тело, приблизительно однородное по химическому составу и физическим свойствам	naturally occurring chemical compound with a unique three dimensional crystalline structure and chemical composition, component of rocks
Massivdan ajratilgan ruda- Отбитая руда(порода)- Muck	Tabiiy kon ta'sirida foydali qazilma massivdan bir vaqtning o'zida maydalash yo'li bilan massivdan ajratilgan ruda	Отделенная часть полезного ископаемого(породы) от массива посредством приложения внешней силы с одновременным дроблением его для перемещения по горным выработкам	waste rock that has been broken by blasting
Ruda tanasi- Рудное тело- Orebody	Tarkibida foydali komponent bo'lgan tog' jinslari yoki mineral birikmalar	Горные породы или минеральные образования с содержанием полезных компонентов, обеспечивающих экономическую целесообразность их извлечения при современном состоянии техники	a naturally occurring concentration of minerals that can be mined at a profit
Ruda tushirgich- Рудоспуск- Ore pass	Rudani o'z og'irlik kuchi bilan quyi gorizontlarga tushirish uchun mo'ljallangan kichik yoxud vertikal yoki qiya kon lahmi	Небольшой площади сечения вертикальная или наклонная горная выработка или часть выработанного пространства, ограниченная крепью и предназначенная для перепуска руды под действием собственной массы	Vertical or near vertical opening through which bulk material flows by gravity
Selik- Целик- Pillar	Qazib olish ishlari vaqtida kon jinsi qazib olinmay qoldirilgan foydali qazilmaning bir qismi	Часть полезного ископаемого, не извлеченная или временно не извлекаемая в процессе разработки	the columns of rock that are left to support the ceiling in room and pillar mining
Vosstayushiy-	Foydali qazilma konida	Вертикальная или	a vertical or inclined

Восстающий-Raise	bo'yicha o'tkazilgan vertikal yoki qiya kon lahmi	наклонная горная выработка, проводимая по восстанию залежи	opening from one level of a mine that is driven toward the level above
Skip-Скип-Skip	Foydali qazilma yoki tog' jinslarini yuqoriga ko'tarish uchun mo'ljallangan idish	Сосуды предназначенные для подъема полезного ископаемого и породы	a self-dumping bucket used in a shaft for hoisting ore or rock.
Chiqindi-Хвосты-Tailings	Foydali qazilmani boyitish va qayta ishlash natijasida tarkibidan foydali komponent ajratib olingan mahsulot	Получаемый в результате обогащения продукт, в котором содержание ценного компонента ниже чем в исходном материале и в других продуктах тех же операций переработки	materials rejected from a mill after the recoverable valuable minerals have been extracted.
Shtolnya-Штольня-Adit	Yer yuzasiga chiqadigan gorizontal uchastka kon lahmi	Горная выработка, проведенная в месторождении горизонтально или с незначительным подъемом, имеющая непосредственный выход на земную поверхность; предназначенная для обслуживания подземных горных работ.	Main horizontal or near-horizontal underground opening, with single access to the surface
Voronka-Воронка выпуска-Bell	Kesik konus shaklidagi chiqarish teshigining kengaygan qismi	Расширенная часть выпускного отверстия, имеющая форму усеченного конуса.	Funnel-shaped excavation formed at the top of a raise to move bulk material by gravity from a stope to a drawpoint.
Ko'mir tushirgich-Углеспуск-Chute	Ko'mirni o'z og'irlik kuchi bilan quyi gorizontlarga tushirish uchun mo'ljallangan kichik yuzali vertikal yoki qiya kon lahmi	Небольшой площади сечения вертикальная или наклонная горная выработка или часть выработанного пространства, ограниченная крепью и предназначенная для перепуска отбитого угля под действием собственной массы.	Opening from a drawpoint, utilizing gravity flow to direct bulk material from a bell or stope to load a conveyance
Kvershlag-Квершлаг-Crosscut	Yer yuzasi bilan bevosita tutashmaydigan, ruda tanasi yo'nalishiga [illegible]	Горизонтальная [illegible] (рудн.) [illegible]	Tertiary horizontal opening, often connecting drifts and/or

	burchak ostida o'tilgan gorizontal kon lahimi	вскрывающая горная выработка, не имеющая выхода на земную поверхность, проведенная по вмещающим породам под углом к простиранию месторождения	or course, oriented perpendicularly to the strike of a pitching deposit, also *breakthrough*
Uklon Уклон **Decline**	Yer yuzasi bilan bevosita tutashmaydigan va foydali qazilmani yuqori gorizontdan chiqarib tashlash uchun mo'ljallangan qiya kon lahimi	Подземная наклонная выработка, не имеющая непосредственного выхода на поверхность и предназначенная для спуска полезного ископаемого	Secondary inclined opening, driven downward to connect levels, sometimes on the dip of a deposit; also *inclined shaft*
Chiqarish duchkasi- Выпускная дучка- **Drawpoint**	Kvadrat yoki aylana shaklga ega bo'lgan va maxsus ajratilgan rudani qabul qilish gorizontiga chiqarib berish uchun mo'ljallangan vertikal yoki qiya kon lahimi	Короткая вертикальная или наклонная выработка квадратного или круглого сечения, служащая для выпуска отбитой или обрушенной руды из очистного пространства на выработки приемного горизонта.	Loading point beneath a stope utilizing gravity to move bulk material downward and into a conveyance, by a chute or loading machine, also *Drawhole*
G'alvir- Грохот- Grizzly	G'alvirlash ishlarini bajarish uchun mo'ljallangan uskuna.	Аппарат для выполнения операции грохочения	Coarse screening or scalping device that prevents oversized bulk material from entering a material transfer system, constructed of rails, bars, beams, etc.
Tashish shtreki- **Откаточный штрек-** **Haulageway**	Foydali qazilma yoki tog' jinslari tashiladigan shtrek	Штрек, по которому транспортируется полезное ископаемое.	Horizontal opening used primarily for materials handling
Bremsberg- **Бремсберг-** **Incline**	Yer yuzasi bilan bevosita tutashmaydigan va foydali qazilmani yuqori gorizontdan pastki gorizontga chiqarib berish uchun mo'ljallangan qiya kon lahimi	Подземная наклонная горная выработка, не имеющая выхода на земную поверхность, проведенная по простиранию по падению пласта или залежи и предназначенная для спуска полезного ископаемого на транспортный горизонт также или	Secondary inclined opening, driven upward to connect levels, sometimes on the dip of a deposit, also *inclined shaft*

		пласта	
Maydon shtreki- Полевой штрек- Lateral	Atrof tog' jinslaridan o'tilgan shtrek	Штрек, проводимый во вмещающих породах	Secondary or tertiary horizontal opening, often parallel to or at an angle to a haulageway, usually to provide ventilation or some auxiliary service
Qavat- Этаж- Level	Shaxta maydoni chegarasida yuqori qismi shamollatish shtreki va pastki qismi tashish shtreki bilan chegaralangan shaxta maydonining bir qismi	Часть шахтного поля, ограниченная по падению откаточным и вентиляционным штреками, по простиранию- границами шахтного поля	System of horizontal openings connected to a shaft; comprises an operating horizon of a mine.
Lava- Лава- Longwall	Bir tomoni qulatilgan tog' jinslari va ikkinchi tomoni esa foydali qazilmadan iborat uzun qazib olish kon lahimi	Подземная очистная выработка большой протяженности, одна бок которой образована массивом полезного ископаемого, а другой – обрушенными породами	Horizontal exploitation opening several hundred feet (meters) in length, usually in a tabular deposit.
Tuynuk- Лаз- Manway	Lahimlarning seksiyalardagi o'tish qismlari bir qavatga o'tishdagi odam mo'ljallangan kon o'tkazuvchi tuynuk	Отверстие, которое служит для перехода рабочих с одного этажа на другой	Compartment of a raise or a vertical or near-vertical opening intended for personnel travel between two levels.
Og'iz qismi- Устье- Portal	Kon lahimlarining yer yuzasi yoki boshqa kon lahimlari bilan tutashgan qismi	Место примыкания подземной выработки к поверхности или к другой выработке	Opening or connection to the surface from an underground excavation.
Qiya transport s'ezdi- Наклонный транспортный съезд- Ramp	Spiral shaklga ega bo'lgan harakat foydali qazilma va atrof tog' jinslarini avtomobil yordamida tashish uchun mo'ljallangan qiya kon lahimi	Вспомогательная наклонная горная выработка, имеющая спиральную форму и предназначенная для транспортировки полезного ископаемого и также горных пород автосамосвалами	Secondary or tertiary inclined opening, driven to connect levels, usually in a downward direction, and used for haulage.
Kamera- Камера- Room	Yon tomonidan foydali qazilma yoki atrof tog' jinslari bilan o'ralgan kichik uzunlikdagi (5-10 m) qazib olish lahimi	Очистная выработка с забоем небольшой длины (5-10 м), ограниченная по бокам массивом или целиками полезного ископаемого	Horizontal exploitation opening, usually in a bedded deposit.
Vertikal stvol	Vertikal [illegible]	Вертикальная горная	Primary vertical or near-

Вертикальный ствол- Shaft	[illegible] kon lahimi	выработка, проведенная в вертикальном направлении	vertical opening connecting the surface with underground workings, also vertical shaft
Qazib olish kon joyi- Очистной забой- Stope	Foydali qazilma bevosita qazib olinadigan foydali qazilmalar yoki asosiy kon jinslarining qazib olinadigan yuzasi.	Перемещающаяся в пространстве поверхность полезного ископаемого или вмещающих его пород, с которой непосредственно осуществляется их выемка	Large exploitation opening, usually inclined or vertical, but may also be horizontal
Qavatcha- Подэтаж- Sublevel	Bir necha qavatlarda material tayyorlash va qazuvchi kon lahimlarini [illegible] qismi	Часть этажа с самостоятельным комплексом подготовительных, нарезных и очистных выработок, отрабатываемая по падению группы [illegible] (ортами)	Secondary or intermediate level between main levels or horizons, usually close to the exploitation area
Tunnel- Туннель- Tunnel	Chuqur karyerlarning [illegible] tashqi tomon chiqadigan kon [illegible] temir yo'l, avtomobil va konveyer transporti yordamida tashish uchun mo'ljallangan qiya kon lahimi	Наклонная подземная горная выработка, служащая для вскрытия рабочих горизонтов глубоких карьеров и перевозки горной массы железнодорожным, автомобильным или конвейерным транспортом.	Main horizontal or near-horizontal opening, with access to the surface at both ends
Pastki o'yiq Нижний вруб Undercut	Bir necha qator skvajina yordamida kon lahimi ostini qazish shaklida o'yiq	Вруб, образуемый проходкой нижних штреков, [illegible] очистной выработки	Low horizontal opening excavated under a portion of a deposit, usually a stope, to induce breakage and caving of the deposit. Also a narrow slot cut in the face of a massive deposit to facilitate breakage
Gezenk- Гезенк- Winze	Er yuzasi bilan bevosita tutashmaydigan va foydali qazilma yoki tog' jinslarini pastdan yuqoriga o'z og'irligi bilan yoki mexanik vositalar yordamida [illegible]	Вертикальная выработка, не имеющая непосредственного выхода на поверхность и	Secondary or tertiary vertical or near-vertical opening, driven downward from one level to another

	[illegible]	предназначенные для [illegible] способом	