BLAST DESIGN FORMULAS

HOW TO READ FORMULAS

FORMULA NAME

FORMULA

VARIABLES and [UNITS]

Variables used in formula and required units in [brackets]. If input variables are not in required units, then you must use the unit conversion tables.

Absolute Bulk Strength (ABS)

$$ABS_E = AWS_E \times d_E$$

VARIABLES and [UNITS]

ABS_E = Absolute bulk strength of the explosive [cal/cc]

AWS_E = Absolute weight strength of the explosive [cal/g]

d_E = Density of the explosive [g/cm^3]

Absolute Weight Strength (AWS)

$$AWS_E = \frac{RBS_E \times 7.462}{d_E}$$

VARIABLES and [UNITS]

AWS_E = Absolute weight strength of the explosive [cal/g]

RBS_E = Relative bulk strength of the explosive [ANFO = 100]

d_E = Density of the explosive [g/cm^3]

Base-Charge Length Formula

$$E_b = [(0.3 \rightarrow 0.5) \times B] + J$$

VARIABLES and [UNITS]

E_b = Length of base charge of high density explosives [ft]

B = Average burden [ft]

J = Sub-drilling depth [ft]

Acutual Scaled Distance Formula

Actual Scaled Distance

$$SD = \frac{D}{\sqrt{W}}$$

Maximum Charge Weight per Delay

$$W = \left(\frac{D}{SD}\right)^2$$

Minimum Distance

$$D = SD \times \sqrt{W}$$

VARIABLES and [UNITS]

SD = Scaled distance factor

W = Charge weight per delay [lb]

D = Distance [ft]

Burden Formula

$$B = D_e \times \left(2 \times \left[\frac{d_e}{d_r} \right] + 1.5 \right)$$

VARIABLES and [UNITS]

B = Burden [ft]
d_e = Density of the explosives [g/cm^3]
d_r = Density of the rock [g/cm^3]
D_e = Diameter of fully coupled explosive column [in]

Deck Stemming Formula

For Dry Holes $T_d = 0.5 \times D$

For Wet Holes $T_d = 1.0 \times D$

VARIABLES and [UNITS]

T_d = Minimum length of stone deck consisting of particles of size T_s [ft]
D = Blast-hole diameter [in]

Face Height Formula

$$H = (5 \rightarrow 10) \times D$$

VARIABLES and [UNITS]

H = Face Height [ft]
D = Blast-hole Diameter [in]

Hole-to-Hole Delay Time Formula

$$D_{hth} = \underset{ms/ft}{(0 \rightarrow 5)} \times S$$

VARIABLES and [UNITS]

D_{hth} = Delay time between holes in a row [ms]
S = Spacing between holes in a row [ft]

Hole-to-Hole Delay Times to Improve Fragmentation

Rock Type	*ms/ft*
Sands, Loams, Marls and Coals	1.8 - 2.1
Some Limestones, Rock Shale and some Shales	1.5 - 1.8
Compact Limestones and Marbles, some Granites and Basalts, Quartzite Rocks and some Gneisses and Gabbros	1.2 - 1.5
Diabase, Diabase Porphyrites, Compact Gneisses, and Mica Schists and Magnetites	0.9 - 1.2

Leading underground mining technology.

Loading Density Formula

$$d_l = 0.3404 \times D_e^{\,2} \times d_e$$

VARIABLES and [UNITS]

d_l = Explosives loading density [lb/ft]
D_e = Diameter of explosives column [in]
d_e = Density of explosives [g/cm^3]

Loading a blast on an iron ore range.

Maximum Charge Weight per Delay

$$W = \left(\frac{D}{SD}\right)^2$$

VARIABLES and [UNITS]

SD = Scaled distance factor
W = Charge weight per delay [lb]
D = Distance [ft]

Minimum Distance Formula

$$D = SD \times \sqrt{W}$$

VARIABLES and [UNITS]

SD = Scaled distance factor
W = Charge weight per delay [lb]
D = Distance [ft]

Powder Factor Formula

Volume of Rock

$$PF = \frac{W_e}{V}$$

VARIABLES and [UNITS]

PF = Powder factor [lb/yd^3]
W_e = Total weight of explosives used in blast [lb]
V = Total volume of rock generated in blast [yd^3]

Weight of Rock

$$PF = \frac{W_r}{W_e}$$

VARIABLES and [UNITS]

PF = Powder factor [t/lb]
W_r = Total weight of rock generated in blast [t]
W_e = Total weight of explosives used in blast [lb]

Pre-Splitting Formulas for Air-Decked Charges

Spacing of Air-Decked Charges

$$S = (1.5 \rightarrow 2.0) \times D$$

VARIABLES and [UNITS]

S = Spacing between air-decked holes [ft]
D = Diameter of blast-hole [in]

Weight of Air-Decked Charges

$$W = (0.08 \rightarrow 0.12) \times S \times L_h$$

VARIABLES and [UNITS]

W = Weight of air-deck charge [lb]
S = Spacing between blast-holes [ft]
L_h = Length of blast-hole [ft]

Stemming Column Length

$$T = (1.0 \rightarrow 1.2) \times D$$

VARIABLES and [UNITS]

T = Stemming column length [ft]
D = Diameter of blast-hole [in]

Pre-Splitting Formulas for De-Coupled Charges

Linear Charge Weight

$$W_l = \frac{D^2}{28}$$

VARIABLES and [UNITS]

W_l = Linear charge weight for pre-splitting explosive [lb/ft]
D = Diameter of blast-hole [in]

Spacing between Pre-Split Holes

$$S = \frac{D^2}{2.8}$$

VARIABLES and [UNITS]

S = Spacing between pre-split holes [ft]
D = Diameter of blast-hole [in]

Pressure Formula

$$P = 0.000000233 \times VOD^2 \times d_E$$

VARIABLES and [UNITS]

P = Pressure [kbar]
VOD = Velocity of detonation of explosive [ft/sec]
d_E = Density of explosive [g/cm^3]

Relative Weight Strength (RWS)

$$RWS_E = \frac{AWS_E}{91{,}000}$$

VARIABLES and [UNITS]

RWS_E = Relative weight strength of the explosive [ANFO = 100]

AWS_E = Absolute weight strength of the explosive [cal/g]

Resistance Formulas

For Parallel Circuits

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_n}$$

For Series Circuits

$$R_{total} = R_1 + R_2 + R_3 + \ldots + R_n$$

VARIABLES and [UNITS]

R_{total} = Total resistance of the electrical circuit [Ω]

$R_1 \ldots R_n$ = Resistance of individual blasting caps or circuit branches [Ω]

Bulk trucks preparing for another day on the job.

Row-to-Row Delay Time Formula

$$D_{rtr} = (2 \rightarrow 15) \times B \quad \text{ms/ft}$$

VARIABLES and [UNITS]

D_{rtr} = Delay time between consecutive rows [ms]

B = Maximum burden in front of a row of holes [ft]

Effects of Various Row-to-Row Delays

Effects	*ms/ft*
Violent excessive air-blast and back-break	2
High pile close to face, moderate air-blast and back-break	2 - 3
Average pile height, average air-blast and back-break	3 - 4
Scattered pile with minimum back-break	4 - 6

Stone Stemming Particle Size Formula

$$T_s = \frac{D}{12 \rightarrow 20}$$

VARIABLES and [UNITS]

T_s = Clean crushed stone stemming particle size [in]

D = Blast-hole diameter [in]

Sub-Drilling Formula

$$J = (0.2 \rightarrow 0.5) \times B$$

VARIABLES and [UNITS]

B = Burden [ft]
J = Sub-drilling [ft]

Industry's leading Detonating Cord

"Supersonic" Face Velocity Formula

$$D_{min} = \frac{S}{1.127}$$

VARIABLES and [UNITS]

D_{min} = In order to avoid air-blast from "supersonic" lateral face velocity, the delay between holes must be more than D_{min} [ms]
S = Spacing between blast holes [ft]

Spacing Formulas

	If: $\frac{H}{B} \geq 4$	*If:* $\frac{H}{B} < 4$
Instant	$S = 2.0 \times B$	$S = \frac{H + (2 \times B)}{3}$
Delayed	$S = 1.4 \times B$	$S = \frac{H + (7 \times B)}{8}$

VARIABLES and [UNITS]

H = Face height [ft]
B = Burden [ft]
S = Blast-hole spacing [ft]

Top Stemming Length Formula

$$T = (0.7 \rightarrow 1.3) \times B$$

VARIABLES and [UNITS]

B = Burden [ft]
T = Top stemming length [ft]

Water Displacement Formula

$$C = \frac{L_w \div L_c}{1 - \left(\frac{D_c}{D_h}\right)^2}$$

VARIABLES and [UNITS]

C = Number of explosives cartridges required to rise above standing water
L_w = Length of the standing water column [ft]
L_c = Length of one explosives cartridge [ft]
D_c = Diameter of explosives cartridges [in]
D_h = Diameter of blast-hole [in]

HEET Truck on display at an open house in 2001

Weight of Rock per Blast Hole Formula

$$W = V \times d_r$$

VARIABLES and [UNITS]

W = Weight of rock generated per blast-hole [t]
V = Bank volume of rock generated per blast-hole [yd^3]
d_r = Bank density of rock [t/yd^3]

Vibration Level Predictation Formulas

Peak Particle Velocity Prediction

$$PPV = K \times SD^{-1.6}$$

VARIABLES and [UNITS]

PPV = Peak particle velocity [in/s]
K = Ground transmission constant [K=160 if no other seismic data is available]
SD = Scaled distance factor

Site Specific Ground Transmission Constant

$$K = PPV \times SD^{1.6}$$

VARIABLES and [UNITS]

K = Ground transmission constant
PPV = Peak particle velocity [in/s]
SD = Scaled distance factor

Volume of Rock per Blast Hole Formula

$$V = \frac{B \times S \times H}{27}$$

VARIABLES and [UNITS]

V = Bank volume of rock per blast-hole [yd^3]
B = Burden [ft]
S = Spacing [ft]
H = Face height [ft]