FDTAS D&B QUICK REFERENCE 002

STEMMING:

KEEP THE ENERGY IN THE HOLE

Stemming & Confinement

A practical guide to stemming length, material selection and confinement in surface bench blasting.

Stemming is the inert material placed in the collar of a charged blasthole. Its job is to provide confinement long enough for the explosive gases to do useful work on the surrounding rock rather than vent prematurely through the collar. Stemming length, material type, particle size, placement and the condition of the collar all influence performance.

$$T \approx 0.7 \times B$$

A commonly cited first approximation for collar stemming in surface blasting. T = stemming length; B = burden.

IMPORTANT

0.7 × burden is a starting check, not a universal design rule. Research shows that stemming performance depends on explosive loading, hole diameter, rock mass, stemming material and the required balance between fragmentation and containment.

1. What good stemming is trying to achieve

- Delay premature escape of high-pressure detonation gases from the collar.
- Improve utilisation of explosive energy within the rock mass.
- Reduce the likelihood and severity of stemming ejection, collar violence and gas venting.
- Support acceptable fragmentation through the upper part of the bench.
- Help manage airblast and flyrock risk as part of the complete blast design.

FDTAS FIELD NOTE

Stemming is not simply the uncharged section above the explosive. It is an important part of blast confinement. Too little stemming can allow premature gas venting and stemming ejection, while excessive stemming can reduce explosive energy in the upper section of the bench and contribute to coarse fragmentation.

2. Stemming length - the trade-off

Condition	Likely consequence	What to review
Stemming too short	Premature ejection or gas venting; increased collar violence, airblast/flyrock potential; inefficient gas confinement.	Burden, collar condition, explosive energy, stemming material/size, initiation position.
Stemming too long	Reduced explosive column and increased risk of coarse fragmentation or boulders in the collar zone.	Upper-bench geology, burden, charge distribution, deck/column configuration, fragmentation requirement.
Stemming poorly placed	Voids, bridging or inconsistent confinement can make nominal stemming length misleading.	Material flow, moisture, collar condition and placement method.
Variable collar geology	A single stemming length may not perform consistently across the blast.	Weathering, joints, cavities, weak seams and local burden.

3. What the research tells us

There is no single optimum stemming ratio for every bench blast. Published field and experimental studies report different optima because rock mass, explosive, hole geometry and stemming material differ. A 2024 large-scale study reported an optimum stemming-to-burden ratio near 0.67 for its test conditions, while older field guidance has commonly used about 0.7 × burden as a first approximation.

$$T / B \approx 0.67 - 0.70$$

Useful as a preliminary comparison only; verify against site conditions and measured blast performance.

Other studies express stemming relative to blasthole length or charge diameter. This variation is itself useful: it is a reminder that stemming should be calibrated to the actual blast rather than selected from one universal number.

EVIDENCE CHECK

A limestone quarry study using 89 mm holes found that increasing drill-cuttings stemming from 3.0 m to 4.5 m increased the proportion of +70 cm fragments. Longer stemming therefore does not automatically mean better blasting.

4. Stemming particle size

Stemming effectiveness depends on particle size as well as stemming length. Angular, clean crushed rock with limited fines can interlock against the blasthole wall and resist ejection more effectively than very fine drill cuttings.

$$d_s \approx D / 10 \text{ to } D / 20$$

Practical rule-of-thumb range for angular crushed stemming. d_s = stemming particle size; D = blasthole diameter.

This corresponds to approximately 5-10% of blasthole diameter. Different recognised references use different points within this range: USACE guidance gives D/20 (5%), while Dyno Nobel's current surface-blasting guide gives D/10 to D/20 for angular material with minimum fines.

Hole Ø (mm)	D/20 (5%)	D/15 (~6.7%)	D/10 (10%)
89	4.5 mm	5.9 mm	8.9 mm
102	5.1 mm	6.8 mm	10.2 mm
115	5.8 mm	7.7 mm	11.5 mm
127	6.3 mm	8.5 mm	12.7 mm
140	7.0 mm	9.3 mm	14.0 mm
165	8.2 mm	11.0 mm	16.5 mm
203	10.2 mm	13.5 mm	20.3 mm

Worked example - 140 mm blasthole

For a 140 mm blasthole, the practical D/20 to D/10 range is approximately 7-14 mm. The selected product should be angular, consistently graded and compatible with site loading procedures; avoid treating the upper end of the range as a universal optimum.

FDTAS FIELD NOTE

Very fine material can be easily ejected, while excessively coarse material may bridge during loading. Particle shape matters as well: angular crushed rock generally provides better interlock than rounded gravel.

5. Stemming material matters

Material / condition	Practical observation	Consideration
Sized crushed rock / angular aggregate	Generally provides stronger mechanical interlock and resistance to ejection than loose fines.	Requires suitable material and handling.
Drill cuttings	Common, convenient and low cost.	Particle size, moisture and fines content can vary; performance may be inconsistent.
Wet / muddy cuttings	May bridge, compact unevenly or create placement problems.	Check actual collar condition rather than assuming the measured length is fully effective.
Specialised stemming products	Can improve retention in selected applications.	Must be evaluated against manufacturer guidance, site procedures and cost.

6. Stemming retention - not just stemming length

U.S. Bureau of Mines tests linked stemming ejection time to burden movement. Under the specific small-bore limestone test conditions, a stemming length of at least 26 charge diameters prevented premature stemming ejection. This should not be transferred directly to production bench design, but it demonstrates the underlying principle: the stemming must remain effective long enough for useful burden movement to develop.

KEY PRINCIPLE

Effective confinement is about retention time as well as measured length. A column of poor material that ejects early may provide less useful confinement than a shorter column of well-selected, properly placed stemming.

7. The traditional 'Stemming Shuffle'

Bench humour, not a design method. The 'stemming shuffle' is the familiar practice of kicking available drill cuttings back into the charged hole. It is quick, cheap and requires no specialist equipment - which explains why it has survived on blast benches around the world.

The problem is not the boot. The problem is assuming that whatever happens to be around the collar is automatically good stemming. Drill cuttings can vary greatly in grading, moisture and compaction behaviour, and careless placement can create bridging or inconsistent confinement.

FDTAS VIEW

If drill cuttings are being used, treat them as a blast-design material: inspect them, understand their condition, place them consistently and measure the result. Convenience should not be mistaken for quality control.

8. What should influence stemming selection?

- Burden and spacing.
- Blasthole diameter and total hole depth.
- Explosive type, density, energy and charge concentration.
- Charge position and initiation / primer location.
- Bench height and upper-bench geology.
- Rock strength, jointing, weathering and cavities.
- Actual collar burden and drilling deviation.
- Stemming material grading, angularity, moisture and placement.
- Required fragmentation and tolerance for collar boulders.
- Flyrock, airblast, vibration and nearby infrastructure constraints.

9. Signs that confinement deserves investigation

Field observation	Possible stemming / confinement question
Visible collar blowout / early venting	Is stemming too short, poorly retained, bridged or affected by local geology?
Excessive airblast / flyrock from collar zone	Is confinement inadequate, or is actual burden / charge geometry contributing?
Coarse collar fragmentation / boulders	Is stemming excessive, or is the upper bench difficult to break?
Highly variable results hole-to-hole	Are stemming material, collar condition, drilling accuracy and loading consistency controlled?
Good lower-bench breakage but poor top fragmentation	Review stemming length together with charge distribution and upper-bench geology.

10. FDTAS stemming & confinement workflow

1	**Establish the baseline**	Start from burden, hole diameter, charge geometry and recognised site / empirical guidance.
2	**Inspect the collar zone**	Check actual burden, weathering, joints, voids, water and collar condition.
3	**Assess the material**	Confirm stemming type, grading, moisture and suitability.
4	**Control placement**	Avoid bridging and inconsistent filling; verify actual stemming depth.
5	**Review the explosive column**	Check charge concentration, top of charge and initiation position.
6	**Observe the blast**	Look for ejection, venting, collar violence, flyrock and upper-bench response.
7	**Measure the result**	Fragmentation, collar boulders, muckpile, airblast and downstream performance.
8	**Calibrate by geology / domain**	Retain proven parameters and adjust when geology, explosive or geometry changes.

REMEMBER

Stemming cannot compensate for a poor blast design. Burden, spacing, drilling accuracy, subdrill, charge distribution, timing, geology and available relief all interact with confinement.

Professional reference disclaimer

References & further reading

- U.S. Army Corps of Engineers (2018). EM 1110-2-3800, Blasting for Rock Excavations. Recommends angular stemming material with particle size approximately D/20.
- Dyno Nobel Asia Pacific (2025). Explosive Engineers' Guide - Rules of Thumb for Surface Blasting. Stemming material size: D/10 to D/20, angular material with minimum fines.

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- Cevizci, H. & Ozkahraman, H.T. (2012). The effect of blast hole stemming length to rockpile fragmentation at limestone quarries. International Journal of Rock Mechanics and Mining Sciences, 53, 32-35.
- Chen et al. (2021). The movement process and length optimization of deep-hole blasting stemming structure. International Journal of Rock Mechanics and Mining Sciences, 146, 104836.
- Assessment of the optimized stemming length considering rock fragmentation and escape of explosive gases using actual large-scale results (2024). Results in Engineering.

Keep it simple. Keep it clear. Keep it practical.