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Stemming Materials Assessing and its Effect on Rock Fragmentation using Digital Image Analysis at Chouf Amar Quarry, M'sila, Algeria

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Abstract

Mining blasting efficiency is essential for mining operations for economic and technical reasons. Rock blasting operations should be conducted optimally to obtain a particle size distribution that optimises downstream operations, such as loading, transport, crushing, and grinding. The nature of the stemming material significantly impacts the degree of rock fragmentation during mining operations. Stemming refers to the material used to fill the space above explosives in a borehole, which helps confine the explosive energy and optimise rock fragmentation during detonation. This study aims to evaluate the stemming materials and their effect on the particle size distribution of blasted rocks at the Chouf Amar quarry in M'Sila, Algeria. The analyses performed in this study indicate that the blasting results obtained by the company reflect poor fragmentation quality, with a significant quantity of oversized fragments, making up 20–23% of the total pieces. To address this issue, a new operational blasting plan is proposed to enhance fragmentation quality. This plan employed three stemming materials: drill cuttings, 3/8 crushed aggregates, and sand. The test blasts were performed in a limestone quarry, and the results were evaluated using the highly reliable and widely respected image analysis software WipFrag 3.3. The results reveal that using crushed aggregates as stemming material significantly improves fragmentation quality, reducing the proportion of oversized fragments from an average of 23% (with sand stemming) to 2.6%.

1. Introduction

Blasting operations are frequently employed in hard-rock mining. Rock extraction from the massif using explosives is an alternative method with the advantage of fragmenting large volumes of rock; the most effective blasting achieves maximum production with minimal costs [1]. This method involves using explosives to break hard rocks into smaller pieces, thereby facilitating their extraction or handling [2]. In the mining sector, the quality of rock fragmentation is paramount because it affects all technological stages (loading, transport, and crushing) and is a crucial element in establishing the economic profitability of mining activities [3]. To obtain an appropriate blasting result, the rock fragments must have an average size, which is determined based on the downstream operations' specific requirements and the equipment's capacity [4]. The blasting operation can be considered well executed if the fragmented rocks are smaller than the average fragment size. In contrast, rock fragments larger than the average fragment size are responsible for forming rock blocks, leading to secondary blasting to reduce the size of fragmented blocks, referred to as oversized blocks, below the average fragment size [5].

Practical field studies have shown that controllable and uncontrollable parameters are essential for rock fragmentation [6-10]. Among the controllable parameters, geometrical parameters, such as bench height, burden/spacing ratio, charge explosive length, stemming length, hole diameter and length, and hole priming mode (position of

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detonator), have significantly improved rock fragmentation. The process generally begins with drilling holes where the explosives are placed in the rock. Once the explosives are in place, they are detonated using micro-delay detonators, causing a shockwave [11]. Subsequently, the shockwave transforms into a compressive stress wave; the action of the stress wave in the rock causes circumferential and radial fractures, while the role of the explosive gas extends the fracture further, thus fracturing and breaking the rock [12]. Incorrect or inappropriate use of one of these factors during blasting operations can lead to wasted energy and incomplete stress distribution in the rock mass, resulting in poor fragmentation and the creation of oversized material.

Explosive blasting in mining is vital in achieving optimum performance from technical and economic perspectives. In all cases, obtaining an optimal particle size distribution is desirable considering the loading-transport chain and possibly downstream crushing [8,13,14]. However, the multiplicity of parameters makes it difficult to control this operation. Several studies have shown the value of considering the impact of a single parameter on all other parameters affecting blasting results.

Poor fragmentation, accompanied by a large amount of oversized material, can pose several problems in construction and mining projects [15]. Here are some points to consider: 1. Inappropriate fragmentation can make rock pieces too large to handle or transport easily. This can slow down operations and increase costs. 2. Additional costs: The need to reprocess or demolish areas can lead to unforeseen expenses. Additionally, processing oversized materials may require special equipment or alternative methods that can increase the budget. 3. Safety: Large rock pieces can pose a danger to workers, increasing the risk of accidents at the site. 4. Poor fragmentation can affect the properties of the extracted materials, making their use in construction projects less viable [16]. 5. Planning and control: To avoid these problems, it is essential to have rigorous planning and quality control when using explosives. This includes choosing the right types of explosives, the drill holes' depth and spacing, and the detonation timing. To remedy these problems, it may be helpful to analyse the fragmentation methods used and adjust them to improve the quality of the results [17].

Stemmed materials are key in containing explosives and efficiently using blasting energy during blasting [18, 19]. Stemming is an essential operation in the process of rock blasting in quarries. It consists of introducing explosives into holes drilled in the rock and tamping them in such a way as to create sufficient pressure to cause rock fragmentation during detonation [4]. Research in mining engineering has used different types of stemming materials, such as drilling debris, crushed aggregates (gravel), sand, plaster, and clay, yielding remarkable and optimal results in improving fragmentation quality [20, 21].

Recent research [22–30] has highlighted the significance of choosing suitable stemming materials and introduced innovative approaches that have greatly enhanced blasting performance. These studies also explored the environmental consequences of blasting, underscoring the necessity of advanced predictive models to reduce negative impacts. The effectiveness of stemming plays a key role in determining the fragmentation quality of blasted rock in quarries. The stemming length is a vital aspect of blast hole design, as it affects parameters such as the powder factor, explosive charge, blasting safety, and the resulting rock fragmentation. In a comprehensive investigation, Moomivand et al. (2025) [24] and Dhekne et al. (2020) [31] evaluated the optimal stemming length by considering both rock fragmentation and the escape of explosive gases using large-scale experimental data. Their findings indicate that the burden (B) influences the appropriate stemming length, and that an optimal St/B ratio of 0.67 minimises the median fragment size (X50), achieves optimal fragmentation, and improves the efficiency of quarry blasting.

This study highlights the importance of stemming quality in the degree of fragmentation. Using digital image software (WipFrag), we investigated the influence of stemming materials (sand, drill cuttings, and crushed aggregates) on the particle size distribution of blasting plans conducted in a quarry. For this purpose, we conducted five blasting tests for each stemming to analyse the impact of the stemming materials on the size of the blasted rocks.

2. Studied Area and Geological Setting

This study was conducted at the Lafarge Cement Factory limestone quarry, which is located northwest of M'Sila province, 8 km southeast of Hammam Dalaa municipality, and 216 km from the capital. That is, 2.5 km from the asphalt road in part leading to the locality of El-Euch, Daira of El Hammadia, Wilaya of Bordj Bou Arreridj (Figure 1a).

The deposit is characterized by two monoclinal compartments, which are separated by a trough oriented SNE–NSW (N 75°) and exhibiting a dip of 15° (N 170°) [32]. The reserves of the deposit exceed 200 million tons, which provides a lifespan of 50 years, contingent upon the production capacity of 4 million tons per year. This deposit incorporates upper Cretaceous formations that are stratified into three distinct layers. At the base, layer C3, measuring 15 meters, is composed of micritic bioclastic and massive limestones, which outcrop in the southwestern region due to tectonic activity. A more substantial intermediate layer, C2, with a thickness of 30 m, consists of dark gray limestone beds and frequently fossiliferous outcrops located in the western and southwestern sectors. The upper layer, called C1, varies in thickness between 14 and 30 m and outcrops throughout the deposit, except for the southwest region [33, 34]. This layer comprises locally fossiliferous crystalline limestone beds (Figure 1.b).

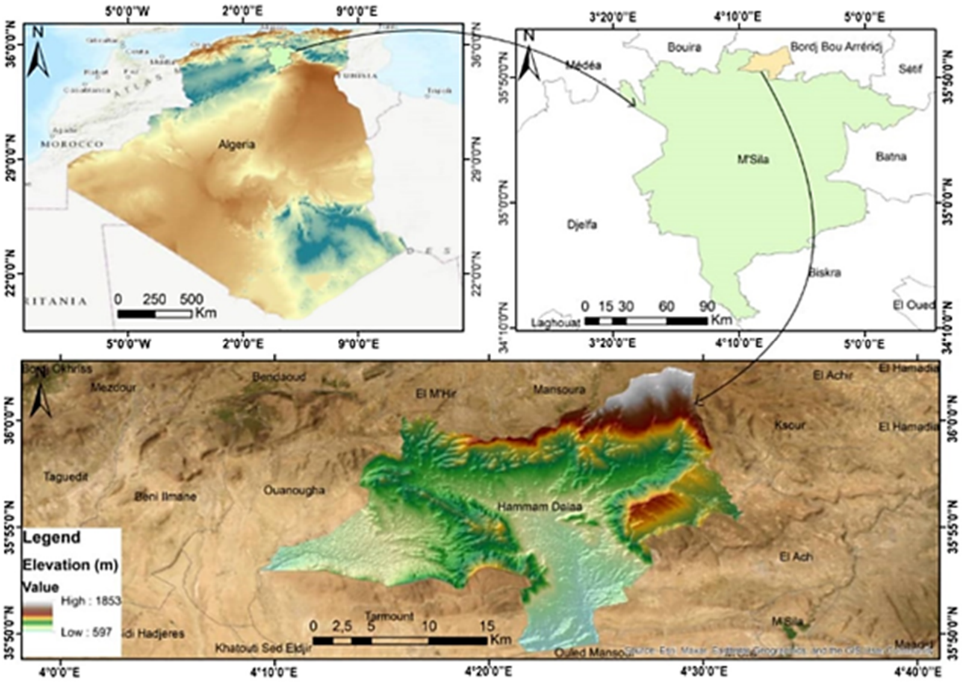


Figure 1.a. Site map location of the Chouf Amar quarry

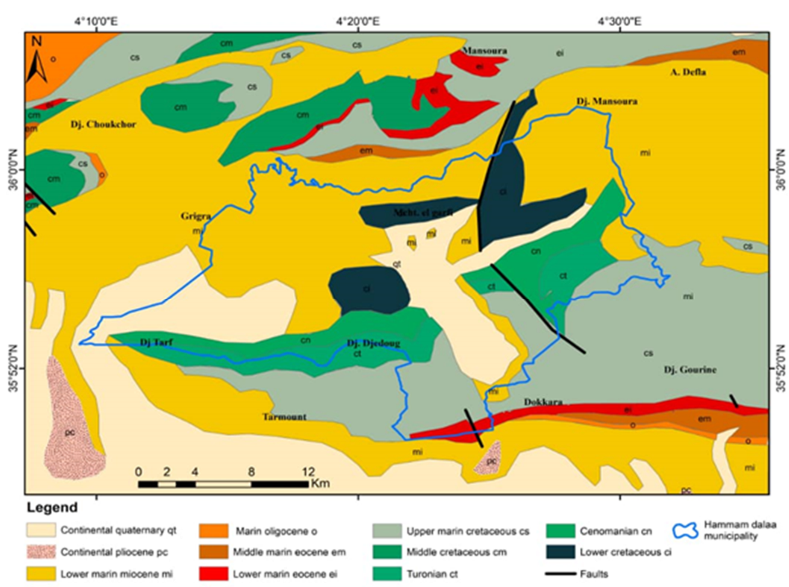


Figure 1.b. Geological map of the Chouf Amar quarry

3. Materials and Methods
3.1. Methods

Various techniques exist for evaluating rock fragmentation, which fall into two main categories: direct and indirect techniques. Sieving is the only accurate direct method that delivers the highest accuracy, but is expensive and time-consuming [35]. Indirect approaches include visual estimates, empirical models, and numerical image processing methods [36]. The best-known empirical model is the Kuz-Ram formulation (Kuznetsov, 1973), with numerous refinements introduced in recent years [37–39]. Advances in digital imaging have made software-based analysis the most widely adopted indirect approach for assessing bone quality [29]. Over the last few decades, various image analysis software packages have been developed, such as WipFrag, Split Desktop, FragScan, Power Sieve, GoldSize, BLASTFRAG, TUCIPS, and IPACS [40], which can rapidly process large sample areas without interrupting quarry operations. These tools are relatively inexpensive compared to sieving [41, 42], generate standardised particle size distributions, and directly link blast design parameters to fragment outcomes. Any residual error can be further reduced by acquiring multiple high-resolution images per blast, ensuring robust parameterisation and reliable size-distribution results.

3.2. Blasting Parameters

This study was conducted at the Chouf Amar quarry, utilising the existing blasting plan parameters. The primary variable was the stemming material, which alternated among drill cuttings, 3/8, crushed aggregates, and sand, to evaluate their influence on rock fragmentation and reducing oversized material after blasting. The quarry operates at the 1065 m level with a west–east orientation. The blasting design parameters included a hole diameter of 110 mm, bench heights ranging from 15 to 20 m, and specific settings for the inclination, stemming length, spacing, burden, and sub-drilling (Table 1). The quarry typically uses Samex II and Anfomil explosives and drill cuttings as stemming materials. The design parameters of the blasting plan and stemming materials are presented in Figure 2.

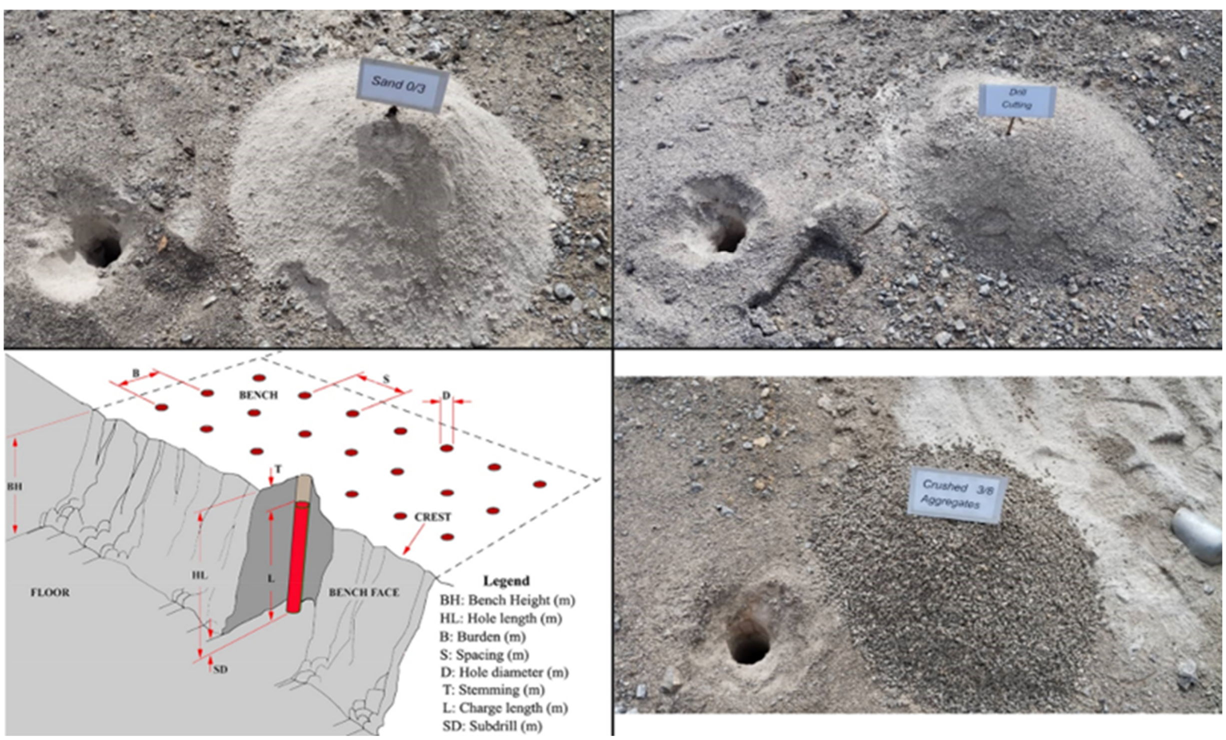


Figure 2. Schematic of the blast pattern and stemming materials used in the Chouf Ammar quarry

After blasting, some of the blasted rocks have blocks whose dimensions are not admissible in the quarry's opening crushers; these blocks are oversized materials. To reduce the dimensions of these blocks, secondary breakage is used, either by rock breakers or explosives, which affects the quarry's production chain and overall economy.

Table 1. Drill and blast design parameters at the Chouf Ammar quarry

Parameters	Values
UCS (MPa)	90.41
Density (t/m³)	2.67
Hole diameter (mm)	110
Bench height (m)	15-20
Inclination of blast holes (degree)	82
Stemming length (m)	4
Spacing (m)	4
Burden (m)	4.5
Sub-drilling of the hole (m)	1 - 1.6
Hole length (m)	16 – 21.6

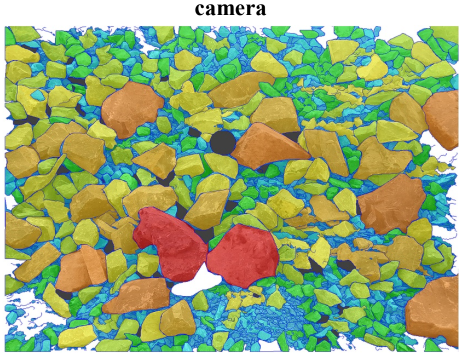
3.3. WipFrag Methodology

WipFrag 3.3 (developed by WipWare Inc., Canada [43]) was used for digital image analysis to assess the effect of the stemming material on fragmentation. WipFrag analyses high-resolution images of blasted rock piles to generate detailed particle size distributions and quantitative data on fragment sizes [44–46]. This approach allows for a consistent and objective comparison of the fragmentation outcomes for each stemming material.

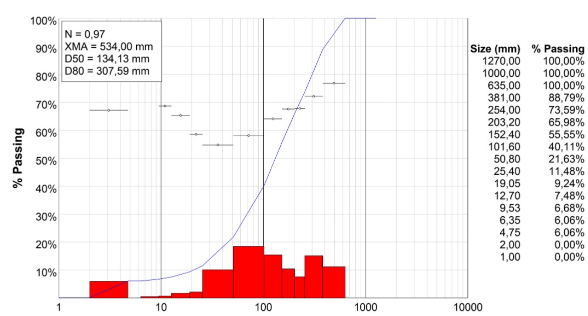
The methodological flow proceeded in three main stages: (1) sampling site selection, (2) image acquisition, and (3) image analysis. First, representative areas of the blasted rock mass were carefully selected at the quarry faces to capture the variations in the blast performance. During the image acquisition phase, several high-quality digital photographs of the muck piles were taken in three steps (after blasting, at one-third and two-thirds of the loading by shovel) immediately after each blast (Figure 3a). To ensure accurate scaling, 20 cm diameter balls were placed in the field of view as reference objects. Finally, the image analysis phase consisted of importing the photographs into WipFrag, where its automated image-processing algorithms delineated individual rock fragments (Figure 3b), generated particle size distributions, and provided quantified metrics such as F20, F50, F80, and the proportion of oversized blocks (Figure 3c). By maintaining uniform camera settings, lighting, and sampling procedures across all 15 blasts, the analysis was standardised to minimise bias. In WipFrag, each image is converted into a fragment "net," transformed into volumes and weights, and presented as particle-size distribution curves (Figure 3d). This dual application of WipFrag 3.3 to fragmentation measurement and stemming material evaluation ensured consistency across all tests while providing comparative and quantitative data for each stemming configuration. The reliability and speed of detecting fragment contours allow fully automatic remote monitoring at a rate of a few seconds per image [9, 10, 47, 48].

(a). Close up digital: Images were captured by a digital camera

(b). Digital images were transferred into grayscale and scaled



(c). Images were edited and particles were computed



(d). Particle size distribution graphs were prepared

Figure 3. Systematic image analysis process with WipFrag

3.4. Experimental Design

Fifteen blasts were conducted (five for each stemming material) to evaluate the impact of stemming material on fragmentation. This study assessed the effects of variations in the quality of the stemming material on fragmentation outcomes. Particle size analysis was performed using WipFrag to calculate the passing fragments and the oversized blocks. A comparative study of the three materials was conducted to determine the influence of stemming quality on fragmentation results. This methodology aims to improve rock fragmentation quality, enhance mining efficiency, and reduce operational costs by optimising stemming material selection. Figure 4 depicts the flow sheet and specific methodology of this study.

4. Results and Discussion

Several photos were taken of each stemming material after blasting in the quarry to cover the entire blasted rock and obtain a realistic distribution of fragment sizes (Figure 5). Based on the quarry equipment for loading, transport, and crusher opening, the desired size of the fragmented rock was set to a maximum of 1200 mm. Table 2 and Figure 6 compare F20, F50, and F80 with the results of varying the stemming material in the five-blast block.

Tables 2, 3, and 4 evaluate the 15 blasting events performed at the Lafarge Cement Factory limestone quarry

Table 2 shows the fragmentation sizes F20, F50, and F80 (representing the sizes at which 20%, 50%, and 80% of the blasted materials pass through, respectively) for the three stemming materials: sand, drill cuttings, and crushed aggregates. The 1st stemming material (sand) produced larger fragments overall, with average F20=578.12 mm, F50=1000.70 mm, and F80=2132.62 mm, and exhibited less effective fragmentation than the other blasting materials. The 2nd stemming material (drill cuttings) resulted in smaller average fragment sizes (F20=741.72 mm, F50=889.58 mm, F80=1065.95 mm) and showed improved fragmentation compared with sand. The crushed aggregates (3rd stemming material) produced the smallest fragments overall (F20=250.46 mm, F50=545.86 mm, and F80=794.96 mm), indicating that fragmentation was the most efficient among the three materials.

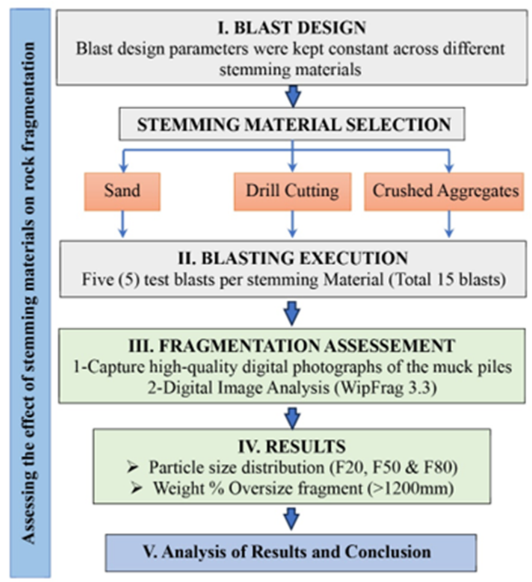


Figure 4. Summary of the study methodology

Figure 5. Photos of the blasted rocks taken for each of the stemming materials after blasting

Tables 3 and Figure 7a, b, and c show the fragment size distribution, which is the weight percent retained (cumulative oversize), for five blasts per stem material in blasting tests at the Chouf Amar limestone quarry (by WipFrag). When sand was used as a stemming material, the average percentage of material passing obtained for five blasts below the primary crusher's gape of 1200 mm did not exceed 55.21%, with the presence of very high percentages of cumulative oversized (retained materials) ranging from 37.77%–44.79%. In Figure 7a, we observe moderate variability among the five stemming sandblasts. The curves remained relatively high throughout the 400–1200 mm range, indicating a significant proportion of larger fragments. The most dramatic increase in retention occurred between 800 and 1000 mm (approximately 25%), suggesting that a substantial proportion of the fragments fell within this size range.

In the second stemming material (drill cuttings), the average percentage of material passing obtained for the five blasts increased to 83.54%. However, a notable proportion of oversized fragments remained, with retention values ranging from 15.05 to 24.46%, with an average of 20.04% retained across all blasts (Table 4). This average closely matches the proportion of oversized fragments typically found in the Chouf Amar quarry, confirming the WipFrag assessment that using drill cuttings for stemming results in more than 20% oversized fragments. The results for the drill cuttings were highly consistent across all five blasts (Figure 7b). Notably, a sharp increase of approximately 52% between the 1000 and 800 mm fragment sizes indicates that most fragments are concentrated within this size range. While drill cuttings produce fewer large fragments (>1000 mm) than sand, they generate more 400–800 mm-sized fragments. Overall, the drill cuttings showed improved performance compared to sand but retained a significant proportion of oversized pieces.

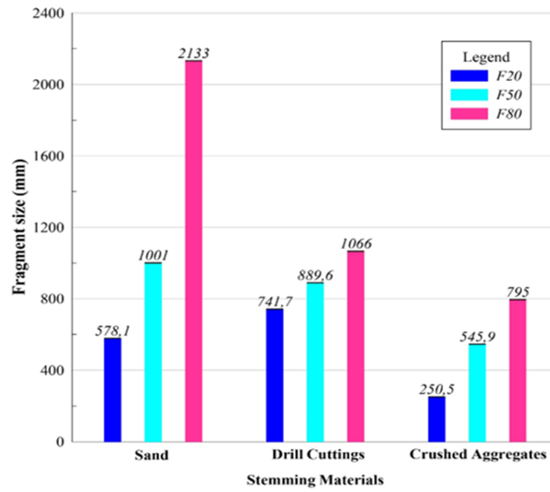


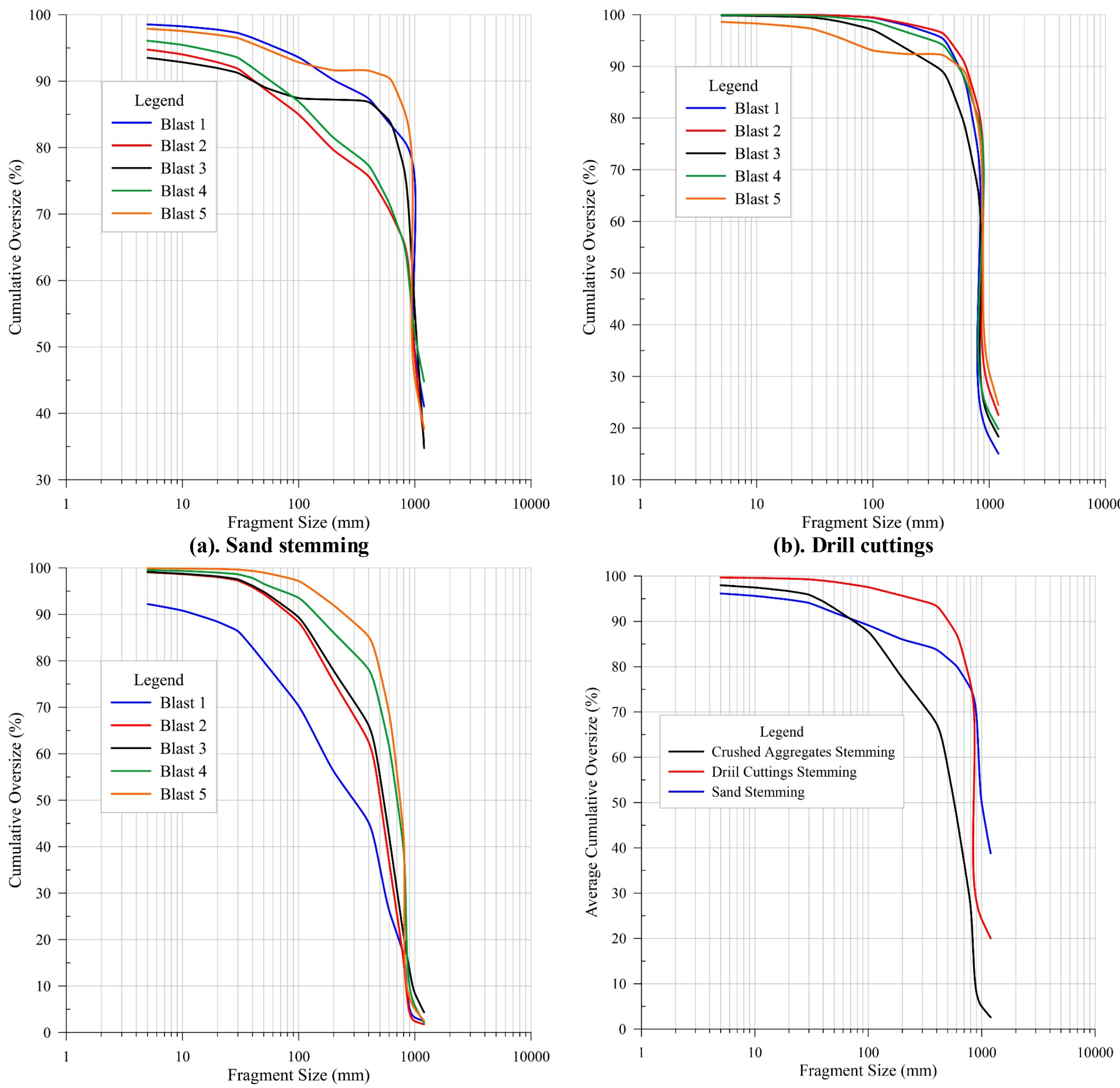
Figure 6. Average of particle size distribution of F20, F50, and F80 in the three cases of stemming materials

Table 2. Details of particle size distribution in the three cases of stemming materials

Blasts	Stemming materials (sand)			Stemming materials (drill cuttings)			Stemming materials (crushed aggregates)		
	F20 [mm]	F50 [mm]	F80 [mm]	F20 [mm]	F50 [mm]	F80 [mm]	F20 [mm]	F50 [mm]	F80 [mm]
B1	826.22	967.41	2315.54	714.24	832.24	932.33	45.05	227.82	740.75
B2	197.35	912.78	1959.38	824.96	923.5	1125.85	183.92	489.16	685.21
B3	732.88	1161.58	2075.68	587.29	867.25	1046.67	166.29	550.03	817.9
B4	318.29	1049.16	2611.92	812.38	916.15	1109.12	375.5	719.81	866.01
B5	815.86	912.58	1700.6	769.73	908.78	1115.82	481.58	742.51	864.97
Average	578.10	1001.00	2133.00	741.70	889.60	1066.00	250.50	545.90	795.00

Table 3. Fragmentation size distribution, which is the weight% retained (cumulative oversize) for five blasts per stem materials in blasting tests at the Chouf Amar limestone quarry (by WipFrag)

Fragment size [mm]	Stemming material (sand)					Stemming materials (drill cuttings)					Stemming materials (crushed aggregates)				
	B 1 [%]	B 2 [%]	B 3 [%]	B 4 [%]	B 5 [%]	B 1 [%]	B 2 [%]	B 3 [%]	B 4 [%]	B 5 [%]	B 1 [%]	B 2 [%]	B 3 [%]	B 4 [%]	B 5 [%]
1200	41.02	35.77	34.77	44.79	37.65	15.05	22.55	18.35	19.77	24.46	2.45	1.76	4.35	2.01	2.49
1000	49.25	48.32	55.23	51.88	45.21	18.25	27.35	21.76	23.02	30.75	3.22	2.42	8.44	5.75	5.05
800	81.12	65.9	77.07	65.65	85.88	73.54	82.04	66.13	80.1	78.85	16.65	15.18	20.93	39.13	42.03
600	83.72	70.65	84.08	71.63	90.48	88.02	91.07	79.34	88.19	89.24	26.31	36.81	42.3	61.54	68.72
400	87.37	75.66	86.85	77.29	91.58	95.35	96.37	88.92	94.11	92.17	45.17	62.51	66.09	78.11	85.19
200	90.17	79.62	87.22	81.47	91.64	97.85	98.22	93.24	96.55	92.38	56.21	75.5	77.87	86.04	91.95
100	93.58	84.97	87.45	86.92	92.84	99.42	99.47	97.05	98.68	93.09	70.25	88.25	89.33	93.53	97.16
50	95.84	88.93	89.16	90.79	94.98	99.84	99.84	98.75	99.48	95.66	79.84	94.37	94.85	96.58	98.99
40	96.52	90.25	90.07	92.04	95.67	99.91	99.91	99.12	99.65	96.42	82.86	95.85	96.16	97.82	99.35
30	97.25	91.86	91.23	93.52	96.48	99.96	99.95	99.46	99.74	97.28	86.37	97.26	97.52	98.61	99.64
20	97.75	92.84	91.97	94.38	96.97	99.98	99.97	99.62	99.86	97.76	88.42	98.01	98.17	98.99	99.77
10	98.25	94.02	92.85	95.45	97.54	99.99	99.99	99.77	99.92	98.3	90.8	98.65	98.74	99.35	99.87
5	98.54	94.75	93.51	96.08	97.88	99.99	99.99	99.84	99.95	98.6	92.2	99.05	99.12	99.53	99.92



(a). Sand stemming **(b). Drill cuttings**

(c). Crushed aggregates **(d). Average cumulative oversize**

Figure 7. Fragment size retained (cumulative oversize) per stem material

When crushed aggregate was used as the stemming material, the percentage of fragments passing was 97.39%, and the rate of retained fragments (oversized rock) was very low, giving acceptable results ranging from 1.76% to 4.35% (best blast no.2 with 98.24% of passing (see Table 3)). These results for the energy efficiency of crushed aggregates can help concentrate the explosive energy in a specific direction, thus increasing the detonation efficiency and optimising the blasting results. Figure 7c shows greater variability between the blasts than between the other stemming materials. The most notable feature is that the curves are significantly lower throughout the 400–1200 mm range, indicating a much finer overall fragmentation. The increase in retention was more gradual across size ranges, suggesting a more uniform distribution of fragment sizes than in the other materials.

Table 4 and Figure 7d present the average percentage of fragments retained (cumulative oversize) at each fragment size, ranging from 1200 mm to 5 mm, for five blasts in the Chouf Amar quarry using three stemming materials: sand, drill cuttings, and crushed aggregates. First, at the largest fragment sizes (1200–800 mm), sand stemming resulted in the highest percentage of coarse fragments (e.g., 38.8% at 1200 mm), indicating poor fragmentation. Drill cuttings showed a lower rate than sand (20.04% at 1200 mm), suggesting improved fragmentation, although there was still a significant amount of coarse material. Crushed aggregates exhibited the lowest retention (2.61% at 1200 mm), reflecting the most effective breakage and finest fragmentation among the three materials tested. Second, as the fragment size decreases to the medium range (600–200 mm), the percentage of retained fragments increases for all materials; however, the gap between the sand/drill cuttings and crushed aggregates becomes more significant. Finally, at the smallest fragment sizes (100–5 mm), all materials approach high cumulative percentages, but differences remain; drill cuttings, in particular, retain the highest rate at these finer sizes.

Table 4. Average fragment size retained (cumulative oversize) for five blasts per stem material

Fragment size [mm]	Average fragment size (sand) [%]	Average fragment size (drill cutting) [%]	Average fragment size (crushed aggregates) [%]
1200	38.80	20.04	2.61
1000	49.97	24.22	4.97
800	75.12	76.13	26.78
600	80.11	87.17	47.13
400	83.75	93.38	67.41
200	86.02	95.64	77.51
100	89.15	97.54	87.70
50	91.94	98.71	92.92
40	92.91	99.00	94.40
30	94.06	99.27	95.88
20	94.78	99.43	96.67
10	95.62	99.59	97.48
5	96.15	99.67	97.96

This study confirmed that crushed aggregates exhibit higher confinement efficiency owing to their angular shape and dense-packing characteristics. The interlocking of particles helps reduce the escape paths for explosive gases, thereby improving the energy retention within the blast hole. Additionally, the lower void ratio and higher bulk density of crushed aggregates compared with sand or drill cuttings contribute to better gas sealing and a more focused energy transfer into the surrounding rock. These physical advantages result in a more efficient rock breakage mechanism and a finer, more uniform fragmentation profile

5. Conclusions

This study systematically evaluated the influence of three stemming materials (sand, drill cuttings, and crushed aggregates) on blast-induced rock fragmentation at the Chouf Amar limestone quarry in Algeria. By combining photographic analysis, field measurements, and WipFrag image analysis, this study comprehensively assessed the fragment size distribution across multiple blast and stemming scenarios. The results demonstrate that the choice of stemming material significantly affects fragmentation efficiency.

1. Sand stemming consistently produced the most significant fragments, with an average F80 of 2133 mm and a high proportion of oversized material (average 38.8% retained at a 1200 mm diameter). This indicates poor energy confinement and less effective fragmentation, leading to operational inefficiencies due to the increased need for secondary breakage and handling large boulders.
2. Drill cuttings stemming improved fragmentation compared with sand, reducing the F80 to 1066 mm and the proportion of oversized fragments to an average of 20.04% at 1200 mm. While this represents a substantial improvement, some fragments still exceeded the desired size, particularly in the 400–800 mm range of the size distribution. Drill cuttings also yielded highly consistent results across blasts.
3. Crushed aggregates stemming yielded the best performance, with the smallest average fragment sizes (F80 of 795 mm) and the lowest retention of oversized fragments (average 2.61% at 1200 mm). The distribution curves for the crushed aggregates were consistently lower across all size ranges, indicating finer and more uniform fragmentations. This suggests that crushed aggregates provide superior energy confinement, maximising the effectiveness of the explosive charge and minimising oversized generation.

These findings have important implications for quarrying operations. Using crushed aggregates as stemming material can substantially enhance blasting efficiency, reduce secondary breakage requirements, and optimise downstream processes such as loading, hauling, and grinding. The results also highlight the value of careful stemming material selection and control as key parameters in blast design and stemming length, uniformity, and placement.

This study confirmed that the choice of stemming material is critical for controlling the blast fragmentation outcomes. Adopting high-performance materials, such as crushed aggregates, can significantly improve operational efficiency, and continued research in this area will further refine blasting practices in the mining industry.

It is recommended that quarry blasting engineers consider crushed aggregates as stemming materials, particularly in operations where oversized fragments frequently lead to operational or safety challenges. Although the present study, based on 15 blasts conducted under uniform conditions at a single limestone quarry, demonstrated reliable results, future research should broaden the investigation to include other rock types (such as granite and sandstone), larger datasets, and broader ranges of stemming lengths and compaction techniques. Furthermore, incorporating economic analysis models and advanced particle size simulation tools is recommended to refine and expand the practical applicability of this method

6. References

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دانشگاه صنعتی شاهرود

ارزیابی مواد اولیه و تأثیر آن بر خردایش سنگ با استفاده از تحلیل تصویر دیجیتال در معدن سنگ چوف عمار، مسیله، الجزایر

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کلمات کلیدی

خردایش

ریشه یابی

WipFrag

انفجار

آنالیز اندازه ذرات

چکیده

راندمان انفجار معدن به دلایل اقتصادی و فنی برای عملیات معدنکاری ضروری است. عملیات انفجار سنگ باید به طور بهینه انجام شود تا توزیع اندازه ذرات به گونه‌ای باشد که عملیات پایین‌دستی مانند بارگیری، حمل و نقل، خردایش و آسیاب را بهینه کند. ماهیت مواد اولیه به طور قابل توجهی بر میزان خردایش سنگ در طول عملیات معدنکاری تأثیر می‌گذارد. مواد اولیه به موادی گفته می‌شود که برای پر کردن فضای بالای مواد منفجره در گمانه استفاده می‌شود و به محدود کردن انرژی انفجار و بهینه‌سازی خردایش سنگ در طول انفجار کمک می‌کند. هدف این مطالعه ارزیابی مواد اولیه و تأثیر آنها بر توزیع اندازه ذرات سنگ‌های منفجر شده در معدن شوف آمار در مسیلا، الجزایر است. تجزیه و تحلیل‌های انجام شده در این مطالعه نشان می‌دهد که نتایج انفجار به دست آمده توسط این شرکت، کیفیت خردایش ضعیفی را نشان می‌دهد، به طوری که مقدار قابل توجهی از قطعات بزرگ، ۲۰ تا ۲۳ درصد از کل قطعات را تشکیل می‌دهند. برای رسیدگی به این موضوع، یک طرح جدید انفجار عملیاتی برای افزایش کیفیت خردایش پیشنهاد شده است. در این طرح از سه ماده اولیه استفاده شده است: قلمه‌های حفاری، سنگدانه‌های خرد شده ۸/۳ و ماسه. انفجارهای آزمایشی در یک معدن سنگ آهک انجام شد و نتایج با استفاده از نرم‌افزار بسیار معتبر و مورد احترام تحلیل تصویر WipFrag 3.3 ارزیابی شدند. نتایج نشان می‌دهد که استفاده از سنگدانه‌های خرد شده به عنوان ماده‌ی ساقه‌زن، کیفیت خردایش را به طور قابل توجهی بهبود می‌بخشد و نسبت قطعات بزرگ را از میانگین ٪۲۳ (با ساقه‌زن شنی) به ٪۲.۶ کاهش می‌دهد.

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