Construction Quicklime (CQL): Paving the Way for Faster, Cost-Effective Projects

SECTION 1. EXECUTIVE SUMMARY

Construction Quicklime (CQL) by Mintek Resources, Inc. is an innovative approach to the manufacturing of quicklime designed to meet the evolving needs of the construction industry. This whitepaper provides a comprehensive overview of CQL, highlighting its key benefits and features. These include faster hydration, improved performance, and significant time and cost savings. The purpose of this whitepaper is to demonstrate how CQL can accelerate project timelines and reduce labor costs beyond that of even the use of traditional quicklime, making it an ideal choice for demanding, modern construction projects.

SECTION 2. INTRODUCTION

In the construction industry, time and cost efficiency are paramount. Traditional methods, such as remove-and-replace, often fall short in meeting the increasing demands of modern construction projects. While chemical stabilization practices have long been a superior choice for soil stabilization due to their effectiveness in improving soil properties, there is still room for improvement. Traditional quicklime often requires multiple passes and extended mellowing times, leading to increased labor hours and project costs. There is a clear market need for a product that can address these inefficiencies and accelerate project timelines without compromising quality. CQL by Mintek Resources, Inc. builds upon the substantial benefits of quicklime, offering enhanced performance. It is particularly effective in lower to moderate plastic soils, which do not benefit as much from the extra mellow time and mixing required by traditional chemical stabilization methods.

SECTION 3. MARKET OVERVIEW

CQL represents an advancement over traditional quicklime, specifically engineered to meet the demands of modern construction projects. One of the key features of CQL is its significantly higher surface area, which allows for faster hydration and accelerates chemical reactions. This enhancement reduces the time required for soil stabilization, making CQL a more efficient choice for construction projects.

In addition to its higher surface area, CQL boasts a finer particle size distribution, being twice as fine as traditional (¼ inch by zero) quicklime fines. This increased fineness improves the product's performance by enhancing its ability to mix and homogenize with soil. The result is a more uniform mixture that accelerates the chemical reactions necessary to transform unsuitable soil into a viable construction material, which is crucial for the success of construction projects and their demanding schedules.

These new features of CQL offer several unique benefits that set it apart from traditional quicklime. The reduced mellow period of only four hours allows CQL to be placed and compacted similarly to Portland cement, significantly speeding up the construction process. CQL also provides accelerated early strength development, achieving a stable working platform faster and enabling contractors to complete work more quickly. The product's improved homogenization with soil means that single-pass mixing is sufficient for most soil types, reducing the need for multiple passes and further cutting down on labor hours. Additionally, CQL's unique sizing enhances its compatibility with a broader range of spreading equipment, increasing its versatility on the job site.

The benefits of CQL extend to improved transfer rates, as its unique sizing accelerates product transfer from pneumatic trucks to spreaders, decreasing detention time and enhancing overall efficiency. The better flow characteristics of CQL facilitate better distribution and reduce void space, allowing more material to be added to a spreader than traditional quicklime, consequently improving spreading

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Figure 1. Example of Material Distribution in a Typical Spreader Truck

SECTION 4. PERFORMANCE METRICS

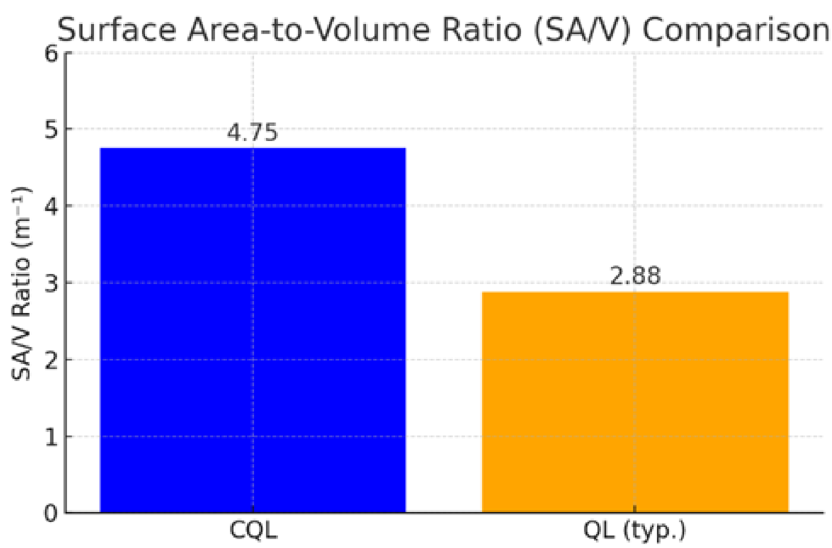
Lab Data

The performance of CQL has been rigorously tested in laboratory settings to ensure its effectiveness and reliability. Key metrics from these tests highlight CQL's superior performance. One of the primary metrics is the time required from placement and mixing to compaction, often referred to as mellow time. CQL achieves optimal compaction within just 4 hours, comparable to that of Portland cement. This rapid compaction time is a significant improvement over traditional quicklime, which often requires a mellowing period of 24 hours.

There are several parameters that explain why CQL so effectively reduces the mellowing period. Firstly, the particle size distribution (PSD) of the two products (Figure 2). This difference in PSD results in CQL having a significantly higher surface area-to-volume ratio (SA/V). The calculated difference shows that CQL has an SA/V ratio of 4.75 m^{-1} compared to 2.88 m^{-1} for traditional quicklime fines (Figure 3). This proportional increase translates to 65% more surface area available for chemical reactions in CQL, enhancing its reactivity and accelerating the chemical reactions necessary for soil stabilization. This rapid hydration is crucial for transforming unsuitable soil into a viable construction material in a shorter time frame. The complete SA/V calculations are provided in Appendix A.

Figure 2. Particle Size Distribution - CQL vs. Traditional Quicklime Fines

Figure 3. Surface Area-to-Volume Ratio - CQL vs. Traditional Quicklime Fines



Secondly, the finer particle size distribution of CQL enhances its ability to mix and homogenize with soil. The smaller particles ensure a more uniform distribution, which is crucial for consistent chemical reactions throughout the soil. This improved homogenization also leads to faster modification of soil properties such as increased strength (Figure 4) and decreased expansion (Figure 5), reducing the required mellowing time and allowing for quicker compaction.

Figure 4. Soil Strength - Before and After Lime Treatment

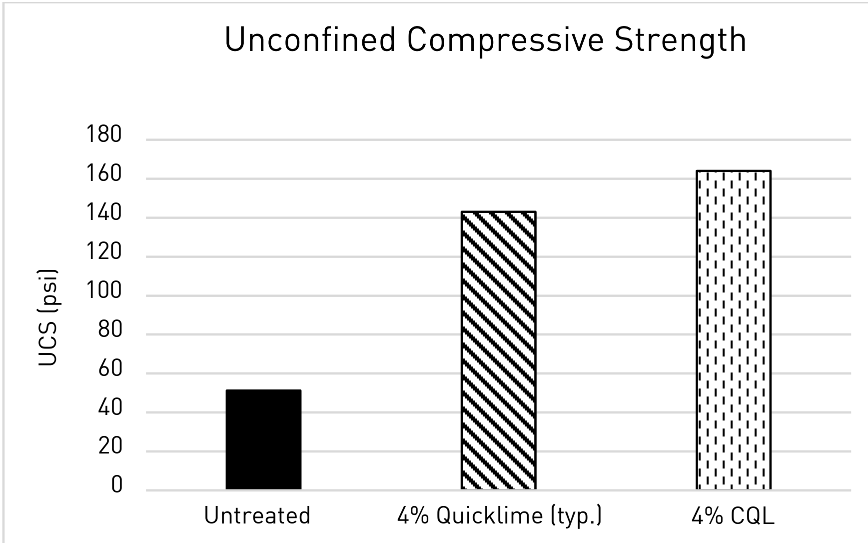
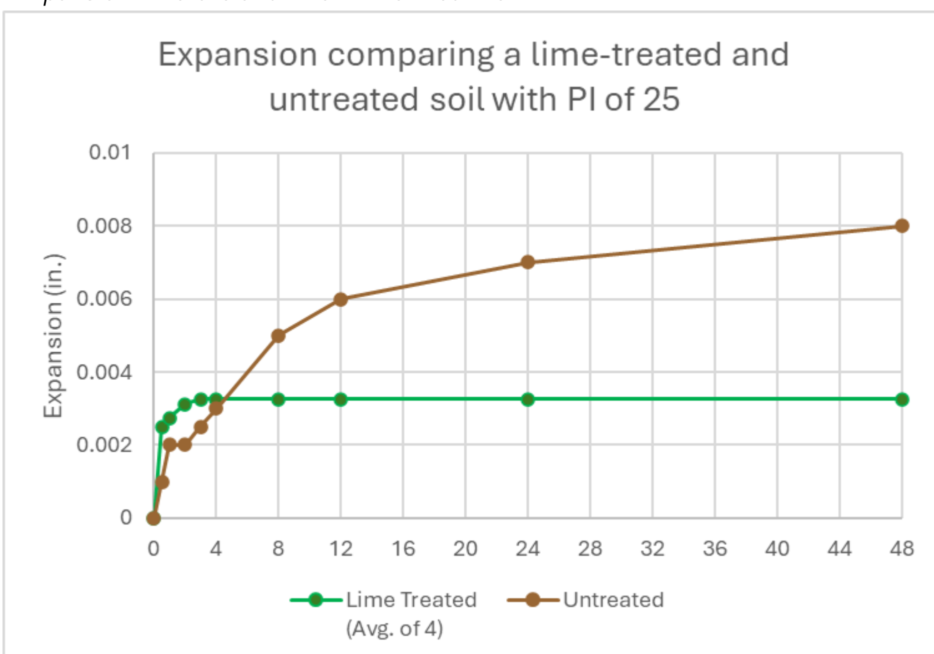


Figure 5. Soil Expansion – Before and After Lime Treatment



In summary, the superior performance of CQL in reducing the mellowing period can be attributed to its higher surface area and finer particle size distribution. These characteristics lead to faster hydration and better homogenization with the soil, which in turn results in accelerated soil modification and compaction times.

SECTION 5. FIELD DATA

Field tests have confirmed the superior performance of CQL in real-world construction scenarios. One of the notable benefits observed, beyond those already mentioned, is the faster transfer time and reduced pneumatic truck detention time. The unique sizing of CQL accelerates the transfer process from pneumatic trucks to spreaders, minimizing delays and improving overall efficiency on the job site.

Figure 6. CQL Being Transferred from a Pneumatic Delivery Truck to a Spreader Truck.

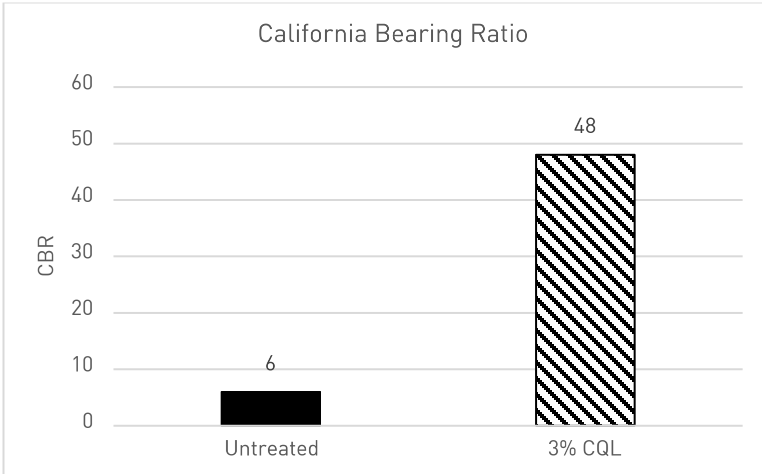
In practical applications, CQL has demonstrated its ability to reduce labor hours and accelerate project completion. The improved performance of CQL reduces the need for multiple passes and extended mellowing periods, cutting down on labor hours and project costs. Contractors have reported that CQL's enhanced homogenization allows for single pass mixing in most soil types, validating our laboratory testing and further reducing project timelines.

Comparative field tests on projects using CQL alongside other materials have provided valuable insights into its advantages. These tests have shown that CQL's accelerated early strength development allows stabilized areas to be opened to traffic sooner, minimizing disruptions and allowing for faster progression of construction activities. Feedback from contractors has highlighted the ease of use and overall project efficiency when using CQL.

Figure 7. Stone Application Immediately Following CQL addition, mixing and compacting.

Additional field data includes metrics such as the time required to achieve a stable working platform, the rate of early strength development, and the overall reduction in project timelines. These metrics provide a comprehensive understanding of CQL's performance in different conditions and applications, reinforcing its value as a superior construction material.

Figure 8. California Bearing Ratio of CQL treated soil.



SECTION 6. CONCLUSION

Construction Quicklime (CQL) by Mintek Resources, Inc. represents a significant advancement in the field of soil stabilization and construction materials. Through extensive lab and field testing, CQL has demonstrated its ability to meet the evolving needs of the construction industry by offering faster hydration, improved performance, and significant time and cost savings.

The key differentiators of CQL include its higher surface area and finer particle size distribution, which contribute to faster hydration and improved soil mixing. These features translate to reduced labor hours, accelerated project timelines, and overall cost savings. The product's compatibility with a wide range of spreading equipment and its ability to achieve a stable working platform quickly make it an invaluable asset for construction projects.

Case studies have shown that CQL can significantly reduce project timelines and costs while maintaining high standards of quality and performance. Feedback from early adopters highlights the ease of use and efficiency gains achieved with CQL, reinforcing its value as a superior construction material.

In summary, CQL is paving the way for faster, cost-effective construction projects. Its innovative features and proven performance make it an ideal choice for contractors looking to improve efficiency and reduce costs. Mintek Resources, Inc. is committed to providing high-quality products that meet the demands of the modern construction industry.

For more information about CQL and how it can benefit your projects, please contact Mintek Resources, Inc. at 937-431-0218 or sales@mintekresources.com.

Appendix:

Surface Area-to-Volume Ratio (SA/V) Calculation and Its Effect on Reactivity

Calculation of Surface Area-to-Volume Ratio (SA/V)

To quantify the differences between the CQL (Mintek's enhanced construction quicklime) and QL (typ.) (a typical 3/8" screened quicklime fines product), we calculated the surface area-to-volume (SA/V) ratio based on the corrected particle size distributions. The SA/V ratio is crucial in determining the reactivity of powders, such as quicklime, as it relates to the amount of surface area available for interaction relative to the volume of the material.

Step 1: QL Data - Retained Percentages

The retained fraction was determined for both CQL and QL (typ.) The retained fraction represents the material that is "caught" on each sieve and the % retained for each sieve is shown here:

Mesh Size	Sieve Size (microns)	% Retained CQL	% Retained QL
3/8"	9510	0.0	0.2
1/4"	6350	0.0	2.9
No. 4	4760	0.1	3.3
No. 8	2380	6.1	12.6
No. 16	1190	15.8	20.0
No. 30	595	10.0	10.7
No. 50	297	10.4	9.7
No. 100	149	2.5	12.6
Pan	0	55.1	28.0

Step 2: Midpoint Diameters

The midpoint diameter for each size fraction was calculated as the average of two consecutive sieve diameters. This gives a representative size for particles that are neither too coarse nor too fine within each size range:

$$\text{Midpoint Diameter} = (D_n + D_{n+1}) / 2$$

The midpoint diameters used were:

Sieve Size Range (microns)	Midpoint Diameter (microns)	Midpoint Diameter (m^{-1})
9510 - 6350	7930	7.9300
6350 - 4760	5555	5.5550
4760 - 2380	3570	3.5700
2380 - 1190	1785	1.7850
1190 - 595	892.5	0.8925
595 - 297	446	0.4460

297 - 149	223	0.2230
149 - 1	75	0.0750

Step 3: Derivation of the SA/V Ratio Formula
The surface area-to-volume ratio (SA/V) is derived based on the simplification that the particles are spherical in shape.

1. **Surface Area of a Sphere:** The surface area of a sphere with radius r is given by the formula:
   A = 4πr2

2. **Volume of a Sphere:** The volume V of a sphere with radius r is given by the formula:
   V = (4/3)πr3

3. **Surface Area-to-Volume Ratio:** To find the surface area-to-volume ratio (SA/V), we divide the surface area by the volume:

   A/V = 4πr2 / (4/3)πr3 = 3/r

Therefore, the SA/V ratio for a sphere is inversely proportional to its radius r.

4. **Using Diameter Instead of Radius:** Since sieve sizes are typically given in terms of diameter D, and the diameter is 2r, we can rewrite the formula in terms of diameter:

   SA/V = 6/D

This formula provides the surface area-to-volume ratio in terms of the particle diameter D.
Using these equations, the SA/V ratios for each midpoint diameter are:

Midpoint Diameter (m^{-1})	SA/V Ratio (m^{-1})
7.9300	0.76
5.5550	1.08
3.5700	1.68
1.7850	3.36
0.8925	6.72
0.4460	13.45
0.2230	26.89
0.0750	80.00

These SA/V ratios are then multiplied by the corresponding % retained in each size fraction to obtain the weighted SA/V ratio for each fraction.

Step 4: Final SA/V Ratios
To calculate the total SA/V ratio for each powder, the weighted SA/V ratios are summed across all size fractions. Below are the calculations for each powder:

CQL:
Total SA/VCQL = ∑ (SA/V × %Retained CQL) = 4.75m−1

QL (typ.):
Total SA/VQL = ∑ (SA/V × %Retained QL) = 2.88m−1

Impact of Surface Area-to-Volume Ratio on Reactivity
The surface area-to-volume ratio (SA/V) plays a critical role in the reactivity of powders. A higher SA/V ratio indicates a greater surface area available for interactions, which directly correlates to increased chemical reactivity. In this case:

- CQL, with its higher SA/V ratio of 4.75m−1, is expected to exhibit greater reactivity compared to QL (typ.), which has a lower SA/V ratio of 2.88m−1.
- The finer particle size distribution of CQL results in more surface area available for interactions with other substances, making it particularly effective in applications requiring rapid chemical reactions, such as soil stabilization.

In contrast, QL (typ.), with its lower SA/V ratio, would exhibit slower reactivity.

Percent Difference in SA/V Ratios
To quantify the difference between the SA/V ratios of CQL and QL, the percentage difference was calculated using the formula:

Percent Difference = [(SA/VCQL − SA/VQL) / SA/VQL] × 100

Substituting the values:
Percent Difference = [(4.75 − 2.88) / 2.88] × 100 = 64.93%

Thus, the surface area-to-volume ratio of CQL is 64.93% higher than that of QL (typ.), indicating that CQL has significantly more surface area available for chemical interactions, which correlates to its increased reactivity in various applications.

* This is why CQL can effectively be mellowed in only for 4 hours for most soil types *