Technical Note

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SEGMENTAL RETAINING WALL BLOCK CRACKING

Segmental retaining walls (SRWs) are beneficial on sites with a topography which would limit or prohibit the development and are used to create or increase buildable area. Using SRWs for land development and space utilization is a cost-effective solution to address both grade changes and still offer an aesthetic advantage over conventional retaining wall systems.

For taller walls, segmental wall blocks are combined with geosynthetic reinforcement to create a composite mass. This composite mass is often referred to as mechanically stabilized earth or MSE. Mechanically stabilized earth consists of a facing element in combination with alternating layers of compacted soil and relatively closely spaced reinforcement layers. This results in a structure that acts as a coherent gravity mass and allows the system to reach greater heights and resist higher loads. In MSE structures, the facing units act mainly as erosion protection and an aesthetic façade for the system.

As of 2020, Hundreds of millions of square feet of segmental retaining walls have been installed in North America. Many of these retaining walls exceed 40 feet tall and a few exceeding 70 feet. The performance of these structures has been reliable as they continue to be widely specified as a grade separation solution.

In some cases, especially when dealing with taller walls, segmental retaining wall facing units can crack. While it is warranted to document cracked blocks in a completed wall project, cracked facing units are normal and to be expected in a flexible system that is intended to withstand differential settlement. Cracked blocks do not automatically indicate deficiencies with the performance of the overall segmental retaining wall system.

This Technical Note provides background information and general guidance for accessing and monitoring segmental retaining wall blocks that have cracked after installation. If any structural or visual anomalies exist, such as bulging, excessive differential settlement, or gapping the owner and engineer of record should be notified immediately. In cases where there is a risk of loss of property or human life, the area in question should be roped off until the wall can be inspected by a qualified engineer.

CRACKING OF SRW UNITS

Since the introduction of segmental retaining wall systems to the US in the 1980s, cracked blocks have been observed in countless critical segmental retaining wall structures due to differential settlement or other factors. The National Concrete Masonry Association, the international trade association representing block producers and suppliers in the concrete masonry and hardscape industry, addresses block cracking in their Segmental Retaining Walls Best Practices Guide. The Best Practices Guide notes “While this cracking may present an aesthetic distraction, it does not compromise the structural stability of the system.” (1)

In addition to the experience and guidance provided by the National Concrete Masonry Association, this Technical Note draws on experience from Anchor Wall Systems and Anchor Wall Engineering, LLC. Anchor Wall Engineering, LLC, has designed over 75 million square feet of walls with over 300 million square feet of Anchor Wall Systems’ products being designed by other design professionals. Through this experience, Anchor Wall Systems has found that taller walls have a higher likelihood of experiencing cracked facing units. Shorter walls, generally less than 12 to 15 feet, appear to have considerably more flexibility than taller walls, those greater than 15 feet.

As segmental walls increase in height the normal load placed on the lower courses increases. Taller walls increase the confining pressure on the blocks which restricts movement and allows shear and flexural stresses to concentrate to a point where the blocks may crack to relieve stress. Due to the concentration of stresses, this form of cracking is generally seen in the bottom third of the wall. Cracks of this type are not necessarily detrimental to the overall structural stability of the wall. As noted in the National Concrete Masonry Association’s Best Practices Guide “the cracking may actually help to redistribute the stresses at the wall face for increased system stability.” (1)

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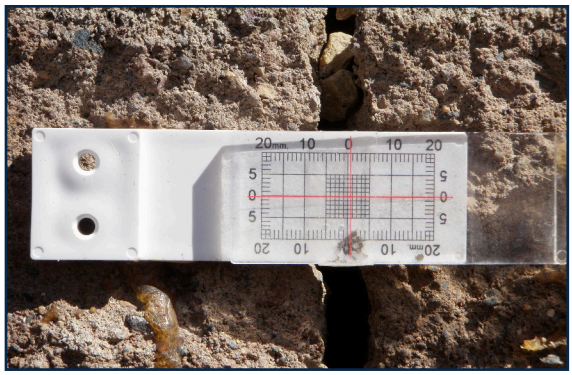
As previously stated, cracked blocks in a segmental retaining wall typically do not represent a structural deficiency with the overall wall system, but the nature and frequency of cracks should be assessed. Occasional thin cracks with no displacement are not typically a concern. Cracks that represent greater than 5% of the units, follow a pattern, or have significant displacement should be carefully assessed by a qualified segmental retaining wall engineer. Crack monitoring is typically recommended in these scenarios (see the picture of a crack meter below) to evaluate if the retaining wall is continuing to move. If there are concerns about the overall movement of the wall structure it may be necessary to have a professional surveyor establish control points on the wall. The control points would be monitored until it is determined that unusual wall movement(s) is not occurring.



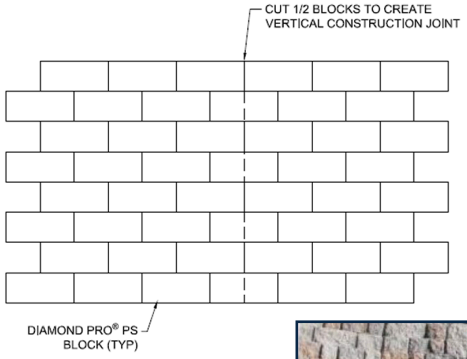
DIFFERENTIAL SETTLEMENT

The National Concrete Masonry Association (NCMA) recommends limiting differential settlement to less than 1 percent. Given the relatively small unit size and the flexible nature of SRW structures, in most cases, this limit has proven to be reasonable based on Anchor Wall Systems' experience. If larger than normal settlement is anticipated, then foundation improvement programs should be evaluated by the project geotechnical engineer working in conjunction with the wall designer.

When greater than 1 percent differential settlement is anticipated, the use of slip joints is one solution that can increase wall flexibility reducing stresses in the wall facing system. An example of an SRW slip joint detail and photograph are depicted below.

SRW LAYOUT CONSIDERATIONS

Adding corners and tight outside curves to a tall wall may increase cracking/gapping problems. Corners and tight outside curves increase stresses in the wall facing units that can concentrate cracking or gapping at these features especially when combined with poor compaction and/or poor quality backfill. The wall backfill moves laterally causing outward movement of the block which is amplified



NOTE: Do not terminate geosynthetic reinforcement layers at control joints

in corners and tight radiuses causing gapping and cracking from the concentration of forces at the wall face. For more in-depth design recommendations related to outside corners and curves refer to the National Concrete Masonry Association's Segmental Retaining Walls Best Practices Guide and Design Manual (2).

SUMMARY

Over the past 35 years, segmental retaining walls have become one of the most economical and reliable grade separation solutions available for earth retention. For those involved in layout, specifying, design, construction, and sales it is important to understand how design and site conditions impact the long-term performance of these structures. In general, minor vertical block cracking/gapping in a retaining wall does not impact the structural integrity of the wall. In some cases, cracked units can also be a symptom of more serious problems. If more serious problems are suspected the wall should be inspected by a qualified engineer. After inspection, an appropriate course of action may include monitoring for additional movement.

REFERENCES

1. *National Concrete Masonry Association. (2018). Segmental Retaining Walls Best Practices Guide*

2. *National Concrete Masonry Association. (2009) Design Guide for Segmental Retaining Wall Systems.*