ROLES AND RESPONSIBILITIES ON SEGMENTAL RETAINING WALL PROJECTS

INTRODUCTION

On all construction projects, including those involving segmental retaining walls (SRWs), it is the owner's responsibility to achieve coordination between construction and design professionals that ensures all required design, engineering analysis, and inspection is provided. In many cases, a design professional such as a site civil engineer or an architect acts as the owner's representative. In either case, the owner or owner's representative should ensure that the engineering design professionals' scope of work, roles and responsibilities are clearly defined so that there is no ambiguity regarding responsibility for investigation, analysis and design, and that all required testing is performed.

The roles outlined in this Tech Note are typical industry roles for various engineering disciplines. SRW design and construction should generally follow these traditional roles. However, these roles may vary from project to project, depending on the contractual obligations of each consultant. For example, for simpler projects, such as residential landscapes, one design professional may take on the responsibility of several roles, if acceptable to local building code requirements.

For tall or complex walls and for commercial projects, each of these roles is likely to be provided by separate firms, each with expertise in a particular discipline. The discussion in this Tech Note is generally oriented towards projects where several design professionals are contracted.

Reinforced SRWs, because of their nature as composite soil structures, may have unique design and inspection considerations for the site civil engineer, the geotechnical engineer, and the independent testing agency. These considerations are discussed in further detail in the following sections.

Detailed guidance on SRW design, construction and inspection can be found in references 1 through 3.

OVERVIEW OF ROLES

The owner/developer, or a designated representative, is ultimately responsible for ensuring that all applicable requirements of governing authorities for the permitting, design, construction and safety on the project are addressed. The owner or owners' representative should ensure that the types of retaining walls specified are appropriate for the site conditions and ensure the wall alignment fits within the site's space limitations. It is the owner's or owner's representative's responsibility to contract an engineer to provide site civil engineering including site layout, drainage and grading. The

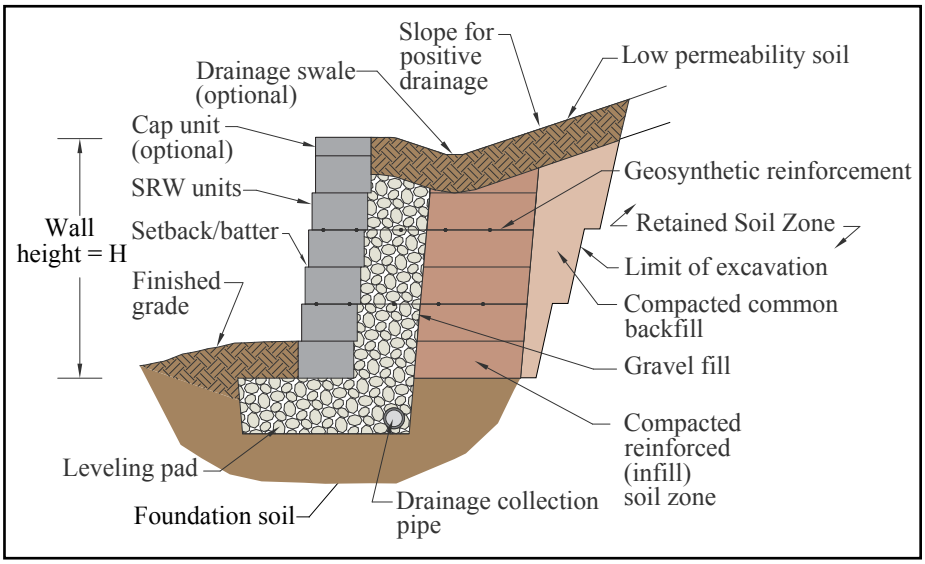

Figure 1—Reinforced Segmental Retaining Wall System Components

owner must also ensure that a geotechnical engineer and testing agency are contracted to provide all necessary and required soils exploration, analysis and earthwork inspection for the entire project, including in the vicinity of the SRWs, just as they do in the vicinity of building structures. The owner or owner's representative must also ensure that a qualified wall design engineer provides an SRW structural design.

The most straightforward means for the owner or owner's representative to ensure all engineering roles are well-defined is for the SRW design engineer's assigned roles to be the same as those traditionally given to a structural engineer designing a cast-in-place concrete retaining wall, and for the other design professionals, such as site civil and geotechnical engineers, to also provide the same roles and services as they would for a cast-in-place retaining wall.

Table 1 contains an itemized list of the suggested roles for each professional discipline for larger walls and commercial projects involving SRWs. A more thorough explanation of the site civil engineer's, geotechnical engineer's and SRW engineer's roles, and construction observation and testing roles is provided in the following sections. The actual responsibilities for each discipline should be contractually based.

SITE CIVIL ENGINEER SUGGESTED ROLES OVERVIEW

It is suggested that the site civil engineer be contracted for all traditional site civil duties, including the design of surface drainage, storm drainage collection structures, utility layout, erosion control and scour protection. The site civil engineer is also typically responsible for site layout and grading plans, including slopes and retaining wall locations. The site civil engineer should, in consultation with the geotechnical engineer, ensure that all planned grades, including those at the top and bottom of SRWs, do not exceed the stable slope angles and do not cause surface drainage or erosion problems.

The site civil engineer should also plan the wall alignment so that the SRW structure does not encroach on any easements. In addition, the site civil engineer should be responsible for any other issues related to the wall location, such as proximity to property lines, utilities, watersheds, wetlands, or any other easements. In some cases, the site civil engineer may also act as the SRW Design Engineer and take on suggested roles for the SRW Engineer discussed below.

The site civil engineer should evaluate and design for any hydrologic issues and structures such as: culverts, open channels, detention/retention ponds, scour and erosion control details, as well as defining high water levels, flow volumes, flood areas and scour depths. The site civil engineer should provide any pertinent hydrologic data that may affect the SRW to the SRW engineer.

Often, when not designing the SRW in-house, the site civil engineer specifies the engineering design of SRWs to be part of the SRW construction contract (a design/build bid). While a common practice, this type of bid can place the SRW engineer in a different position than other project engineers. Unlike other engineers working directly for the owner, the SRW engineer in this design/build case is often working directly for a contractor, who is often a subcontractor to other contractors. This can cause design coordination issues because the SRW engineer may not be included in project discussions with other engineers, such as pre-construction meetings. Therefore, it is suggested that the site civil first determine if it is appropriate to have the SRW engineering specified as part of the wall construction contract. For some more complicated projects, it may be preferable to have the SRW design engineer perform the design prior to bidding the construction rather than as part of a design/build bid. If the site civil engineer chooses to specify the SRW design as part of the construction bid, it is recommended that the site civil engineer ensure that the SRW design engineer is involved in any required design and construction observation services before and during construction, similar to the way geotechnical engineers are often contracted for their services during construction.

GEOTECHNICAL ENGINEER SUGGESTED ROLES OVERVIEW

The geotechnical engineer should typically be contracted to provide the same engineering roles in the vicinity of the SRW as they do for all other structures on site. The geotechnical engineer's typical roles are the investigation, analysis and testing of the site soil materials and groundwater conditions. Just as geotechnical engineers traditionally provide bearing capacity, settlement estimates and slope stability analysis for building structures, it is suggested they do the same for SRWs. The geotechnical engineer's role should include providing soil properties such as soil shear strength parameters, ground water elevation, seismic conditions, and bearing capacities to the SRW engineer.

Responsibility for slope stability evaluation around an SRW can be a source of confusion, because the SRW engineer can often address slope stability issues near a geosynthetic-reinforced SRW by modifying the geosynthetic reinforcement layout. Thus, the SRW engineer is sometimes requested to evaluate and design for slope stability by the civil engineer's specifications. However, involving the SRW engineer in addressing slope stability should not remove ultimate global/slope stability responsibility from the geotechnical engineer.

It is therefore suggested that, regardless of the SRW engineer's involvement, the geotechnical engineer be contracted to have the ultimate responsibility for the site's slope stability, including: determining when and where global stability analyses are required, determining the appropriate soils and groundwater properties to be used for the analyses, and ensuring that all required failure planes are analyzed. While the geotechnical engineer may need to coordinate with the SRW engineer for evaluating potential failure planes that pass through the reinforced soil (compound failures), the geotechnical engineer has the primary responsibility for these analyses.

When the geotechnical consultant is retained to provide construction observation and soils testing for a project, the contract should include inspection and testing of SRW

Table 1—Suggested Roles for a Segmental Retaining Wall Project

Owner/Developer or Owner's Representative:
Ensure that design professionals are contracted to provide all required engineering evaluation, layout, design, testing and inspection.
Construction Observation and Testing Agencies:
Earthwork inspection preferably performed by the geotechnical engineering consultant.
Inspect SRW foundation area, including area below planned geosynthetic-reinforced soil fill, to verify that bearing, soil, and groundwater conditions meet design assumptions.
Inspect native soils in retained zone for consistency with reported soil types and properties.
Monitor fill placement and laboratory- and field-testing to ensure specified soil types used for fill and specified compaction achieved.
Inspect overall wall material installation–preferably contracted directly with SRW engineer or site civil engineer.
Observe placement of SRW units and geosynthetic reinforcement installation.
Review material submittals for conformance with specifications.
Additional review of soil properties and earthwork testing, provided by the geotechnical engineer, for conformance with wall material specifications.
Geotechnical Engineer:
Subsurface investigation, including any required soil borings and laboratory soils testing.
Define pertinent subsurface conditions including soils, rock and groundwater conditions in the area of SRWs.
Determine properties and strengths of retained soil/rock behind and foundation material underneath the SRWs as well proposed soil for use as reinforced fill.
Evaluate foundation capacity below SRW, including bearing capacity and settlement estimates and recommendations for any required foundation improvements.
Global stability analysis throughout site including above and below SRWs.
Supervise and coordinate slope stability evaluation and corrections around the SRW with the SRW engineer.
Evaluate seismic potential and recommended design accelerations, if applicable.
Construction inspection and testing of on-site and fill soils (generally on a time and materials basis, separate from the soils exploration report contract).
Landscape Architect/Architect:
May act as specifier of retaining walls, rather than site civil engineer, primarily for walls near building structures (architectural walls) or for landscaping features.
Specify retaining walls appropriate to project conditions, if not civil engineer's responsibility.
For walls near building structures or for landscaping, retaining wall layout and alignment on site plan, if not site civil engineer's responsibility.
Coordinate SRW layout with site civil engineer's site and grading plans.
Structural Engineer:
Structural design of appurtenant structures to SRW such as guide rails, traffic barriers and structural slabs at top or bottom of wall.

Table 1—Suggested Roles for a Segmental Retaining Wall Project (continued)

SRW Engineer:
Design SRW for structural stability including external stability (sliding and overturning), internal stability, and facial stability.
Determine maximum unreinforced height of SRW.
Design geosynthetic reinforcement layout, when required.
Determine minimum embedment of wall (except in the case of scour depth or erosion control issues, which should be determined by site civil).
Specify SRW unit, geosynthetic reinforcement, drainage material within wall structure and reinforced soil properties.
Determine which structures can or cannot be placed within the reinforced soil zone and wall face, and detail the SRWs to accommodate acceptable structures.
Under the direction of geotechnical engineer, assist in coordination of slope stability evaluation around and through the SRW and the geosynthetic reinforcement design in reinforced SRWs to address slope stability in vicinity of SRW, as required.
If contracted to and notified, observe construction of the overall SRW installation and review SRW material submittals (generally on a time and materials basis, separate from the wall design contract). See *Construction Observation and Testing Suggested Roles Overview* below.
When required by state law that the SRW engineer be a licensed professional structural engineer (S.E.), structural engineer also takes on SRW engineer role. In this case, the general project structural engineer often may be a different firm than the SRW structural engineer, depending on the project structural engineer's familiarity with SRWs and interest in designing SRWs.
Site/Civil Engineer:
Specify retaining walls appropriate to project conditions.
Act as SRW Engineer (see above) when wall design performed in-house.
Prepare site plan and grading plan, including slopes and SRW heights and alignments.
Address any space limitations and easement issues relevant to SRW layout.
Design surface grading for drainage and design for erosion control around SRWs.
Design storm water collection structures and detention/retention ponds.
Utility design and layout around SRWs.
Pavement section design and grading above SRWs.
Layout of traffic control structures, such as pedestrian fall protection, curbs, wheel stops, guide rails and traffic barriers behind walls.
Hydrologic evaluations including water flows, scour depths, flood areas and high water level predictions around SRW.
Ensure SRW engineer contracted for involvement in pre-construction meetings and construction inspection services coordination.
Observe construction of the overall SRW installation and review SRW material submittals, if SRW engineer not contracted specifically for these services.
Owner (after installation):
Maintenance and cleaning.
Ensure landscaping and other site work does not damage or impair the SRW installation.

earthwork along with all other earthwork on site. See SRW-TEC-008-12, *Inspection Guide for Segmental Retaining Walls* (ref. 3) for further discussion of inspection roles.

While geotechnical engineers should be contracted for the same traditional roles regarding SRWs as for other structures, the soils engineering for SRWs may require some slightly different methods of analysis compared to evaluating soils below rigid structures on spread footings. Design guidelines for SRWs are provided in Reference 1.

SRW DESIGN ENGINEER SUGGESTED ROLES OVERVIEW

As noted previously, the SRW design engineer should serve the same roles for SRWs as a structural engineer would for the design of a cast-in-place concrete retaining wall. In some cases, the site civil engineering firm may also act as the SRW engineer, while in others, the SRW design engineer will be a separate firm. The SRW design engineer should design a stable SRW, given the specified wall geometry and site conditions provided by the site civil and geotechnical engineers. The SRW engineer's duties typically include determining the SRW's maximum stable unreinforced height and providing a geosynthetic reinforcement layout design when required.

The SRW design engineer is typically responsible for preparing the SRW construction drawings, and for determining the internal stability, facial stability of the SRW units, internal drainage of the SRW (both at the face of the wall and at the rear of the reinforced soil mass, if required), external stability (sliding and overturning), and internal compound stability.

The SRW designer engineer's output generally consists of specifications of wall components, a wall elevation detail, typical cross sections, details for any required drainage materials within or just behind the wall system, and details for how to incorporate any other structures (utilities, pipe penetrations, posts, etc.), if feasible, within the reinforced zone and wall face.

The SRW design engineer should typically not assume any duties typically relegated to the geotechnical engineer elsewhere on site. While an SRW engineer may be asked to participate in addressing the slope stability immediately around the SRW or foundation improvements in the soil below an SRW, it is recommended that the geotechnical engineer be clearly contracted to have ultimate responsibility for all slope stability and bearing capacity/settlement concerns on site, including those below and around SRWs.

It is appropriate that the SRW engineer be contracted to provide services during construction, especially on larger projects, but it is recommended that these not be included in a design/build contract for the wall construction. Time lag between design and construction can make it impractical to expect the designer to be available for services during construction and, given the often unpredictable extent and timing of construction, it is inappropriate to have services during construction be in a lump-sum design/build contract. Rather, it is suggested that the SRW engineer be hired under a separate contract directly with the owner or owner's representative to provide services during construction. These services may include preconstruction correspondences and meetings, review of materials submittals, review of earthwork testing performed by the geotechnical engineer, and review of the wall contractor's building practices.

CONSTRUCTION OBSERVATION AND TESTING SUGGESTED ROLES OVERVIEW

The soil in the reinforced zone should be checked to ensure it meets specifications; just as concrete and steel are inspected in a cast-in-place concrete retaining wall.

The wall contractor is responsible for quality control of the wall installation: performing necessary observation and testing to verify that the work performed meets minimum standards.

It is the owner's or owner's representative's responsibility to perform quality assurance: auditing and verifying that the quality control program is being performed properly.

Just as is done for building structures and cast-in-place concrete retaining walls, foundation and retained soils should be evaluated for consistency with the soil properties used in the design. Generally, the geotechnical engineer evaluates the onsite soil conditions and performs earthwork testing. It is suggested that the geotechnical engineer perform any field and laboratory testing they deem required to verify soil conditions. The geotechnical engineer should confer with the SRW engineer regarding the reinforced soil specifications and provide the SRW engineer with the fill soil test results. The geotechnical engineer should also determine the frequency of tests required to ensure that compaction of the SRW reinforced fill meets the project specifications.

OWNER SUGGESTED ROLES OVERVIEW

Segmental retaining walls are designed to provide a long life with little to no maintenance required. After the SRW installation is complete, some very basic maintenance will help maximize the SRW project's beauty and durability.

The most basic maintenance task is a periodic visual assessment of the SRW units and overall wall. If coatings have been applied to the wall, the need for re-coating should be assessed based on the coating manufacturer's recommendations and the exposure conditions of the wall. Table 2 lists regular inspection tasks that can be performed on SRWs and their suggested frequency.

Periodic cleaning of SRWs may be desired to maintain the wall's aesthetics. Cleaning recommendations for SRWs are essentially the same as those for other concrete masonry walls. The reader is referred to: TEK 08-04A, *Cleaning Concrete Masonry*; TEK 08-02A, *Removal of Stains from Concrete Masonry*; and TEK 08-03A, *Control and Removal of Efflorescence* (refs. 5, 6, 7), for more detailed guidance.

In addition to maintenance and cleaning, the owner is also responsible for ensuring that subsequent digging or trenching, such as for landscaping, does not impact the SRW installation. During any excavation, care should be taken to leave a zone of undisturbed soil behind the segmental retaining wall. Particular care should be taken to ensure that excavation does not

Table 2—Example SRW Maintenance Schedule (ref. 4)

Task:	Frequency
Check overall appearance of the structure for any signs of damage or poor performance.	Periodically
Examine drainage outlets to ensure proper function.	Biannually
Check to ensure roof drains, downspouts and other water sources are directed away from the wall. Check that water collection structures are operating properly. Clean and repair as necessary.	Spring and fall
Check for locations and sources of water.	Annually (spring)
Check to ensure grade slopes away from wall or that drainage swales are working properly.	Annually (spring)
Examine drainage outlets for presence of vermin. Remove nests and clean as necessary. Install vermin caps or screens as necessary.	Annually
If a coating has been applied, examine the condition of the coating.	Annually
Examine the condition of cap units and the effectiveness of cap unit adhesive.	Annually
If large trees and/or shrubs are present, examine the impact of root structures on the wall.	Annually
Check for the presence of dirt, efflorescence and graffiti. Clean as necessary.	Annually
Check vertical and horizontal alignment of wall surfaces.	Every 2 to 5 years

damage, cut or remove the geosynthetic soil reinforcement, if present. For this reason, the owner should maintain a record of the installation, including the locations of geosynthetic reinforcement.

Once established, tree roots do not typically damage an SRW. The roots will typically not damage the wall face from behind because the drainage aggregate behind the SRW face does not support root growth. In fact, the root system can act as additional soil reinforcement, helping to further stabilize the soil. When newly planted, trees and other large vegetation should be adequately supported to prevent them from toppling and potentially damaging the SRW.

REFERENCES

1. *Design Manual for Segmental Retaining Walls*, *Third Edition*, SRW-MAN-001-10, Concrete Masonry & Hardscapes Association, 2010.
2. *Segmental Retaining Wall Installation Guide*, SRW-MAN-003-10, Concrete Masonry & Hardscapes Association, 2010.
3. *Inspection Guide for Segmental Retaining Walls*, SRW-TEC-008-12, Concrete Masonry & Hardscapes Association, 2012.
4. *Maintenance of Concrete Masonry Walls*, TEK 08-01A, Concrete Masonry & Hardscapes Association, 2004.
5. *Cleaning Concrete Masonry*, TEK 08-04A, Concrete Masonry & Hardscapes Association, 2005.
6. *Removal of Stains from Concrete Masonry*, TEK 08-02A, Concrete Masonry & Hardscapes Association, 1998.
7. *Control and Removal of Efflorescence*, TEK 08-03A, Concrete Masonry & Hardscapes Association, 2003.

ABOUT CMHA

The Concrete Masonry & Hardscapes Association (CMHA) represents a unification of the Interlocking Concrete Pavement Institute (ICPI) and National Concrete Masonry Association (NCMA). CMHA is a trade association representing US and Canadian producers and suppliers in the concrete masonry and hardscape industry, as well as contractors of interlocking concrete pavement and segmental retaining walls. CMHA is the authority for segmental concrete products and systems, which are the best value and preferred choice for resilient pavement, structures, and living spaces. CMHA is dedicated to the advancement of these building systems through research, promotion, education, and the development of manufacturing guides, design codes and resources, testing standards, and construction practices.