Anchor
RETAINING WALL SYSTEMS

Anchor Landmark System

Caltrans Approved!

A Breakthrough in Retaining Wall Technology

Revolutionary Wall Technology

The Landmark system represents a breakthrough in reinforced wall engineering. Combining innovative thinking with time-tested engineering principles, Anchor Wall Systems has developed the next-generation segmental retaining wall system.

Designed to meet the high standards set by the transportation industry, the Landmark system is the culmination of years of research and testing to develop a modular block, mechanically stabilized earth (MSE) structure for high performance under extreme loading conditions.

The performance features of the Landmark system enable cost-effective design solutions using either the AASHTO or NCMA design methodology in the United States and, internationally, codes of practice such as BS8006 and AS4678. Landmark walls can be built in straight runs, with inside and outside radii and 90-degree corners. Unlike typical retaining wall blocks, the Landmark block face presents a vertical aspect. The blocks are also available in two slightly different front-to-back dimensions to permit construction of wall faces with unique shadow textures.

▲ *The lock bar mechanically clamps the geosynthetic reinforcement to the Landmark block.*

◀ *With its vertical orientation and outstanding capacity to perform, the Landmark system sets a new precedent for engineered SRW innovation.*

▲ *The mechanical connection between the Landmark block and geogrid does not depend upon the confining stress of blocks above the connection, thanks to ZNL® technology.*

◀ *The Landmark system was chosen for this Colorado, USA, trail project because the cost was less than half of the cast-in-place wall estimate.*

Connection Capacity

The Landmark Zero Normal Load (ZNL)® connection technology consists of specially formed channels in the top surfaces of the blocks and PVC lock bars. The lock bars are inserted into the aligned channels in a course of blocks and subsequently rotate within the channel to provide a mechanical connection between the block and the geosynthetic reinforcement.

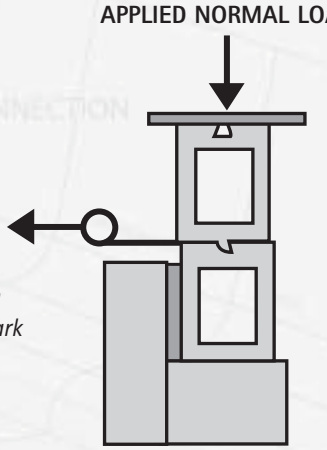
The ZNL connection generates unsurpassed block-to-grid connection values. The system's innovative mechanical connection of the reinforcement material to the block maximizes reinforcement design strength. The ZNL connection typically allows designers to use 100 percent of the allowable design strength of the geosynthetic reinforcement. (Designers are generally limited to using between 20 to 60 percent of the reinforcement's allowable design strength using frictional or semifrictional systems.) This results in material cost efficiencies as wall height increases, with no risk to integrity.

In addition, unlike other modular block systems, the highly efficient Landmark ZNL connection technology does not depend on the presence of blocks and weight above the point of connection. This is especially relevant in seismic areas where vertical accelerations can reduce the available confining stress or in cases where differential settlement occurs and block-to-block contact is lost.

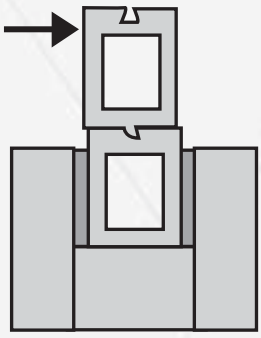
Connection capacity tests performed on the Landmark system in combination with a range of reinforcement products prove that the system's mechanical connection maintains a firm grip on reinforcement materials.

Superior Overturning Resistance

Overturning test results performed on the Landmark system demonstrate that the conservative overturning resistance of Landmark units is up to 600 percent greater than the overturning resistance of conventional SRW units of similar depth. Unlike conventional SRW units, the Landmark system is designed so the units mechanically interlock



▶ *Schematic of connection test apparatus with Landmark modular units.*



▶ *Schematic of overturning capacity test apparatus with Landmark modular units.*

Designers needed a tall wall capable of supporting a 100-ton loading capacity built in a Pennsylvania, USA, rock quarry. Taking advantage of the mechanical connection, the Landmark wall was built with high-strength fabric reinforcement and stone backfill. Then the 44-foot-tall (13.5 meter-tall) wall was incorporated into a hopper-loading system.

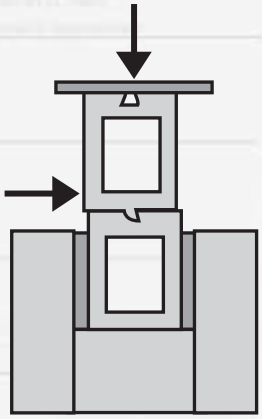
with one another. The lock flange of one unit engages the receiving channel of the unit below to resist overturning.

The SRW overturning performance test, developed by Bathurst Clarabut Geotechnical Testing Inc. (Kingston, Ontario, Canada) and Anchor Wall Systems, measured the overturning force required to cause failure of the units. The overturning resistance of the units also takes into account the force required to overcome the strength of the mechanically interlocking lock flange and channel.

The Landmark system units feature a lock flange with a 45-degree inclined plane and a mating receiving channel with an inverse 45-degree inclined plane.

Shear Capacity

The lock flange also creates significant course-to-course shear resistance. Shear capacity tests (the shear resistance of an SRW is a measure of the unit's ability to resist displacement or shear of one unit relative to another) show that the Landmark system is capable of withstanding greater shear loads than conventional systems. The Landmark units have uniquely shaped flanges that establish a high resistance to shear forces generated from lateral earth pressure and surcharge loads.



Schematic of shear capacity test apparatus with Landmark modular units.

Shear capacity testing was performed at Bathurst Clarabut Geotechnical Testing Inc., using the industry's standard shear capacity performance test, ASTM D 6916. With Zero Normal Load, the Landmark system achieves shear capacities exceeding 3,000 pounds per foot (43.8 kN/m). At higher normal loads, the units reached shear capacities exceeding 10,000 pounds per foot (146 kN/m).

Economics of Mechanical Stabilized Earth (MSE) Structures

Since 1973, there have been various surveys of MSE structure costs. In 2001, a paper presented at the Geosynthetics Conference by Robert M. Koerner and others provided the latest survey information. The costs are based on a survey of state transportation engineers in the United States about the installed (bid) costs of different types of earth retaining walls in different height categories. The reported costs included footings; facing;

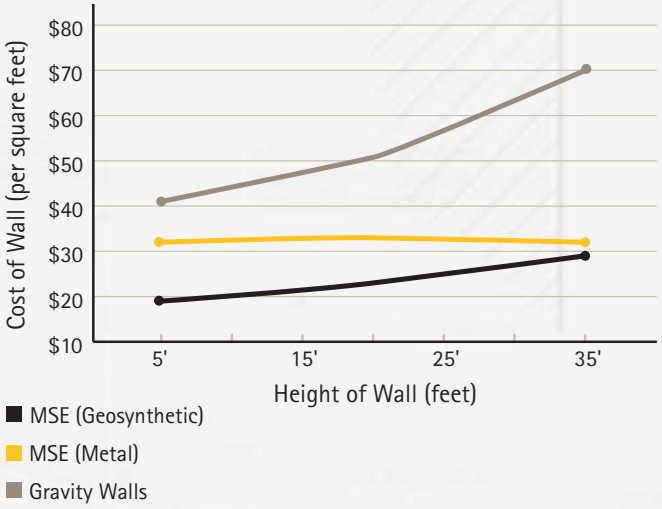
As a mechanically interlocked structure, the Landmark system demonstrates overturning resistance that is 600 percent greater than that achieved with conventional systems of similar depth.

backfill; drainage; reinforcement, if used; finishing details and contractor/manufacturer markup. These costs are counterpointed to three earlier retaining wall cost studies conducted by others in 1973, 1981 and 1988. The relative cost position of different wall types has remained the same over the 25-year period.

These surveys show that geosynthetic-reinforced, modular-block systems such as the Landmark system are, in general, one of the lowest-cost engineered systems on the market.

ECONOMICS OF MSE STRUCTURES

Source: Earth Retaining Wall Costs in the USA, Koerner et al, Drexel University, 2001.



Structural Anchorage System

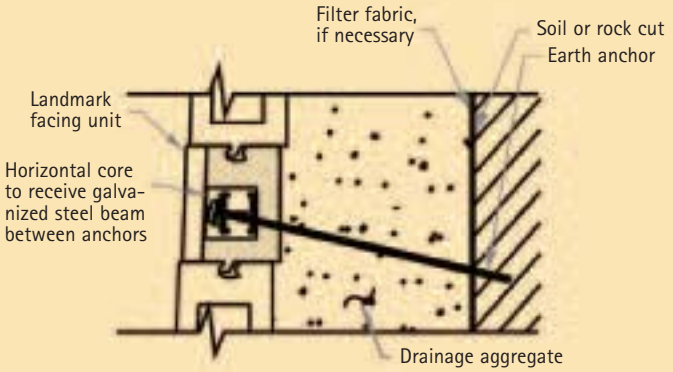
In many retaining wall applications, sufficient space does not exist behind the face units to allow excavation and subsequent placement of geosynthetic reinforcement. In these applications, retaining wall systems such as driven H-pile with wood or concrete lagging or soil nailing with a temporary or permanent facing are generally used. The permanent facing for these types of walls has typically been cast-in-place concrete. The Landmark Structural Anchorage System is an alternative solution that is more aesthetically pleasing and less costly then conventional cast-in-place concrete.

The shape of the Landmark full-height unit was specifically designed to accommodate galvanized steel beams (walers) concealed within the horizontal unit cores. This unique design allows the Landmark system to be directly attached to soil nails, rock bolts or soil tieback systems.

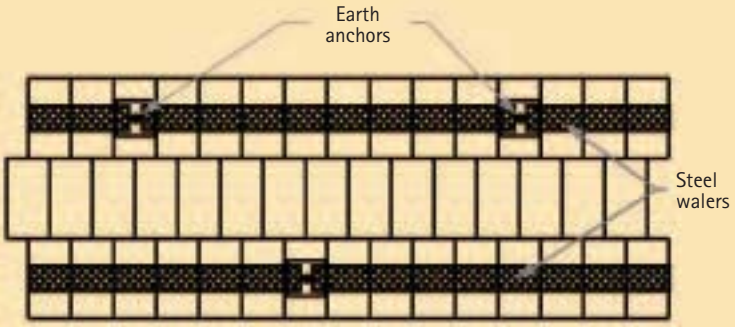
This system consists of an anchor (e.g., soil nail) installed into the ground and connected to walers placed within the horizontal cavity in the Landmark blocks. Each steel beam spans two adjacent anchors, transferring the load from the SRW units to the anchors.

▶ *Space was tight on this construction site next to railroad tracks in Pennsylvania, USA. And a water main ran through the face of the wall (see inset photo).*

LANDMARK/EARTH ANCHOR CONNECTION – SECTION VIEW
(not to scale)



LANDMARK/EARTH ANCHOR FRONT – ELEVATION VIEW
(not to scale)



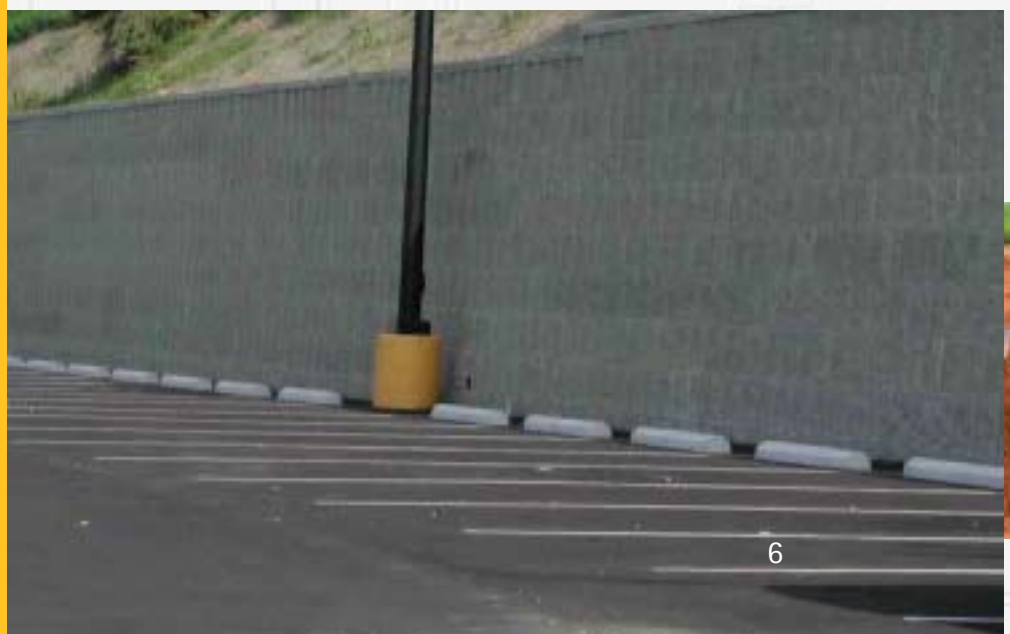
Typical connection and wall detail for direct anchorage applications.

The space between the excavated face and the Landmark units is filled with free-draining aggregate. In addition to transferring stresses from the retained soil to the block units, the fill is selected to provide drainage between the excavated surface and the wall face. Since the Landmark units are not mortared, but interlocked, hydrostatic pressure is released through the joints in the blocks as well as the drain outlets typically placed along the bottom of the wall.

Applications

Typical applications for the Landmark Structural Anchorage System include earth-retaining structures where limited space prevents excavation of soil behind the retaining structure (e.g., lane-widening under an overpass).

Another application of the Landmark Structural Anchorage System is the repair of existing earth retaining systems. Retaining walls that have experienced internal, external or facing instability may be repaired using this system.



▼ *By using soil nails and the Landmark system, this parking lot was enlarged to meet the developer's needs. The cut was close to a highway, so there was no room to excavate for reinforcement.*

▲ *The timbers facing the wall below a tennis court had failed. The owner wanted the wall repaired while the tennis court was in use. By using the Landmark system, the wall was refaced, and play was uninterrupted.*

Many earth retaining structures experience deterioration of the exposed face of the structure while still maintaining internal and external stability. Facing stability is the only issue requiring remediation for these existing structures. The Landmark Structural Anchorage System is ideally suited to correct this problem. Working from the bottom to the top of the structure, soil nails may be installed and connected to Landmark units to create a new stable face in front of the old face.

Rock cuts are often susceptible to weathering of the exposed rock and local instabilities. The Landmark units, in combination with rock bolts, may be used as a permanent facing for this condition, protecting the rock face from weathering and strength loss.

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Product Specifications

The Landmark components are designed to work in conjunction with geosynthetic reinforcement and earth anchors to create tall walls capable of withstanding extreme loading conditions. Enlist the expertise of an experienced segmental retaining wall design engineer to ensure proper wall design. Contact Anchor Wall Systems for estimating, design and installation assistance.

Depths of units vary slightly to achieve a staggered, rock-like appearance once the wall is built. This variation does not affect estimating and does not require special installation. Actual unit weight, size and availability may vary by region. Specifications may vary or change without notice.

HITEC, established through a cooperative agreement between CERF and the Federal Highway Administration (FHWA), is a nationally recognized clearing house for implementing highway innovation. It provides impartial performance evaluations for products where no standards or specifications exist. HITEC found the Landmark/Mirafi system a technically viable and cost-competitive MSE structure. The report was completed with no noted exceptions.

The New South Wales Roads and Traffic Authority (RTA) is based in Sydney, Australia. Other States within Australia have similar government departments, however the RTA is the country's leading review body for products that are to be used in government infrastructure projects. Most of the seven other states and territories in Australia recognise the RTA certificate and in many cases, make it a pre-requisite in order to bid for government projects outside of New South Wales. Anchor Wall Systems has obtained RTA certification for Diamond, Vertica and Landmark with various geo-grid combinations.

Anchor Wall Systems has obtained BBA certification for the Landmark system. The British Board of Agrément is an independent organisation partnered with the UK Government. Their Agrément Certificates provide authoritative and independent information on the performance of building products and particularly contain important data on durability, installation and compliance with Building Regulations and design codes.

Assessment and ongoing audits involve three distinct areas – Laboratory testing (carried out wherever possible to UKAS requirements), site inspections, undertaken by the BBA's own Inspection Services team, and factory production control.

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M581 3/05 10M

	Full Component	Tapered Full Component**
Nominal Dimensions*	15" x 8" x 12⅝" (380 mm x 200 mm x 320 mm)	15" x 8" x 11⅞" (380 mm x 200 mm x 300 mm)
Approx. Weight*	85 lbs. (39 kg)	80 lbs. (36 kg)
Coverage	.83 sq. ft. (.077 m^2)	.83 sq. ft. (.077 m^2)
Setback/Batter	1" (25 mm)/3.8°	1" (25 mm)/3.8°

	Half-High Component	Foundation Component
Nominal Dimensions*	7½" x 8" x 12$^{3}/_{16}$" (190 mm x 200 mm x 310 mm)	7½" x 8" x 11¾" (190 mm x 200 mm x 298 mm)
Approx. Weight*	50 lbs. (23 kg)	48 lbs. (22 kg)
Coverage	.415 sq. ft. (.039 m^2)	.415 sq. ft. (.039 m^2)
Setback/Batter	½" (12 mm)/3.8°	

	Corner	Cap
Nominal Dimensions*	7½" x 17½" x 9" (190 mm x 445 mm x 225 mm)	3¾" x 17¼" x 10⅜" (95 mm x 440 mm x 260 mm)
Approx. Weight*	87 lbs. (40 kg)	43 lbs. (20 kg)
Coverage	.91 sq. ft. (.084 m^2)	

* Nominal Dimensions. Actual dimensions and weight may vary from these nominal dimensions due to variations resulting from the manufacturing process. Specifications may change without notice. See your Anchor representative for details, color options, block dimensions and additional information. Width dimensions taken at the bottom of the unit.

** Length of the back of the tapered units is one inch (25 mm) less than at the face of the unit.

▲ *Anchor lock bar extruded polymer Length: 5'4" (1,625 mm)*

▲ *The lock bar mechanically clamps the geosynthetic reinforcement to the Landmark block.*