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A Guide To Installing Plas-Crete Wall Blocks

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INTRODUCTION

Conigliaro Industries is pleased to provide this basic guide for the successful installation of our Plas-Crete Wall Blocks. The information contained in this guide was compiled from many sources, including the National Concrete Masonry Association, many other block manufacturing companies, various trade publications and from our experience as well as the experience of many contractors, landscape architects and engineers whom have successfully used Plas-Crete Wall Blocks in all types of applications.

Our Plas-Crete Wall Blocks are made from cement, sand, recycled plastic and water. They have several unique characteristics due to their recycled-content, including a lighter overall weight. As such, they are uniquely suited for contractors with mini-equipment and jobs with tight space constraints. With their recycled content, Plas-Crete Wall Blocks are favored by environmentalists and others concerned with using products that benefit the environment.

Plas-Crete Blocks are best suited for large retaining wall and foundation projects that require larger, more substantial blocks. They are designed to look great, to be functional and to be easy to install. Unlike typical “runoff” blocks produced by concrete facilities from excess material, each block is molded in a steel form insuring that they are true-to-size every time. With their unique male/female interlocking system, Plas-Crete Wall Blocks are self-centering and self-leveling.

Naturally, this guide is not all-inclusive. While we attempt in this document to provide some basic concepts and ideas, we expect that landscape architects, contractors and engineers with many years of experience may use alternative construction techniques. We encourage new ideas and hope that you will keep us updated on your latest projects and best practices developed while using Plas-Crete Wall Blocks.

Of course, we welcome your questions and suggestions at anytime and look forward to helping make all your projects a success.

HISTORY AND OVERVIEW

Retaining walls have been used for thousands of years as a means of utilizing marginal land. In the past decade, the cost of land has spiraled as building and development continues to consume prime real estate. As a result, landscape retaining walls have grown in popularity as a primary method of maximizing existing land space.

Until the development of segmental wall systems, the construction and landscape industries often used traditional materials and construction techniques to build retaining walls. Poured in-place concrete, conventional mortared masonry walls or timber walls made of pressure treated wood or recycled railroad ties were the popular materials of choice. In the mid 1980's, a new technology emerged and segmental retaining wall systems were created to answer the need for a simplified, easy to install retaining wall. Their appeal continues to grow as property owners look to enhance the value of their property through beautification.

Plas-Crete Wall Blocks were developed for use in large scale applications that required a heavier wall block than most competitive products as well as rapid construction time-frames. In addition, Plas-Crete has proven to be an exceptional choice for contractors and property owners that wish to use a recycled-content product, helping to improve the environment.

Most segmental retaining wall (SRW) systems are suitable for straight walls, corners and stairs. Others may be used for curved walls. SRW systems provide the ideal way to accommodate grade changes in any landscape or garden project. Uses include landscaping walls, terrace walls, tree rings, flower beds, planters and more. SRW's are especially functional for developers because they save space and allow the property to be utilized to its maximum capacity. In heavy-duty structural applications, SRW's can accomplish grade changes, provide erosion control, serve as bridge abutments and support parking areas. They also offer effective retainment for ponds, creeks, lakes and stream channelization.

Evolution of Plas-Crete Building Blocks

Approximately 100,000 tons of waste No. 3-7 plastic is generated annually in Massachusetts, posing a significant problem to the state's objective of a 70% recycling rate by the year 2010. Unless beneficially used, this material, which amounts to approximately 2 million cubic yards of ground plastic, will be subject to costly disposal in already overburdened landfills each year.

Standard Portland Cement Concrete (PCC) products such as retaining walls, wall blocks, traffic diversion barriers and parking stops (jersey barriers) are heavy and must be handled with heavy equipment during construction and placement. The additional manpower and heavy equipment required for placement of PCC products increases labor and transportation costs significantly over Plas-Crete Blocks.

Conigliaro Industries recognized both these problems and the opportunity they presented to create a new business. Utilizing state funded grant money; Conigliaro Industries began investigating the production of the same PCC products, using waste plastic as a substitute for the comparatively heavy virgin stone. They envisioned PCC products serving the same uses, only making them lighter and easier to handle. The No. 3-7 mixed plastics used to substitute the virgin stone comes primarily from town and city plastic drop-off programs and commercial institutions throughout the Metro Boston area.

Plas-Crete is a blend of virgin sand, ground No. 3-7 mixed plastic, water and Portland cement. Conigliaro produces Plas-Crete on-site with a Zimmerman 4000 "Ready-Mix" concrete plant. Each ingredient material is placed in a separate feed unit on the plant. The plant is equipped with controls so that each material can be measured producing batches according to specified customer needs, i.e. military revetments requiring varying PSI levels. The materials are blended together by auger, which leads to a mold, where the uncured Plas-Crete is vibrated into place. Plas-Crete is allowed to cure for 12-24 hours prior to removal from the mold and it is ready to be sold.

Conigliaro Industries began marketing Plas-Crete Blocks in the summer of 2000 throughout New England. These blocks are being sold for retaining walls, bin structures, loading docks and salt buildings. Each block sold uses approximately 250 lb of waste plastic aggregate. The company estimates that the sales of Plas-Crete blocks will consume over 8 million pounds of mixed plastic per year. Waste plastic that would otherwise be sent to landfills that are already overburdened.

Key Benefits of Plas-Crete Blocks for Commercial Applications

- **At 1850 lbs, 2'x 2' x 4" Plas-Crete Blocks are strong, heavy and thick enough for most commercial applications, yet light enough to move, handle and assemble quickly.**
- **Plas-Crete Blocks are uniform, true-to-size and shape.**
- **The "Lego-Like" extrusion and cavity system allows for easy stacking and storage. This same "Lego-Like" system also makes these blocks self-leveling,**

self-centering and fully nestable.

- **Total weight per block - 1850 lb. half the weight of a standard concrete block of equal size dimensions. PSI rating per block: 1400 to 2000 based on specified needs.**
- **The relative light weight of these builder friendly blocks allows a crew of two to place blocks at a rate of 28 blocks per hour using only the blocks inset hook, a chain and either a bobcat, forklift or back hoe.**

Specifications of Plas-Crete and Concrete Wall Blocks

Standard Size Blocks

ITEM	DIMENSIONS	WEIGHT (lbs)	PSI
Plas-Crete	**2' x 2' x 4' Full Block**	**1,850 lbs**	**1400 -1700**
Plas-Crete	**2' x 2' x 2' Half Block**	**925 lbs**	**1400 -1700**
Concrete	2' x 2' x 4' Full Block	2,400 lbs	3000
Concrete	2' x 2' x 2' Half Block	1,200 lbs	3000
Concrete	2' x 2' x 4' Full Block	2,400 lbs	4000
Concrete	2' x 2' x 2' Half Block	1,200 lbs	4000

Jumbo Size Blocks

ITEM	DIMENSIONS	WEIGHT (lbs)	PSI
Plas-Crete	**2' x 3' x 4' Full Block**	**2,775 lbs**	**1400 -1700**
Plas-Crete	**2' x 3' x 2' Half Block**	**1,388 lbs**	**1400 -1700**
Concrete	2' x 3' x 4' Full Block	3,600 lbs	3000
Concrete	2' x 3' x 2' Half Block	1,800 lbs	3000
Concrete	2' x 3' x 4' Full Block	3,600 lbs	4000
Concrete	2' x 3' x 2' Half Block	1,800 lbs	4000

Please Note - all blocks may be made without Top Knobs, i.e. “Flat Top. Flat Tops are normally used for the top course of walls or bins.

Segmental Retaining Walls - Basic Information

Segmental retaining walls (SRWs) are gravity retaining walls that rely primarily on their mass (weight) for stability. The system consists of concrete masonry units which are placed without the use of mortar (dry stacked), and which rely on a combination of mechanical interlock and mass to prevent overturning and sliding. The units may also be used in combination with horizontal layers of soil reinforcement which extend into the backfill to increase the effective width and weight of the gravity mass.

Design Flexibility - The SRW system is composed of units whose size and weight makes it possible to construct walls in the most difficult of locations. Unique layouts can be easily accommodated. Segmental retaining walls have the ability to function equally well in large-scale applications (highway walls, bridge abutments, erosion control, parking area supports, etc.) as well as smaller residential landscape projects.

Aesthetics - Since SRW units are available in a variety of sizes, shapes, textures and colors, segmental retaining walls provide designers and owners with both an attractive and a structurally sound wall system.

Ease of Installation - Most SRW units can be placed by a single construction worker. The dry stack method of laying units without mortar allows erection of the wall to proceed rapidly.

Economics - SRWs provide an attractive, cost effective alternative to conventional cast-in-place concrete retaining walls. Savings are gained because on-site soil can usually be used eliminating costs associated with importing fill and/or removing excavated materials, and because there is no need for extensive form work or heavy construction equipment.

Performance - Unlike rigid retaining wall structures, which may display cracks when subjected to movement, the flexible nature of segmental retaining walls allows the units to move and adjust relative to one another without visible signs of distress.

Site Design Consideration - Typical designs and specifications for segmental retaining walls should be prepared by a designer who has technical knowledge of soil and structural mechanics. Each SRW unit manufacturer can provide design information tailored to that product, which will indicate the wall heights and design conditions when an SRW should be designed by a qualified engineer. In addition, SRW systems should be designed by a qualified engineer when:

- structures will be surcharged
- walls will be subjected to live loads

- walls will be founded on poor foundations
- the nature of the design conditions requires special consideration.

Geosynthetic Length and Spacing - For soil-reinforced segmental retaining walls, geosynthetic reinforcement increases the mass of the composite SRW structure, and therefore increases the resistance to destabilizing forces. Length of the geosynthetic is typically controlled by external stability calculations. Increasing the length of the geosynthetic layers increases the SRW's resistance to overturning, base sliding, and bearing failures. In some instances, the length of the uppermost layer(s) is locally extended in order to provide adequate anchorage (pullout capacity) for the geosynthetic layers. The strength of the geosynthetic and the frictional interaction with the surrounding soil may also affect geosynthetic length.

A sufficient number and strength of geosynthetic layers must be used to satisfy horizontal equilibrium with soil forces behind the wall and to maintain internal stability. In addition, the tension forces in the geosynthetic layers must be less than the design strength of the geosynthetic and within the allowable connection strength between the geosynthetic and the SRW unit.

Drainage System - Drainage is an essential part of a properly designed SRW. Drainage materials are generally well-graded aggregates. A properly designed drainage system relieves hydrostatic pressure in the soil, prevents retained soils from washing through the face of the wall, provides a stiff leveling pad to support a column of stacked facing units, and provides a working surface during construction. Surface water drainage should be designed to minimize erosion of the topsoil in front of the wall toe and to direct surface water away from the structure.

Batter - Segmental retaining walls are generally installed with a small horizontal setback between units, creating a wall batter into the retained soil. The wall batter compensates for any slight lateral movement of the SRW face due to earth pressure, ensuring that the finished wall does not appear to rotate.

Unit Size and Shear - In conventional (gravity) SRWs, where the stability of the system depends primarily on the mass and shear capacity of the SRW units, increasing the SRW unit width or weight provides greater stability, larger frictional resistance, and larger resisting moments. In soil-reinforced SRWs, heavier and wider units may permit a greater vertical spacing between layers of geosynthetic.

All SRW units provide a means of transferring lateral forces from one course to the next. Shear capacity provides lateral stability for this mortarless wall system. This is accomplished by shear keys, leading lips, trailing lips, clips, pins, or compacted columns of aggregate in open cores.

Embedment - The primary benefit of wall embedment is to ensure the SRW is not undermined by erosion of the soil in front of the wall. Increasing the depth of embedment also provides greater stability when site conditions include weak bearing capacity of underlying soils, steep slopes near the toe of the wall, potential scour at the toe (particularly in waterfront or submerged applications), seasonal soil volume changes, or seismic loads.

Elements - The basic elements of each segmental retaining wall system are the foundation soil, leveling pad, segmental retaining wall units, retained soil, drainage fill, and, for soil-reinforced SRWs, the soil reinforcement.

Foundation soil: The foundation soil is the soil which supports the leveling pad and the reinforced soil zone of a soil-reinforced SRW system.

Leveling pad: The leveling pad is a level surface, consisting of crushed stone or unreinforced concrete, which distributes the weight of the SRW units over a wider area and provides a working surface during construction. The leveling pad typically extends at least 6 in. (152 mm) from the toe and heel of the lowermost SRW unit and is at least 6 in. (152 mm) thick.

Segmental retaining wall units: Segmental retaining wall units are concrete masonry units that are used to create the mass necessary for structural stability, and to provide stability, durability, and visual enhancement at the face of the wall.

Retained soil: Retained soil is the undisturbed soil for cut walls or the common backfill soil compacted behind infill soils.

Drainage fill: Drainage fill is free-draining granular material placed behind the wall to facilitate the removal of groundwater and minimize buildup of hydrostatic pressure on the wall. It is sometimes also used to fill the cores of the units to increase the weight and shear capacity. The dry stacked method of construction used for segmental retaining walls permits water to drain through the face of the wall, aiding in the removal of groundwater. In some cases, a geotextile filter is installed between the drainage fill and the infill to protect the drainage fill from clogging.

Reinforced soil: Reinforced soil is compacted structural fill used behind soil-reinforced SRW units which contains horizontal soil reinforcement. A variety of geosynthetic and steel soil reinforcement systems is available.

Construction

The success of any segmental retaining wall installation depends on complete and accurate field information, careful planning and scheduling, the use of specified materials, proper construction procedures, and inspection.

It is good practice to have the retaining wall location verified by the owner's representative. Existing and proposed finish grades shown on the drawings should be verified to ensure the planned design heights are in agreement with the topographic information from the project grading plan.

The contractor should coordinate the delivery and storage of materials at the site to ensure unobstructed access to the work area and availability of materials. Materials delivered to the site should be accompanied by the manufacturer's certification that the materials meet or exceed the specified minimum requirements.

Construction occurs in the following sequence:
1. excavation and leveling pad construction
2. setting, leveling, and backfilling base course
3. placement and backfilling of units in succeeding courses
4. placement, tensioning, and backfilling of soil reinforcement (when required)
5. compaction of backfill to the specified density
6. capping and finish grading.

As with any structure used to retain soil, careful attention should be paid to the compaction equipment and procedures used during construction. When compacting soil within 3 ft (0.9 m) of the front face of a wall, compaction tools should be limited to hand operated equipment, preferably a vibrating plate compactor. Reinforced soil can be compacted with walk-behind or self-propelled riding compaction equipment.

Installation Tips

1. Always start with a smooth base, joint lines in the walls can only be as straight as the base on which they are placed. A six inch blanket of granular material, compacted and raked or screeded smooth is normally a sufficient base.

2. If possible, prepare the entire base before placing retaining blocks so that a visual inspection can be made to minimize bumps and hollows.

3. If the location is not level or has a stepped bottom surface, place the lowest blocks first, taking care to align the front face of the wall.

4. As the surface finish of the blocks is variable, the best face of the block should be turned out.

5. IMPORTANT - Begin placing the second layer after no more than 5 or 6 bottom layer blocks have been placed, again taking care to align the front face of the retaining wall. (Remember, there is approximately 1/2' of clearance in every direction in the fit of the key ways.)

6. Should the clearance become tight for the second row of blocks, merely place the

next block along the bottom row of the wall, with a slight gap (1/4"), the second and subsequent rows will then have sufficient clearance. Continue placing subsequent rows, taking care to align the front face.

7. Non right-angle corners, or corners where walls have different batters are achieved more easily by building the 2 walls independently and pouring the corner afterwards. Chamfer strips attached to the inside of the form work will blend the corner in with the rest of the wall.

8. If desired, walls can be curved either vertically, horizontally, or both.

9. For speed & convenience a track mounted hydraulic excavator is the best machine to place the blocks.

10. Pressure washing & sealing the surface will minimize algae growth and prolong new appearance.

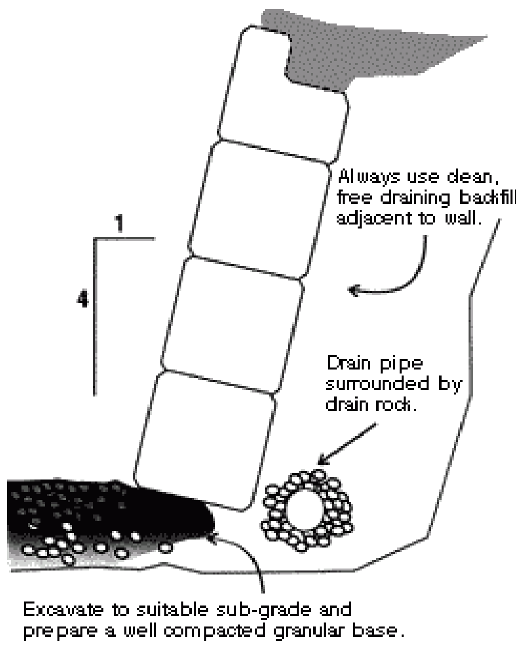
11. Some useful tools to have on the job-site include:

- A transit to lay out a level base. - Shovels and rakes for base preparation.
- A lifting jig to hold blocks at the correct batter.
- A broom to clean the keyways before placing the next layer.
- One or more 5 foot pry bars for jostling the blocks into position.

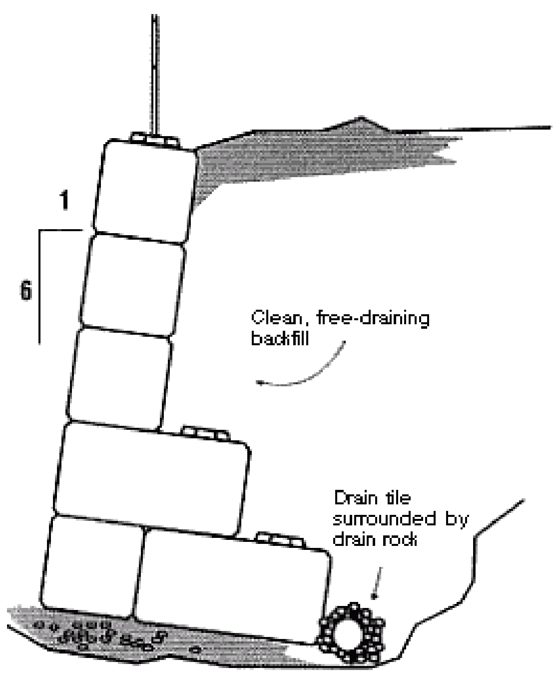
Minimum design considerations for qualified engineers and contractors include:

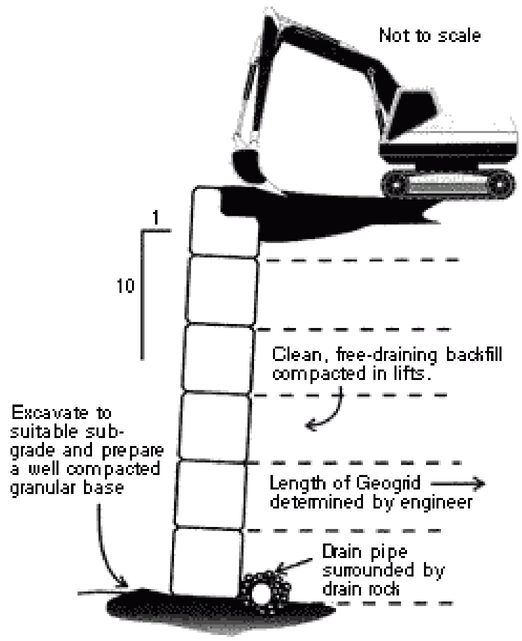
1. Always use free draining gravel or sand and gravel backfill to allow drainage. Where high groundwater conditions occur in the native ground, chimney or blanket drains may be required.
2. Coulomb (sliding wedges) or Rankine (earth pressure) analysis can be used to determine adequate resistance to sliding and overturning of the blocks.
3. Analysis must include additional loading effects of sloping backfill.
4. Additional transient or permanent loads behind the wall.
5. Bearing capacity of foundations including additional loads from backfill on wall should be considered.
6. Prevent migration of fines through wall by use of filter material.
7. Prevent migration of subgrade into backfill.
8. Consider overall stability of retaining wall, backfill, and subgrade.

9. If blocks are to be placed in direct contact with water, i.e. stream channel, lake front or ocean front, you may wish to consider using our standard concrete blocks rather than blocks made with plas-crete. Sizes and dimensions are the same, however the psi ratings are higher. It should be noted, as with any products containing cement, that both products are subject to degradation over time due to water action and salt.



10. A vertical or near vertical wall is possible if a soil reinforcing geo-grid is added to the backfill at every row of blocks. Very high loads can be supported with this type of construction.





11. The greater the batter into the fill, the higher the wall can be built without the need to increase the width of the base or adding reinforcing geo-grid to the backfill.

12. **IMPORTANT - Water pressure and drainage -** A rise in water-table level from the toe of a retaining wall to its top can more than double the horizontal pressure on the retaining wall. This can happen relatively suddenly and is why water is one of the main causes of retaining-wall failures. It is therefore important that the water-table level, direction of water flow and seasonal variations of water in the ground are well understood before construction starts. Also, rain storms or burst water mains can create particularly severe conditions.

    Wall drainage is recommended if the wall backfill is relatively impermeable or if infiltrating water would have nowhere to go. Where no drainage is provided, water pressures should be calculated assuming the highest water-table level that is physically possible, eg before overtopping of a wall element occurs, or before another direction of water flow prevents the water-table level from overtopping the wall. Free-draining wall types such as gabions may be appropriate where water flows are anticipated to be high and maintenance infrequent.

Working with an Engineer

When a retaining wall is to be above 4 feet in height or is to be built in a challenging location or soil, the use of a registered professional engineer may be required. You should also check your local zoning code to determine under which conditions your City or Town's Building Department requires a retaining wall to be designed by a Registered Engineer.

The engineer’s job is to determine the length and the number of geosynthetic reinforcement material that is required to stabilize a site specific segmental retaining wall system, as well as provide drawings and specifications that show how a wall should be constructed.

In order for an engineer to create a project specific design he or she must have the following information:

Soil Information. What kind of soil is on the site, what kind of soil will be used for the backfill and how strong is the soil? This information can be found by contacting the Project geotechnical Engineer or is contained in the evaluation report for the specific site.

Exact block and geogrid combination you wish to use. Once the design is complete, you cannot change the block or the geogrid without having the engineer performing a complete redesign.

Proposed site grading plan. This shows the existing conditions and the proposed conditions. The engineer needs this information to determine the wall loading information, such as slopes, a parking lot or a building. This grading plan will also show specific site information that may affect the wall design. Examples of this site specific information would be site drainage, proximity of adjacent below ground structures, location and evaluation of adjacent ponds, channels, rivers ect.

Conigliaro Industries can direct you to a professional engineer when and if required.

REQUIRED DESIGN INFORMATION WHEN WORKING WITH AN ENGINEER:

The first step in building a retaining wall is thorough planning. Here is what you need:

Site Plan
The Site Plan is a detailed drawing of the site including wall location, length, elevations, information on grading, underground utilities, erosion control, and storm water management.

Design Soils Information
The Design Soils Information identifies the kinds of soils on your construction specifications.

Wall Construction Plan
The Wall Construction Plan is a blueprint of the wall you're going to build, and has 5 requirements: Wall, Toe and Crest elevations; Reinforcement location and length; Soil conditions and parameters; Drainage and other wall details; wall construction specifications

Installation Guidelines:

The best place to find installation guidelines is in the Segmental Retaining Wall Installation Guide from the National Concrete Masonry Association. To receive a copy of the N.C.M.A. Segmental Retaining Wall Installation Guide, call the NCMA directly at (703) 713-1900 or call Conigliaro Industries, Inc. at (888) 266-4425.

EVALUATION

- **Evaluation of the Wall Design**
  With these four design components, you have all the information you'll need to build your wall. Check the wall plan for accuracy, and make sure it's certified by a registered Engineer.

- **Submittals**
  Submittals include obtaining Plas-Crete Wall Blocks literature, signed and stamped drawings with calculations, retaining wall block test results (for example compressive strengths) samples of the block, and samples of the reinforcement and accompanying literature.

ON SITE EVALUATION

- **Building Materials**
  Lay out a storage area for the block, reinforcement, drainage and base materials to keep them protected from surrounding equipment and construction. Check the delivered materials carefully. Elevate the blocks on wooden pallets, and keep the reinforcement dry, covered and clean.
- **Safety**
  Remember, safety first! Follow the guidelines for worker and job site safety established by your state's Department of Labor. And take special precautions for OSHA requirements, which include maintaining safe slopes.

- Coordinate with the foreman to make sure you know the location of underground utilities.

REGISTERED PROFESSIONAL ENGINEERS FAMILIAR WITH DESIGNING WALLS USING PLAS-CRETE BLOCKS

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