

Precast Modular Block (PMB) for Retaining Wall Systems

Field Installation Best Practices Manual



NPCA

Precast ... The Concrete Solution

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NOTES

1. This manual does not claim or imply that it addresses all safety-related issues, if any, associated with its use. The manufacture of concrete products may involve the use of hazardous materials, operations and equipment. It is the user’s responsibility to determine appropriate safety, health and environmental practices, and applicable regulatory requirements associated with the use of this manual and the manufacture of concrete products.
2. Use of this manual does not guarantee the proper function or performance of any product manufactured in accordance with the requirements contained in the manual. Routine conformance to the requirements of this manual should result in products of an acceptable quality according to current industry standards.

INTRODUCTION

This Best Practices Manual is intended to provide general information on wet-cast precast modular block retaining walls and provide guidance in the proper installation. This manual includes the basics of wall construction and presents many details encountered in site work. Visit our website www.precast.org, NPCA's BPM (Best Practice Manual) or consult with your local precast concrete wall design engineer for additional information.

DEFINITIONS

backfill – earth or other material placed between a retaining wall and existing ground to replace material that has been previously excavated.

backfill soil – either in-situ soils or borrow soil used to fill excavated and over-excavated areas behind the wall system. These soils shall be free of debris and deleterious material.

base course – first, or lowest, footing course to be installed; it may be totally or partially buried.

base material – selected free-draining granular material of a planned thickness, compacted and leveled to support the base course; in unusual applications, the base course may be a lean concrete as specified by the design engineer.

borrow soil – any soil imported from another location, typically offsite, to be used as backfill.

contractor – person or entity who undertakes responsibility of the construction of the retaining wall.

discing – to cultivate or break up soil using a harrow or plow that turns and loosens soil with a series of discs

drainage column – see gravel fill

engineer – owner's designated organization or trained and experienced individual with authoritative charge over engineering functions and responsibilities.

foundation soil – soil mass supporting the wall base. Foundation soil is typically undisturbed in-situ soils; these soils may be compacted to reduce settlement from base excavation work. Proof-rolling may be required in order to obtain a firm, unyielding base for the wall.

gravel fill – free-draining, coarse-grained aggregates placed either within the PMB unit cores and between their openings or directly behind the units. Depth of gravel fill should be specified in the contract documents. The gravel fill acts to facilitate drainage either through the PMB units or behind them, depending on its placement, by accepting incidental water thereby relieving hydrostatic pressures. Wall drainage should not be used for conveyance of site runoff; adequate surface drainage structures above and behind the wall should be provided within the site plan.

leveling pad - see wall base

manufacturer's representative – a product representative able to provide technical assistance to the contractor, engineer or owner.

OSHA – Occupational Safety and Health Administration

owner – owner of the project or property, who is identified in the project contract as being responsible for the payment for the work performed under the terms of the contract.

Precast Modular Block (PMB) - wetcast modular retaining wall block

proof-rolling – several passes from a 10-ton smooth-drum vibratory roller or loaded tandem-axle truck used to compact subgrade soils and/or identify any soft or loose pockets that may require removal and replacement, additional compaction, and/or further investigation by the geotechnical engineer.

reinforced soil – compacted structural fill placed behind the PMB units to interact with the geogrid reinforcement; this area extends from behind the PMB units to the tail end of the geogrid.

retained soil – soil immediately behind the PMB units or gravel fill in conventional gravity-wall systems or immediately behind the reinforced soil for mechanically stabilized PMB units.

shop drawings – graphics, usually in contract documents, produced by the PMB supplier to show installation details for the contractor.

site contractor – organization responsible for the installation of the wall system.

soil compaction – proper soil placement and consolidation are essential to the successful performance of retaining wall structures. Soils must be compacted in specified lifts to achieve maximum soil shear strength and validate the design.

subbase soil – see foundation soil

subgrade soil – see foundation soil

swale – a depression or lower level in a stretch of flat land.

wall base – level surface either of gravel fill or lightweight concrete used to distribute the weight of the PMB units evenly over the underlying subgrade.

CONSTRUCTION RESPONSIBILITIES

Precast Retaining Wall Dealer

Dealer responsibilities include assisting the owner, contractor and inspectors in scheduling of materials, construction procedures, contract documents, plans and specifications. The manufacturing representative is available to assist and train the contractor and inspectors as requested and when necessary. To locate an NPCA producer member please click on the following link <http://www.precast.org/find-a-precaster?t=45>

Engineer or Owner's Representative

Owner representative or Engineer is responsible for the enforcement of the contract documents, plans and specifications. Owner shall employ the services of a material engineering firm to provide quality control testing during embankment construction.

Owner and Engineer shall not be responsible for means or methods of construction or for safety of workers or of the public.

Site Contractor/Installer Responsibilities

Owner representative or Engineer is responsible for the enforcement of the contract documents, plans and specifications. Owner shall employ the services of a material engineering/testing firm to provide quality control testing (if required by the owner or building agency) for the casting of panels and pouring of foundations.

Owner and Engineer shall not be responsible for construction means or methods or for safety of workers or of the public.

Site Contractor/Installer Responsibilities

The contractor will be responsible for:

- Checking the materials upon delivery to assure that proper materials have been received.
- Protecting the materials from damage. Damaged materials shall not be incorporated into the wall or the reinforced soil embankments.
- Preventing excessive mud, concrete, adhesives and other substances that may adhere from coming in contact with the materials.
- Furnishing and installing precast wall units to the lines and grades shown on the plans and as specified.
- Safety.

MATERIALS

Concrete for precast modular unit shall have a minimum 28-day compressive strength of 4,000 psi. Entrained air content shall be between 5% and 7%.

Reinforcing steel (if used) shall be Grade 60. Minimum concrete clear cover to reinforcement shall be 1.5 in.

Refer to manufacturer's specifications for PMB tolerances.

DELIVERY, STORAGE AND HANDLING

Check the materials upon delivery to assure that proper material has been received. Remove damaged or otherwise unsuitable material from the site.

Exposed faces of precast modular block units shall be free of chips, cracks, bug holes, stains and other imperfections distracting from their appearance.

Prevent mud, concrete, adhesives and other substances that may harm appearance of unit from coming in contact with the system components.

Geotextile filter and pre-fabricated drainage composite materials shall be delivered, stored and handled in accordance with ASTM D4873.

Reference NPCA Retaining Wall BPM for dunnage procedures.



EQUIPMENT AND SUPPLIES

The following tools are recommended but should not be limited to this list. Site conditions may require other equipment, tools and materials.

Tools and Equipment:

- Excavator
- Skid steer
- Front loader
- Compactor
- Spreader bar
- Chains
- Laser level
- Level
- Shovels
- Brooms
- Pry bars
- Labor

Materials:

- Wall base material
- Unit fill material
- Drain tile (if required)
- Off-site borrow (if required)
- Filter fabric (if required)
- Hand rail (if required)

SITE PREPARATION

- Review the approved site plan to confirm lot lines, wall location, length and elevations.
- Schedule preconstruction meeting.
- Verify the on-site soil conditions.
- Call the local utility companies to confirm the location of underground utilities.
- Obtain all necessary building permits.
- Confirm drainage to avoid erosion or buildup of water behind wall.
- The contractor/installer will be responsible for the positive drainage away from the wall during construction to eliminate any unnecessary impact on the partially constructed wall.

EXCAVATION

Layout the location and length of the wall. If possible, always start the wall base at the lowest elevation of the entire wall.

Excavate as required for installation of the retaining wall system. Use caution not to over-excavate beyond the depth needed for the foundation.

Slope or shore excavation as necessary for safety and for conformance with applicable OSHA requirements.



FOUNDATION PREPARATION

Foundation soils shall be excavated as required for wall base to the dimensions shown on the plans. Foundation soil shall be observed by the Geotechnical Engineer to confirm that the bearing soils are similar to the design criteria.

Foundation soil shall be proof rolled and compacted to a minimum of 95 % of the maximum dry density (ASTM D698, Standard Proctor) and inspected by the Owner's Engineer prior to placement of leveling pad materials. The contractor shall replace any unsuitable soils discovered during excavation at the direction of the Geotechnical Engineer.

WALL BASE CONSTRUCTION

Construct the wall base to the lines and grades shown on the plans. The base may be constructed from lean concrete with a minimum 28-day compressive strength of 3,000 psi concrete or granular material. Construct base to the material and dimensions shown on the plans. Over-excavated areas shall be filled with additional concrete or granular base material.

Compact the wall base to provide a hard and level surface to support the precast wall unit. Base material shall be compacted to a minimum of 95 % of the maximum dry density (ASTM D698, Standard Proctor).

Prepare and smooth the granular material to ensure complete contact of the first course with the wall base. The surface of granular base may be dressed with finer aggregate to aid leveling, provided that the thickness of the dressing layer should not exceed 3 times the maximum particle size used.

Concrete may be placed as a full-thickness base or as a topping to level the base. If used as a topping, the concrete shall have a minimum thickness of 3 in.

It is important to ensure that the wall base has proper drainage. Consult with the Geotechnical Engineer if added drainage is needed.

GRAVITY WALL UNIT INSTALLATION

First Course

Place the first course of precast wall unit directly on the wall base (see detail).

If possible, begin placing precast wall unit at the lowest section of the wall. The unit shall be leveled per plan and specifications side-to-side, front-to-rear and with respect to the adjacent unit. Ensure that precast wall units are in full contact with the compacted base. Adjacent unit should be in contact. **The first course is the most important to ensure accurate and acceptable results. Leveling should be done by means of a level across the top of the unit.**

If the wall base elevation varies refer to detail for wall base steps.

In some cases a mass extension unit or cast-in-place tail extension may be used to achieve taller walls in a gravity configuration. These units shall be installed in accordance with the plans or shop drawings.

Fill all voids between and within the unit or behind the unit depending on the type of unit used (see manufacturer's specific installation guide) with granular unit fill.

If shown on the plans or the shop drawings, provide a geotextile filter for separation from backfill as per Geotechnical Engineer's recommendations.

Drain tile shall be used if shown on the plans.

Blocks to be installed per manufacturer's specifications.



Subsequent Courses

Remove all excess aggregate and other materials from the top of the unit before laying up the next course.

Place the next course of segmental units in running bond with the previous course. Always refer to Manufacturer's specific installation guide. Check the unit for levelness and proper alignment.

The layout of radius and corners shall be installed in accordance with the plans or shop drawings.

Continue placing successive courses to the elevations shown on the plans. Construct wall in level stages, placing the unit at each course for the entire length of the wall, if possible. Unit fill and backfill should be placed to the level of the top of the facing unit before placing the next course.

Provide temporary swales to divert runoff away from wall excavation and away from the wall surface during the construction phase.

Install the precast wall top unit. Place unit fill and backfill level with the back face of the unit.



BACKFILL PLACEMENT AND COMPACTION

Backfill shall be spread in uniform loose lifts of 8 to 12 in. behind the wall system. Each lift shall be compacted to 95% of standard proctor density within 2% of its optimal moisture content.

Excessively wet/dry and/or nonuniform soils shall not be used as backfill unless the following procedures are employed at a minimum:

- For excessively dry soils – water shall be added to the soil and mixed to within $\pm 2\%$ of its optimal moisture content and confirmed by the Geotechnical Engineer.
- For excessively wet soils – these soils may require aeration, discing and drying until they are within $\pm 2\%$ of its optimal moisture content and confirmed by the Geotechnical Engineer.
- For nonuniform soils – as directed by the Geotechnical Engineer, these soils may be mixed by discing with other onsite excavated soils or with borrow soils to achieve properties consistent with the design criteria. Testing of these soils shall be performed by the Geotechnical Engineer in accordance with the design specifications.

Compaction of the backfill shall be completed using lightweight compaction equipment so that the wall’s stability is not disrupted or compromised by vibration from operation of heavy equipment. Hand-operated plate equipment shall be used around the PMB units as well as within 3 ft of the wall.

Heavy construction equipment adjacent to or near the wall should be avoided; these additional loads or vibratory impacts may not have been considered in the design and may result in immediate settlement, and/or may disrupt the wall’s stability and/or cause worker injury.

CONSTRUCTION TOLERANCES

Construction tolerances should be established prior to the commencement of construction; these tolerances are normally outlined within the construction specifications. Agreeing on these tolerances exist prior to construction enables both the owner and the contractor to have an understanding of acceptable limits within the wall system’s construction.

CLEANUP

- Remove any damaged or unused precast wall units.
- Remove any uninstalled unit fill or backfill material.
- Remove site debris caused by wall construction.



TROUBLESHOOTING

Here are some unacceptable wall conditions and relevant troubleshooting parameters to check:

1. First course not level:
 - Wall base not level
 - Unit does not meet manufacturing specifications
 - Subbase not properly compacted
2. Wall leaning in:
 - Alignment units not engaged
 - Unit not level
 - Subbase not properly compacted
3. Wall leaning out:
 - Alignment units not engaged
 - Unit not level
 - Subbase not properly compacted
4. Wall has a dip:
 - Wall base not level
 - Wall base not properly compacted
 - Subbase not properly compacted
5. Unit will not stack flat:
 - Wall base not level
 - Unit does not meet manufacturing specifications
 - Excess aggregate or other material on top of unit
 - Subbase not properly compacted



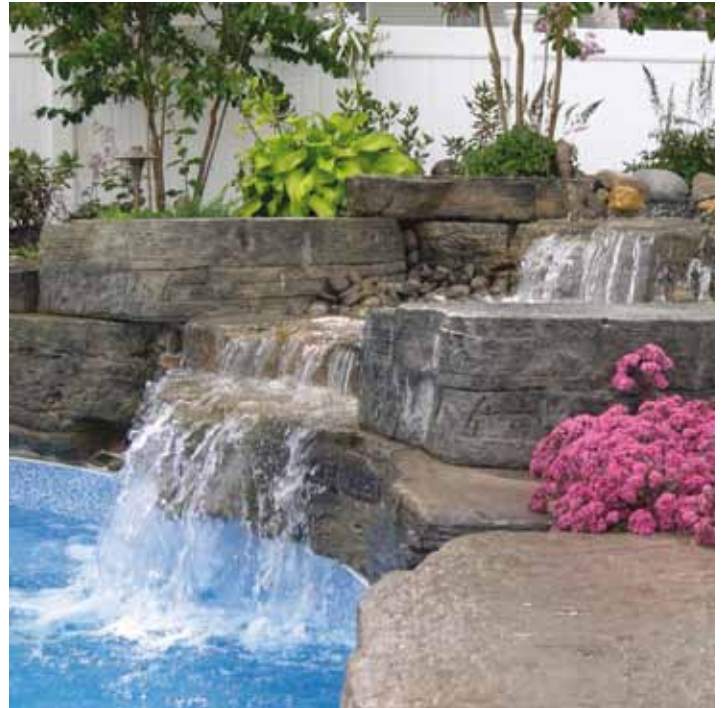
SAFETY & LIABILITY

- The contractor/installer of any PMB wall is solely responsible for construction site safety. The PMB manufacturer shall not be responsible for means or methods of construction or for safety of workers or of the public.
- The contractor/installer will be responsible for the positive drainage away from the wall during construction to eliminate any unnecessary impact on the uncompleted wall.
- The PMB manufacturer shall not be held liable for any damages or claims from the result of storms, floods, weather or other adverse conditions that are caused by nature.



REFERENCES

- ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- ASTM C138 – Standard Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete
- ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete
- ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
- ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³))
- AASHTO T22 – Compressive Strength of Cylindrical Concrete Specimens
- AASHTO T141 – Sampling Freshly Mixed Concrete
- NPCA Best Practices Manual Precast Concrete Retaining Wall Systems
- NPCA Precast Concrete Retaining Wall Products Technical Brochure





This Best Practices Manual is subject to revision at any time by the NPCA Sound and & Soundwall Product Committee, which must review it at least every three years.

Special thanks are given to the Sound Wall Task Group for updating/compiling this manual.

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