Rock Block

Retaining Wall System

Design Manual 1.10

HUDSON CIVIL PRODUCTS

Rock Block is a proprietary precast concrete faux rock retaining wall system design and developed by Hudson Civil Products in Tasmania, Australia. The intellectual property and design details remain the property of Hudson Civil Products.

This installation and design manual is intended to supplement a detailed, site-specific wall design prepared for your project by a professional engineer and/or designer. The construction documents for your project will supersede any recommendations presented in this manual.

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Typical project and construction-specific preparation tasks, such as general project safety planning and practices and/or typical construction site works tasks, are not covered in the below – please use a competent and experienced contractor to ensure that the project is delivered in accordance with all regulatory requirements and safe work principles.

Please ensure that you seek all necessary regulatory and engineering approvals and permits for your project*. Your local council, engineer, building surveyor, designer or other accredited building professional will be able to help confirm the specific requirements for your project. Always seek professional advice and ensure confirmation of the location of any underground services or other site specifics considerations before commencing any work on site.*

Product Overview

The **Rock Block** system is a precast "big-block" style retaining wall, designed and manufactured in Tasmania, by Hudson Civil Products. It features a low number of component types and dry-stack construction for simplicity and rapid installation. The system was developed entirely in-house to be *t*he most attractive, cost effective, site friendly, and fastest installation system of any big-block retaining wall option.

Benefits of the Rock Block system include:

- **Simple standard units:** Only a single standard block size (1500×500×900 mm) is used for base, mid, and top courses (with a 100 mm toe on base blocks), plus a few specialty blocks (half/full corners and optional cap units). This minimizes on-site inventory and handling complexity. All blocks interlock by gravity alone—no mortar or connectors needed (truly "KISS" design!)
- **Flexibility:** Walls can be built vertical or with a setback batter (each course steps back 45 mm), and can be filled with granular drain rock or concrete. The system also supports reinforcement (geogrid tie-backs or through-rod anchors) if needed for very tall walls. The design's flat block surfaces have *no knobs*, allowing geogrid to lay flat without risk of tearing.

- **Speed & Cost Efficiency:** The large blocks stack quickly without grout or complex connections, enabling rapid construction and lower labor hours. Blocks are cast with built-in **SwiftLift** anchors for safe, fast crane handling. Altogether, Rock Block walls can be built significantly faster than conventional small modular units, saving time and money.
- **High Performance:** Despite the simplified design, Rock Block walls can be engineered to any height or load as allowed by soil conditions. The dry-stack, mass-gravity construction and ability to integrate drainage and reinforcement means even demanding applications (high surcharges, poor soils) can be addressed with proper design.
- **Typical applications** include tall cut embankments, seawalls, bridge abutments, wingwalls, and reinforced soil slopes.

Block Specifications and Components

Each Rock Block wall is built from a simple set of precast concrete units (all 500 mm front-to-back depth):

- **Standard Block:**

The workhorse unit for all courses - used as a Base, Intermediate and Top block. Dimensions are 1500 mm (length) × 500 mm (height) × 900 mm (depth). Note: when used as a base course, the additional 100 mm toe below is integral at the bottom (making base blocks 1000 mm high in total). Standard blocks are molded with a textured rock face front. The blocks have internal hollow cores to reduce weight and to accept gravel or concrete no-fines infill (improving stability and increasing mass without a transport or lifting penalty).

- **Full Corner Block:**

Used to form 90° outside corners or box ends. Dimensions are 1500 mm × 500 mm × 750mm deep – essentially the standard block width/height but only 750 mm deep (front to back). Cast in left- and right-hand versions; these blocks are solid concrete (no hollow core) for structural integrity at corners.

- **Half Corner Block:**

Half-length (750 mm × 500 mm × 750 mm deep) corner unit for stepping courses (brick stack style). Also cast in left/right pairs and solid concrete. Half units may be used to terminate a wall with a finished end or to create a staggered corner.

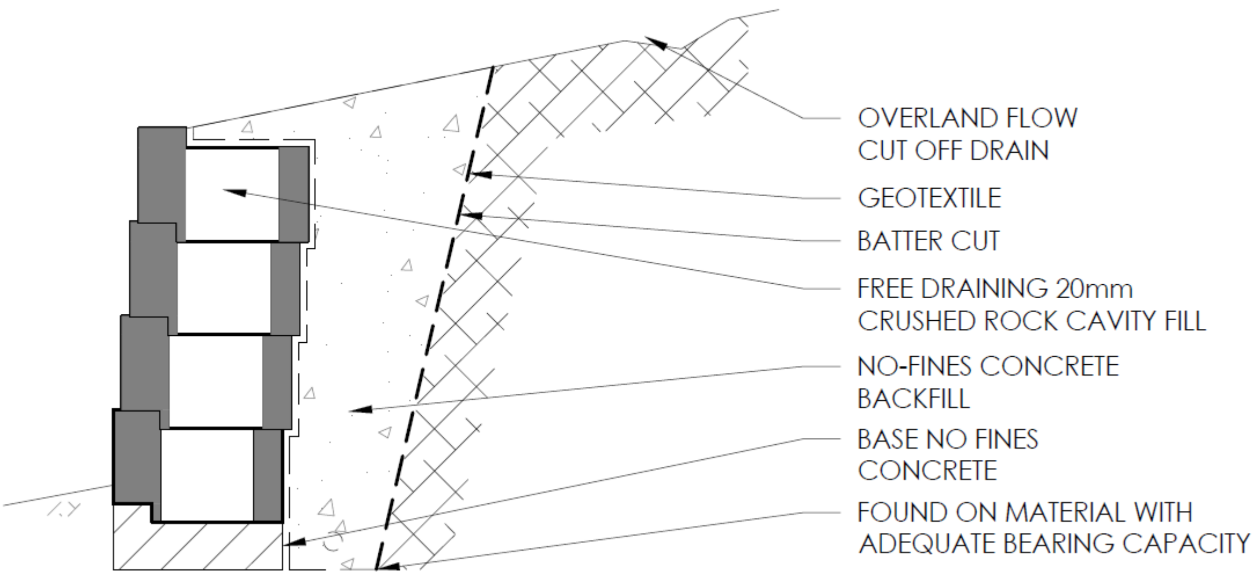
- **Capping Units:** Precast capping stones are available to dress the top of the wall for a clean finish if required.

- **Lifting:** All Rock Block components are equipped with galvanized proprietary ***SwiftLift*** lifting anchors cast in, allowing secure attachment of lifting clutches for safe and efficient placement.

All blocks are manufactured from high-strength structural concrete (typically 40 MPa). The standard block units have internal cavities, which serve to reduce the unit weight and to accommodate granular infill or no-fines concrete for added mass to aid wall design. No separate pins or connectors are needed in assembly; stability is achieved through the weight and geometry of the blocks including the shear key effect of the tongue-like toe on units.

Design Principles

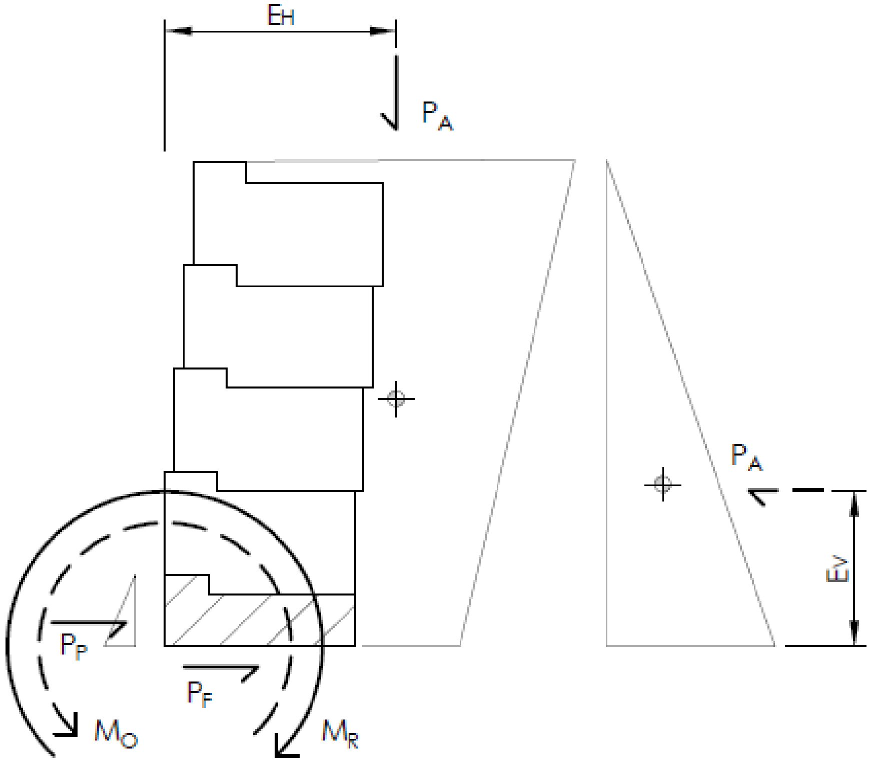
Rock Block walls are gravity retaining structures that resist earth pressures by virtue of their mass and frictional interaction with the foundation.   A typical wall arrangement is shown below:



ROCKBLOCK RETAINING WALL

Designs are developed and checked by comparing *destabilizing forces* (those tending to slide or overturn the wall) against *stabilizing forces* (those resisting movement). In stability calculations, the following general concepts apply:

1.1 Design conditions explained



FREE BODY DIAGRAM

DESTABILISING ACTIONS

SLIDING	P_A - ACTIVE EARTH PRESSURE
OVERTURNING	M_O - OVERTURNING MOMENT = $P_A \times E_V$

STABILISING ACTIONS

FRICTION	P_F - FRICTION ACTION = $P_A \times Ø$
EMBEDMENT	P_P - PASSIVE EARTH PRESSURE
RIGHTING	M_R - RIGHTING MOMENT = $P_V \times E_H$

SAFETY FACTORS

SLIDING	$SF_S = (P_F + P_P) / P_A$
OVERTURNING	$SF_O = M_R / M_O$

The design of a Rock Block retaining wall compares the destabilizing forces with stabilizing forces.

- **Destabilizing forces** include the retaining material, back-fill compaction, and traffic.
- **Stabilising forces** include friction between the wall and the foundation soil, and soil in front of a buried footing (embedment).

1.1.1 Sliding

Sliding considers the wall moving (sliding) horizontally away from the retained material.

1.1.2 Rotating

Rotating considers the wall overturning (rotating) where the bottom of the wall remains in place, while the top of the wall moves away from the retained material.

1.1.3 Global stability

Global stability considers the performance of the whole site. The potential for soil slips in the site material surrounding and below the retaining wall are dependent on the site conditions and must be assessed by a registered professional geotechnical engineer.

1.1.4 Factor of safety

A factor of safety is a number that relates the stabilising forces to the destabilising forces.

$$SF = f_S / f_D$$

SF must be greater than or equal to 1.5

SF is dependent on the project’s required degree of confidence and may be increased.

1.2 Destabilizing forces

1.2.1 Hydrostatic soil

The horizontal force on the rear of the Rock Block retaining wall can be considered as similar to how water pressure increases with depth. Horizontal soil pressure increases as the depth increases. The relationship between soil depth and soil horizontal pressure is dependent on the site materials.

1.2.2 Compaction

Vibrating machine compaction introduces significant stresses in back-fill. Construction of a vehicle pavement is one situation where machine compaction may be anticipated. The horizontal component of these stresses is dependent on the weight of the compaction machinery and the manner in which back-fill layers are placed. As compaction induced forces can be considerable, consideration in the design of a Rock Block retaining wall is required.

1.2.3 Traffic

Vehicle traffic may impose vertical forces on the retained material. These vertical forces may affect both the sliding and overturning forces on the HCP Rock Block wall and must be considered in design.

1.2.4 Roadside furniture

Barriers may be included to resist horizontal traffic forces at the top edge of the Rock Block retaining wall.

Horizontal forces must be considered in determining factors of safety in both sliding and overturning. Additionally, the Rock Block wall design should consider dislodging individual Rock Block components at barrier mounting points.

1.2.5 Global stability

Global stability refers to the overall stability of the soil and how the site performs as a whole. Assessment of global stability should be assessed on a site by site basis by a registered professional geotechnical engineer.

1.3 Stabilizing forces

1.3.1 Friction

Friction between the bottom of the wall and the foundation soil.

Friction at the base resists horizontal sliding forces.

$$F_{friction}\text{-}= \varphi \times F_{wallweight}$$

φ is a property of the materials encountered on site and should be determined by a geotechnical engineer.

1.3.2 Soil forces k

The horizontal force on the Rock Block wall increase as the depth of the retained soil increases.

This horizontal force may be estimated by:

$$Fh = k \times Fv.$$

The value of k should be determined by a geotechnical engineer.

k may be used in calculating the horizontal destabilising force of the retained material on the back of the wall, and the resisting force of the Rock Block pushing against downhill soil.

1.4 Site conditions

1.4.1 Uphill and terracing

Design of Rock Block retaining walls must take into account the slope and / or terracing of the retained materials. The shape of the retained material finished surface may affect the horizontal forces action on the Rock Block wall and must be considered in calculating design actions.

1.4.2 Downhill slopes

Downhill slope may impact both sliding and overturning factors of safety. The capacity of soil resisting horizontal forces where downhill slopes are present must be considered in determining sliding factors of safety,

1.4.3 Drainage

Appropriately designed drainage of retained soils reduces hydrostatic loading on the HCP Rock Block wall and acts to protect against excessive foundation soil moisture levels. Drainage arrangements sized and spaced to mitigate potential for development of water pressure can include:

- Cut-off drains to intercept and redirect surface water.
- Weep holes allowing moisture to pass through the Rock Block wall.
- Slotted drains installed in the retained material parallel to the Rock Block wall.

All drainage should be directed away from the Rock Block wall, and ideally discharged to an onsite storm water reticulation system.

1.4.4 Foundation improvement / bearing capacity

The Rock Block units and back-fill ballast must sit upon material with sufficient bearing capacity. The bearing capacity of soils may change with moisture content. Generally, the bearing capacity of soil reduces as moisture increases. To limit vertical settlement, it is prudent to consider bearing capacity during all expected site conditions. Improving bearing capacity typically addresses site specific conditions.

- Isolated areas of low capacity may be bridged with reinforced concrete footings.
- Sites with shallow soft materials may be excavated and replaced with compacted gravel, or concrete.
- Sites with deep soft materials may require pier and reinforced concrete footings.

1.4.5 Tolerance to sliding

Tolerance to degree of sliding is site and project specific. Horizontal movement may reduce the magnitude of soil compaction forces on the wall allowing for a reduction in materials during construction where some sliding may be tolerated.

Informative Design Table

Using the assumptions above (granular backfill, level ground or mild slopes, drained conditions, Hudson Civil provides *indicative design tables* for Rock Block walls. **Table 1** shows the approximate maximum wall heights (in number of courses and meters) for various backfill conditions and soil friction angles, based on in-house engineering analysis. These values assume a standard wall cross-section (500 mm block depth, one row of blocks) with a nominal embedment of 0.2–0.3 m as noted. **All designs must be confirmed for site-specific conditions by a qualified engineer**; the table is for preliminary guidance only.

Table 1. *Indicative maximum wall heights for Rock Block gravity wall (single depth), given typical soil parameters. Embedment depth assumes dense granular soil in front of wall.*

TABLE 1

Backfill Condition	**Soil Friction angle**	**No. Blocks**	**Approx. Wall Height (m)**	**Required Toe Embedment**
Level backfill, No surcharge	30°	5	2.2 m	0.30 m
	35°	6	2.7 m	0.30 m
	45°	7	3.25 m	0.25 m
Backfill 1:10 slope, No surcharge	30°	4	1.8 m	0.20 m
	35°	5	2.3 m	0.20 m
	45°	6	2.8 m	0.20 m
Level backfill + 5 kPa surcharge	30°	4	1.7 m	0.30 m
	35°	5	2.2 m	0.30 m
	45°	6	2.7 m	0.30 m

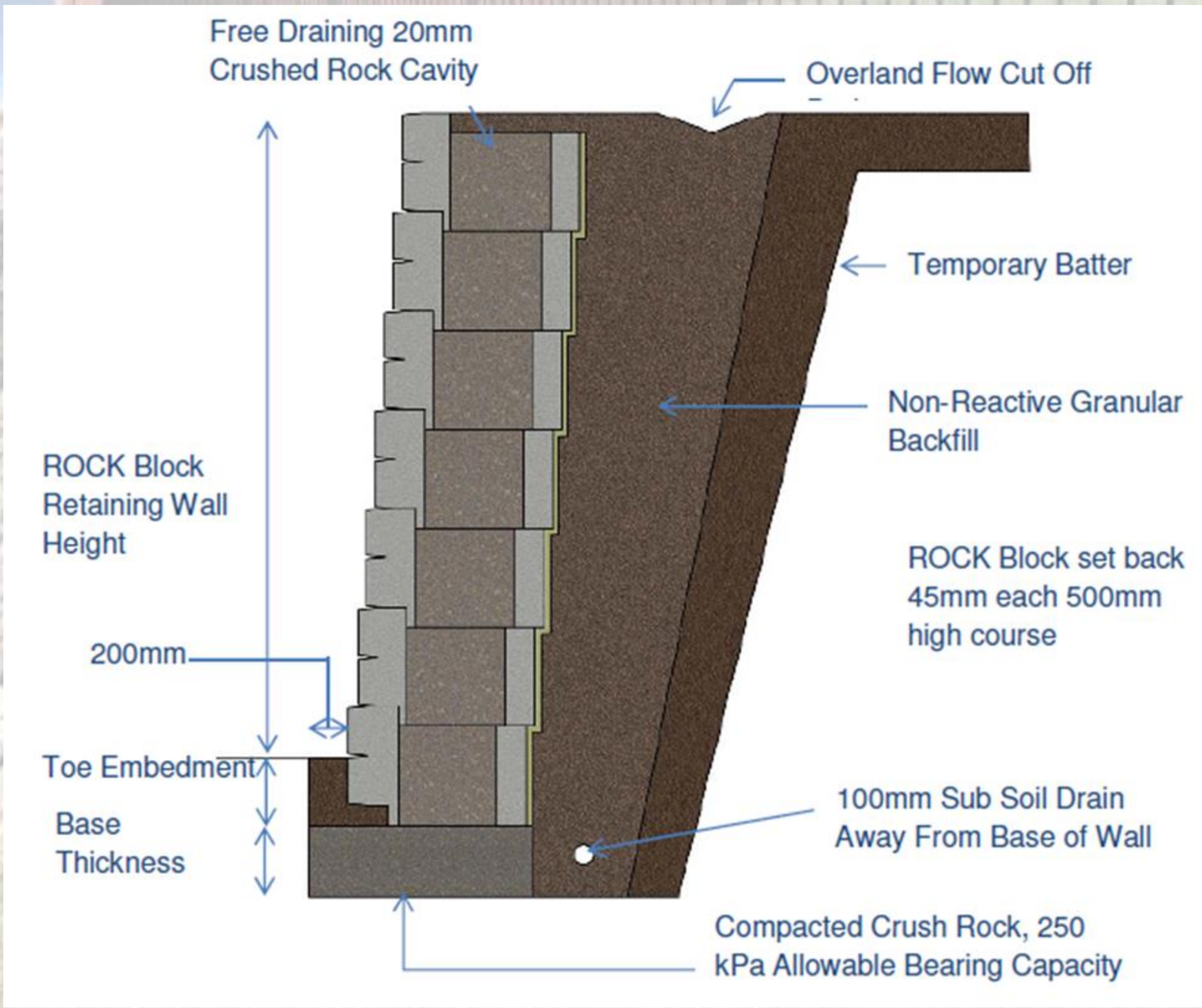
This illustrates that higher friction angle soils (35–45°) or a sloped-back fill profile allow taller unreinforced walls, whereas surcharge loading reduces the allowable height. In practice, if the required height exceeds these values, the wall can be stepped back (using a multi-tier arrangement), or geogrid reinforcement can be introduced to convert it to a reinforced soil wall. Please consult your designer for further details around these options for larger and more complex wall arrangements.

All walls should be designed by a registered engineer or designer using site conditions considering appropriate adverse conditions determined by a professional geotechnical engineer.

Installation Guidelines

Proper construction is essential for the wall to perform as designed. The following guidelines cover typical installation steps for Rock Block gravity walls.

Take the time to review and understand the project drawings and any specifications as prepared by your engineer/designer, including details around site and soil conditions. Pay particular attention to soft or expansive soils or where site conditions deviate from the those nominated in the designed details, as well as ground water or surface water present on or near the site. A pre-construction meeting with the engineer / designer, and other construction professionals such as geotechnical advisor, contractor, along with the client, is recommended.



Typical cross-section of a Rock Block retaining wall (schematic).

Some key notes:

1. **Wall Batter/Setback:** Rock Block walls are built with a built-in setback of 45 mm per course for every one block height of 500 mm (see images below). This provides additional stability and reduces pressure on the wall by leaning it into the retained material.

2. **Granular Infill:** The core of each block and a zone behind the block are filled with 20 mm angular crushed rock or similar free-draining aggregate. This adds weight to the wall and facilitates drainage of any water that enters the wall.

3. **Drainage Systems:** A **100 mm perforated drain pipe** runs behind the base of the wall to collect and remove groundwater. It should be surrounded by free-draining material (clean crushed rock or similar) and wrapped in geotextile (to prevent clogging by fines), then led to a suitable outlet. Additionally, weepholes or open joints every few blocks can allow any water within the blocks to weep out the front as required.

4. **Foundation Base:** The wall should sit on a compacted crushed rock or concrete pad footing with a long-term allowable bearing capacity of the order of 200+ kPa (nominal depending on the specifics of the site and wall design requirements prepared by your designer, for the height of the wall and site conditions). This arrangement provides a firm, level platform and spreads the load. The first course is typically embedded below ground (at least 200 mm or as required) both for stability and to protect against erosion at the toe.

5. **Reinforcement (if required):** In taller installations, geogrid can be layered between courses to tie the wall face into a reinforced soil mass. Because Rock Block units have flat tops (no knobs), geogrid lies neatly and can develop strength without voids or stress concentrations. Additional no-fines concrete behind the wall, to increase mass, can also be beneficial.

Site Preparation and Base Installation

1. **Excavation & Subgrade:** Clear any topsoil, vegetation, or unsuitable material from the wall footprint. Excavate to the design base level, extending a minimum of 300–600 mm in front of the wall to accommodate the toe and working space. The subgrade should be a **firm, level bearing stratum**—remove any soft spots and replace with compacted granular fill as needed. If the native soil has low strength or is moisture-sensitive, consult an engineer; options like over-excavation and replacement, or a concrete leveling footing, may be required.
2. **Base Layer:** Place a compacted **gravel leveling pad** at least 150–200 mm thick under the first course of blocks. Use a well-graded crushed rock (e.g. 20 mm aggregate) and compact it. The top of this base should be level along the wall alignment (use a laser or tightly pulled string line to check grade). Proper base preparation ensures uniform support and eases block placement.
3. **Layout and Batter:** Mark out the wall line at the base. If the wall is designed to lean back (battered), offset the courses accordingly. Each Rock Block course will **set back 45 mm** from the one below (this is built into the block shape). You can place a chalk line or guideline to align the front of each course if a batter is used. For a vertical wall (no batter), align all courses vertically plumb.

Drainage and Backfill Provisions

Proper drainage is critical to prevent water pressure buildup:

- **Subsurface Drain:** Install a perforated **drainage pipe** (100 mm diameter agricultural drain or similar) at the base, behind the first course of blocks. Embed it in free-draining gravel. The drain should have a continuous 1–2% slope to daylight or a stormwater outlet so that water can freely escape. Typically, the drain is placed 300–600 mm behind the wall inside a trench of drain rock wrapped in geotextile. Ensure the outlet of the drain is protected from blockage.
- **Backfill Material:** Use *non-reactive, granular backfill* immediately behind the blocks to promote drainage (e.g. crushed rock or gravel, 20 mm size). Avoid clay or silty soil against the wall; if the native soil is clay, separate it with a geotextile fabric and use a zone of drain gravel at least 300 mm thick behind the wall. Also fill the hollow cores of the blocks with the same free-draining gravel as you stack. This internal fill adds weight and facilitates drainage through the block face.
- **Weep Holes:** Rock Blocks can accommodate **weep holes** or slots in the face if needed to relieve water. In practice, because the block joints are dry-stacked and the blocks are hollow with gravel fill, water will seep out through joints. However, for taller walls or if a decorative sealed face is applied, consider core-drilling 50–75 mm weep holes at the bottom of some blocks (every 2–3 m) to ensure water can escape. Weeps should be screened with mesh or fabric to prevent clogging.
- **Surface Water Control:** Install a swale or **cut-off drain** along the top of the retained slope to divert runoff away from the wall. This can be a shallow V-drain that catches rainwater and directs it to a safe outlet. Preventing uncontrolled surface flow over the wall will reduce erosion and eliminate water ingress into the backfill.

Block Placement and Assembly

1. **First Course:** Place the first course of Rock Blocks on the prepared base. Ensure each block is level in both directions and properly aligned with the wall line. The front toe extension (if present on base blocks) should project into the trench in front. Check that adjacent blocks are tightly abutted with no significant gaps. Use a crowbar or pry tool to adjust blocks as needed while the base is still maleable. Once in position, fill the block cores and the 200–300 mm space immediately behind the blocks with drainage gravel, then **compact** this fill lightly. This locks the base course in place.

2. **Subsequent Courses:** Clean any debris off the top of the lower course, then set the next course of blocks. They should **interlock by gravity** – the naturally rough top surface and any mating features will prevent sliding. Each new block should be pushed fully back against the rear of the lower block to engage the 45 mm setback. This automatic setback creates the wall batter. After placing a course, fill the cores and behind-block zone with gravel and compact as before. **Do not use heavy compaction equipment** directly behind the blocks; use light manual compaction near the wall to avoid dislodging blocks. Repeat this process for each subsequent course.

3. **Geogrid Reinforcement (if required):** If the design calls for geogrid layers (typically at one or more courses for taller walls), install the geogrid at the specified elevations. Geogrid is laid **between block courses**, running continuous from the block core out into the backfill. Thanks to Rock Block's flat top, the geogrid lies flat without interference. The typical procedure is to place and compact backfill to the level of the geogrid, then roll out the geogrid perpendicular to the wall, cut to the design embedment length. The geogrid should exit between the blocks and extend horizontally into the backfill. Place the next course of blocks on top, making sure the grid remains stretched and is sandwiched firmly. Then continue backfilling. **Note:** Ensure the geogrid is not slack and there are no voids under it; any slack could lead to excessive movement before the grid activates.

4. **Top Course and Capping:** When the final course is laid, fill the last block cores and behind with gravel and compact. If using **cap stones**, place a continuous line of construction adhesive on the top course blocks and set the caps in place. Caps are usually flush with the wall face or have a small overhang. They provide a finished appearance and protect the block cores from direct water entry.

Throughout construction, regularly check alignment (use a string line along the face) and batter (plumb bob or level on the face). Also ensure the wall is backfilled and compacted in **layers not exceeding ~300 mm** at a time – this prevents uneven pressure or bulging. Keep heavy equipment at least 1 m back from the wall to avoid disturbing freshly set blocks.

Construction Sequence Summary

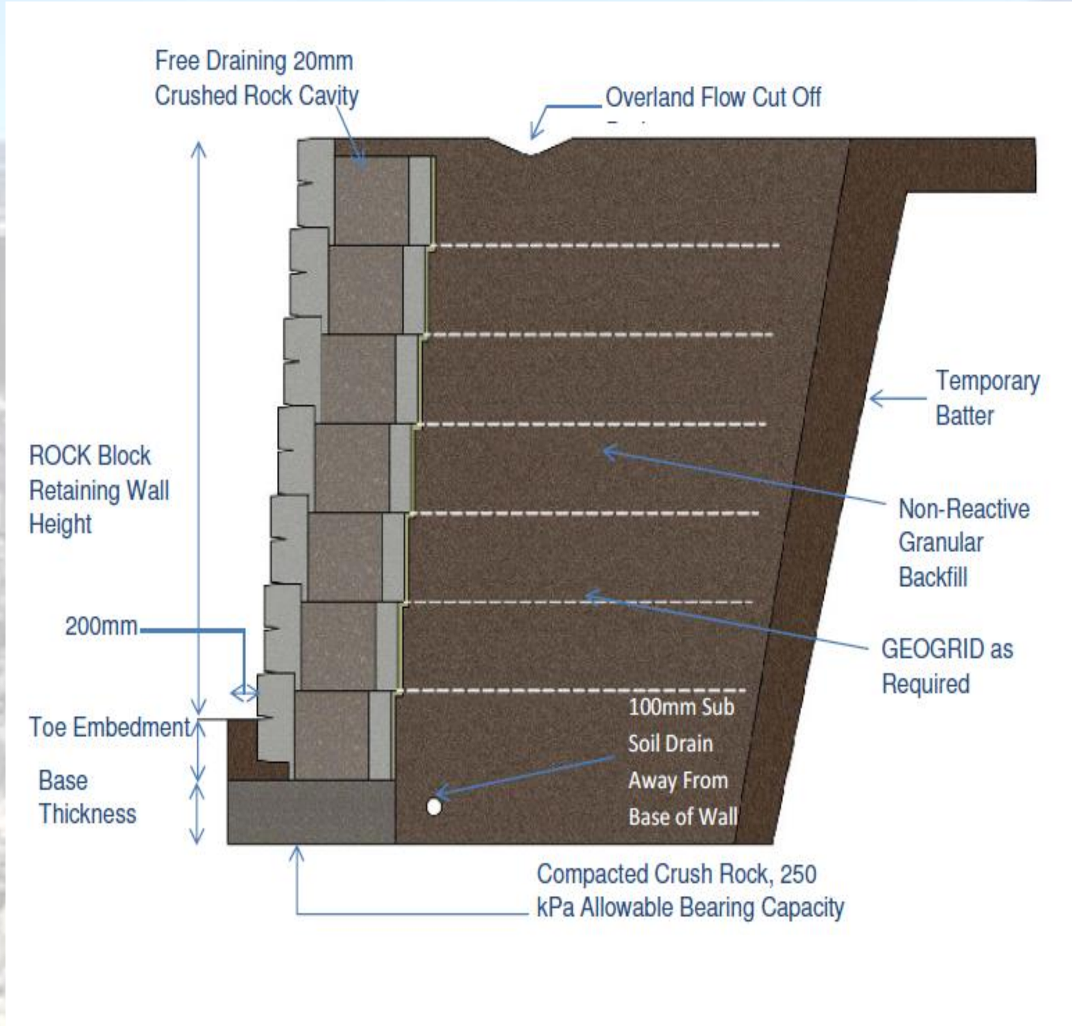
For clarity, a summary of the typical construction steps:

1. **Prepare Base:** Excavate to grade; place and compact crushed rock leveling pad.
2. **Set Base Blocks:** Position first course blocks level and aligned. Backfill cores and behind with gravel; compact.
3. **Install Drainage:** Lay perforated drain pipe behind base course; connect to outlet. Place geotextile and initial backfill.
4. **Build Up Courses:** Stack next course of blocks (with setback), fill cores and behind with gravel, compact. Continue for each course.
5. **Reinforcement (if needed):** At specified layers, install geogrid between courses, extending into backfill. Tension and secure geogrid before placing next blocks.
6. **Finalize Backfill:** Fill and compact to top of wall height, shaping the backfill as required (add top drain/swale now).
7. **Place Caps:** Place and if needed glue down cap units on top course (if used).

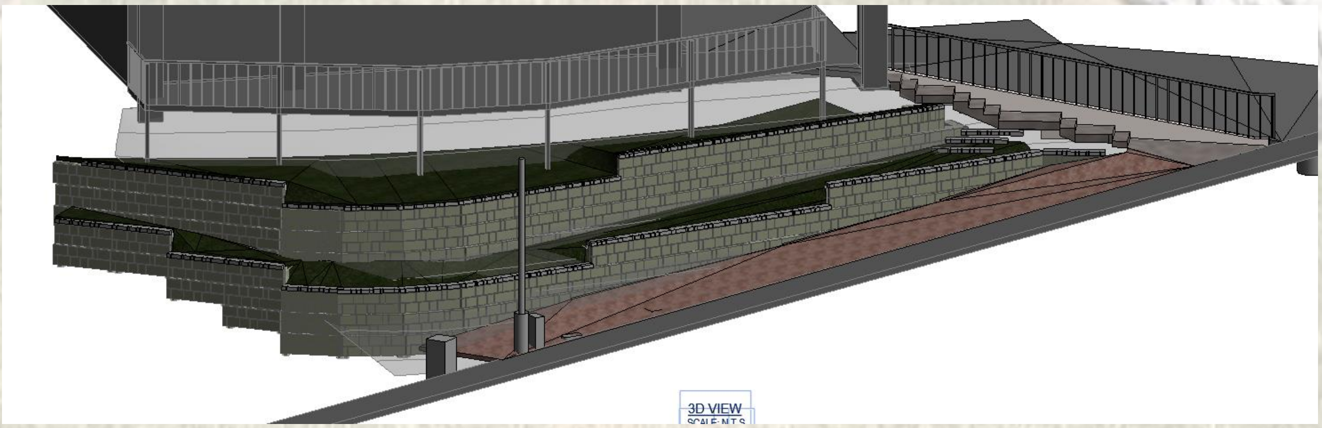
Engineering Considerations and Safety

- **Design:** All Rock Block walls should be designed (and certified where needed) by a registered professional engineer familiar with local site and soil conditions. The engineer will confirm wall stability (sliding, overturning, bearing, global stability) for the specific site parameters. The preliminary tables provided are not a substitute for formal engineering design with appreciation of on-site conditions.
- **Design Factors:** A minimum design factor of 1.5 (against both sliding and overturning) is recommended under static conditions. If the site is seismic or if there are transient surcharges (like highway traffic), the engineer may use higher safety factors or incorporate dynamic analysis.
- **Movement Tolerance:** Like many gravity walls, Rock Block walls may experience very slight movement or settlement as loads develop. A small horizontal deflection can actually mobilize additional resistance (passive pressure and increasing the wall's batter). In non-critical applications, a limited amount of sliding or rotation might be acceptable as a factor of safety trade-off. However, in structural or critical-use walls, designs are suggested to typically aim for effectively zero long-term movement.
- **Foundation and Bearing:** The founding soil must be capable of supporting the wall's weight with adequate safety, over long-term conditions. If the bearing capacity is marginal, options might include over-excavating and replacing soil with compacted gravel, using a levelling concrete footing to spread load, or in extreme cases, deep foundations (piers/piles) under the wall. Differential settlement should be minimized by proper subgrade preparation, which should be confirmed by a qualified professional.
- **Backfill Quality:** Use only clean, free-draining granular material in the block cores and immediate behind-wall zone. Do not use clay or silty soil as backfill immediately behind the blocks. Poor backfill can trap water and increase pressure. Also avoid corrosive materials if geogrid or steel tie-backs are used (follow manufacturer guidance on allowable fill for geosynthetics).
- **Maintenance:** After construction, ensure the drainage measures remain functional. Surface drains and outlets should be kept free of debris. Over time, inspect for any signs of movement (like opening of joints or misalignment of blocks) – this could indicate water buildup or unforeseen loads, and prompt remedial measures (such as adding anchors or buttresses, or re-leveling any sunken base).

Typical Construction Details using GEOGRID



Typical cross-section of a Rock Block retaining wall using GEOGRID (schematic).



Example of terracing, stepped blocks, and curvature to match site conditions (schematic).