Step-By Step Process

1. **Dig a trench** to frost depth plus 4 inches and slope to daylight or dry well (1/8 inch per foot minimum). Width should be at least 16" wide, but depends on soils & loads.
2. **Tamp** disturbed earth and line trench with filter fabric geotextile. *Filter fabric helps prevent silting-in of the footer over time.*

3. **Add 4 inches of stone** and tamp. Ensure that surface of gravel fill maintains drainage slope and is at or below frost line.
4. **Lay 4-inch perforated pipe** continuous drainage across bottom of trench. Slope to daylight (as done for a standard foundation footer). *Note: technically this is optional, since the entire rubble trench footer provides drainage, but it facilitates the building permit.*
5. **Fill remainder of trench** flush to grade with 1½-inch gravel, tamping after every vertical foot of fill. (Hand tampers work well for this.) *Note: the "rubble" fill may be stone or crushed concrete, but in either case, it must be washed free of fines and should provide a variety of sizes with an average of 1½ inches*

6. **Cover formwork** completely with biodegradable oil. This ensures easy release of wood for reuse. Any vegetable oil works well. *Note: formwork can be reused for structural framing once the grade beam has cured.*

7. **Set formwork** for grade beam or slab-on-grade perimeter, adding steel reinforcing as required. *Note the polypropylene sheeting under the slab prevents moisture from creeping up.*

8. **Pour grade beam**. The grade beam can be integrated into the thickened portion of a slab-on-grade (shown here) or can be free-standing. Any structure above this point is standard, and can support a stem wall and crawl space, a full basement, etc.

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DOWN TO EARTH DESIGN

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Rubble Trench Foundations

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What is a Rubble Trench Foundation?

Historical Context

Various forms of the rubble trench foundation have been used for thousands of years in construction. Earthen walls in the Middle East and Africa, for example, are built on top of shallow ditches filled with loose rock. Frank Lloyd Wright came across the rubble trench foundation system around the turn of the 20th Century. He observed the structures to be "perfectly static" with no signs of heaving, due to the complete elimination of water. From then forward, he built consistently with what he termed the "dry wall footing". Many time-tested structures stand as testimony to the durability of the rubble trench.

The Basics

A rubble trench, as its name reveals, describes a continuous trench filled with crushed stone and topped with a grade beam. This type of foundation uniquely provides both structural bearing as well as water drainage in a single foundation system. The width of the trench determines bearing capacity for loads above (as with a standard concrete footer). The stone fill provides a continuous drain along the entire foundation perimeter, ensuring that no water can freeze underneath to cause potential heaving in the building structure. An optional filter fabric liner between the soil and the stone fill provides insurance against silt filling the cavities between the stones, which could impede the flow of water over time. The result produces a resource-efficient, high-performing, low-cost foundation footer.

Why It Works

The compacted gravel acts both as a "French drain" system as well as a spread footer that provides bearing capacity for a grade beam. The required width of the trench is determined using the same variables as for a standard footing: according to the building loads and the bearing capacity of the soil. The reinforced concrete grade beam (or thickened slab perimeter) distributes the building load evenly across the gravel footer. The size of the grade beam and placement of rebar depends on building loads and should be designed by an engineer. Because the footer itself is literally a drainage way, water cannot settle in or around the structure of the foundation. Without water, there is no opportunity for freeze/thaw cycles to cause detrimental heaving of the grade beam.

Benefits

Lower Cost. A rubble trench foundation requires less labor, uses less material, and reduced material costs compared to a standard concrete footing. There is no over dig, no footer forming, and no backfill.

Minimal Site Impact. Digging is limited to only the outline of the building, so site disruption is minimized.

Lower Greenhouse Gas Emissions. Rubble trench footers reduce concrete use by up to 80%, compared to a standard footer *(depending on frost depth)*. Production of concrete requires a great deal of energy and generates 1.25 pounds of greenhouse gas for every pound of cement in the mix. Reducing total concrete used translates to direct reductions in greenhouse gas emissions.

Can Contain Recycled Content. The rubble fill can use recycled crushed concrete instead of gravel, as long as fine particles are washed out.

Improved Drainage. A rubble trench provides full water drainage under every structural bearing element of the foundation, ensuring that the footer remains dry at all times. This type of "static" foundation system ensures that no freeze-thaw heaving can occur.

Challenges

- Soils with low bearing capacity may require an extremely wide trench (or some other footing alternative) to achieve adequate bearing area
- Rubble trench foundations are not specifically identified in building codes, so may require additional dialog with permitting officials. It helps to provide drawings stamped by a licensed engineer.

Building Permits

A rubble trench foundation meets the requirements and the intent of U.S. building codes. However, since this system is not specifically identified in current codes, acceptance is provided on a case-by-case basis. Since this puts permit approval at the discretion of individual building officials, it is recommended to initiate a dialog prior to submitting for a building permit. This provides an opportunity to inform and educate permitting staff and provide adequate information to satisfy everyone's mutual desire to ensure a safe structure. The article written by Elias Velonis for Fine Homebuilding (see "Additional Resources") provides excellent technical information. Stamped structural drawings are recommended.

Resources

Websites

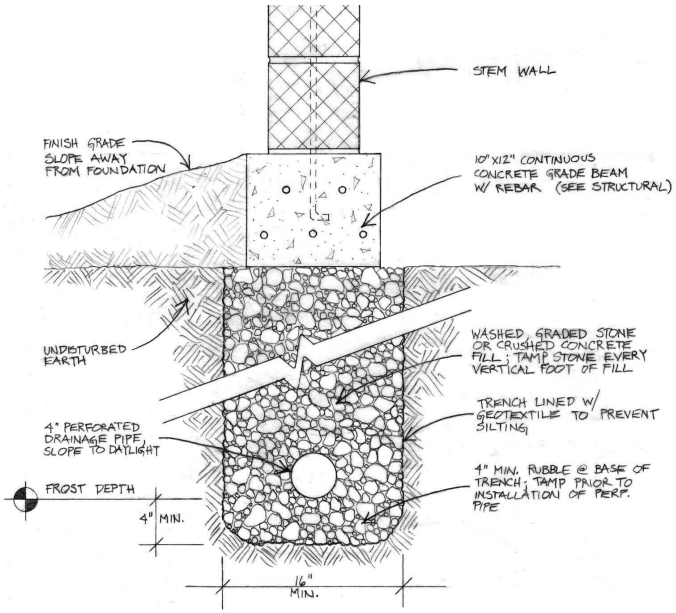
en.wikipedia.org/wiki/Rubble_trench_foundation
www.buildnaturally.com/EDucate/Articles/RubbleTrench.htm

Articles

Koko, Sigi. "Rubble Trench Foundations - A Brief Overview", Building Safety Journal, Volume 1, number 3, May 2003.

Rob, Tom. "Rocks In Your Shoes", The Last Straw Journal, Issue #16, Fall 1996.

Velonis, Elias. "Rubble Trench Foundations: A Simple Effective Foundation System for Residential Structures", The Best of Fine Homebuilding. Taunton Press: Newtown, CT, 1997.



Hands-On Workshops

Down to Earth Design teaches workshops on how to correctly form and install a rubble trench footer.

Workshops Include:

- overview of rubble trench foundations, including why they outperform standard foundation systems
- guided hands-on experience preparing and installing the rubble trench

Check our website **www.buildnaturally.com** for additional information.