Recommended Practices for Construction of Residential Masonry Basements in Minnesota

Fifth Edition

Includes cold weather masonry construction guidelines and recommended radon guidelines

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MIDWEST MASONRY PROMOTION COUNCIL

Recommended Practices for Construction of Residential Masonry Basements in Minnesota (w/ Recommended One and Two Family Residential Cold Weather Masonry Construction Guidelines) 5th Edition and Radon Rules as of June 2009

Disclaimer:
The information presented in this pamphlet is intended to be used as a general construction guide and is not all encompassing. Your project may have specific conditions which dictate different construction practices. Consult your engineer, architect, or building official for job specific design and construction practices.

Section 1

Diagram/Table Pages

Section 2

Section 3

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INTRODUCTION

The information presented in this publication is intended to be used as a general field construction guide and is not all encompassing.

Several phases of construction will be addressed in the basement construction process:

1. Excavation
2. Concrete Footings
3. Mortar & Grout
4. Concrete Block Wall Construction
5. Damp Proofing
6. Waterproofing
7. Insulation
8. Drainage
9. Backfilling

In each phase we will highlight significant material specifications, design details and construction techniques. This information can be used to coordinate tradespeople who are collectively responsible for the construction of residential basements. The responsibilities of the excavator/backfiller, the mason contractor and the builder's laborers will be discussed.

Graphic illustrations of the design details discussed in this publication are included for your reference and clarification.

It should be emphasized that this handbook is not a design manual or guide to the structural design of footings or walls. Each project may have specific conditions which dictate different construction practices. Consult your engineer/architect or building official for job specific design and construction details.

The goal of this publication is to emphasize the influence that each construction phase and trade has on the entire basement system. Suggestions on material selection, detailing, and construction will also be offered.

Note: *This guide contains changes included in the 2007 state building code. Refer to www.MMPC.net for updates to this document and Radon Rules June 2009.*

Refer to the Minnesota Building Code for more information. www.dli.mn.gov/ccld/codes.asp

1. EXCAVATION

1-1 PREPARATION

1-1.1 Coordinate the foundation excavation with the mason contractor while reviewing the approved stake survey. Make sure that all underground utilities are marked and cleared (Gopher State One Call: #800-252-1166 or #651-454-0002).

1-2 EXECUTION

1-2.1 Care should be taken to remain on correct perimeter excavation lines to allow the concrete footings to be accurately aligned. Out-of-square footings may result in misalignment of the concrete block wall or possible footing failure.

1-2.2 Remove all unstable and degradable materials. Fill any such area with additional concrete or compacted granular fill.

1-2.3 Locate utility trenches. Make sure trenches are filled with granular fill and compacted prior to placement of concrete footings.

1-2.4 Limit the over-dig area to 2-4 feet beyond the outside edge of the footing location. This will provide enough room for dampproofing/waterproofing and drainage work while reducing the backfill weight against the wall.

1-2.5 Keep the elevation of the floor slab area 4" – 6" higher than the interior perimeter drain area (bottom of footing). By doing so, a collection channel will be created which will allow water to pass through the footing weeps or underneath the floor slab. In case of transite heat, the drain tile must be located below transite heat.

1-3 STATIONING

1-3.1 Place a layer of aggregate in the basement floor area before delivery of the concrete block to protect the concrete block from dirt and mud.

1-3.2 Access should be made for material deliveries such as concrete block and footing concrete.

2. CONCRETE FOOTINGS

2-1 DESIGN

2-1.1 Concrete footings must bear on soil which is beneath the maximum frost penetration depth. Refer to the [Appendix page A for the Minnesota Frost Depth Map.]

2-1.2 *Refer to IRC Table 403.1 for minimum footing width.* For most conditions typical footing size is 8" high by 16" or 20" wide. Footing dimension requirements can vary depending on soil and load conditions. Footing projections should be at least 2 inches beyond the foundation wall.

2-1.3 Footing concrete should have a minimum compressive strength of 2,500 p.s.i. Specifically, call for the strength of concrete your project requires. Reference Appendix Tables 6, 7, & 8 on pages Q-T of this booklet. Cantilever Foundations require a minimum compressive strength of 3,000 p.s.i.

2-1.4 Although not always mandatory, two ½" minimum reinforcing rods (rebar) placed 3 inches from the bottom of the footing running parallel to the wall, are recommended to help avoid cracking and/or differential settlement of the footing.

2-1.5 Footings should be continuous. Footing height changes are typically accomplished by the use of vertical bulkheads reinforced with two ½" (minimum) reinforcing rods.

2-1.6 Dowels in the footings are not typically required by code for residential concrete block walls. Exception: Some Cantilever Walls conditions may require dowels. See Appendix Tables 6, 7 & 8 on page Q-T of this booklet. Reference to footnote h.

2-2 CONSTRUCTION

2-2.1 The footings should be formed and poured as soon as possible after the excavation is completed. This will avoid excessive moisture (rain, snow) from saturating the ground and possibly destabilizing the soil. If the soil does become "soft", the area should be scraped off or re-dug. Take proper care to ensure that minimum elevation and clearance from the water table is attained.

2-3 Do not pour footings over unstable material such as tree roots, construction debris, soft spots, ice, etc. Remove all unstable material and fill resulting voids with compacted granular fill or concrete before forming or pouring footings.

2-4 Footing alignment must be accurate so that the center line of the concrete block wall stays as close as possible to the center line of the footing.

2-5 Caution should be taken when adding water to concrete in the field. Excessive water can severely reduce the strength of concrete.

2-6 Do not trowel footing surfaces. A slightly rough footing surface helps assure a good bond between the first course of concrete block and the footing.

3. MORTAR & GROUT

3-1 **MORTAR**

- Preblended Mortar: A dry mixture of Portland Cement, Hydrated Lime and Oven Dried Masonry Sand formulated and blended in a manufacturing facility to meet the property specification requirements of ASTM C270.
- Field Mixed Mortars: A mixture of Portland Cement, Hydrated Lime and Masonry Sand or Masonry/Mortar Cement and Masonry Sand mixed at the job site to the proportion specification requirements of ASTM C270.

3-1.1 All mortar used in foundation work should be Type S or Type M. Refer to MCMA Mortar Cards on page F.

3-1.2 Mortar may be pre-blended or proportioned on-site and should meet ASTM C270.

3-1.3 Water should be potable and should not exceed 160° F (71° C).

3-1.4 The preparation of mortar and grout in the field is an integral part of the construction of masonry walls. To provide consistent batching, materials used to charge the mixer must be controlled.

3-1.5 **Pre-Blended Mortar**

3-1.5.1 *Proper Mixing Procedures*

Due to the fact that there are many types of mixers, this procedure refers to mixing masonry mortars in a standard mechanical mixer.

1. Add 2/3 of required water to an empty, clean mixer and start the mixer.
2. Add Preblended Mortar, Preblended Colored Mortar or Grout to the mixer.
3. If necessary, add remaining water to the mixer until proper consistency is achieved.
4. Mix between 3 and 10 minutes.

Note: Completely empty mortar content into wheelbarrow or container.

3-1.6 **Proportioning On-Site Mortar**

3-1.6.1 The *Mortar Cement and Masonry Cement* table and the *Portland Cement and Lime* table on the appendix page F of this book reference typical mortar types and proportioning using ASTM C270.

3-1.6.2 Aside from sand, mortar ingredients are typically sold prepackaged in bags by weight. Since mortar is proportioned by volume, it is necessary to know:

Cementitious Material Weight

Cementitious Material	Pounds per Cubic Foot
Portland Cement	94
Blended & Hydraulic Cement	85 to 94*
Mortar Cement	70 to 90*
Masonry Cement	70 to 90*
Hydrated Lime	40

*See weight on bag

3-1.6.3 *Sand*

A recommended method of measuring sand is by using a five gallon pail (volumetric measure). In the field, sand is typically measured by the use of a shovel. It is important to check for shovel consistency at least twice daily. Additional checks should be performed if the sand moisture content changes or if a new load of sand is delivered. A five gallon pail holds about 2/3 of a cubic foot of sand in damp, loose condition. Therefore, 3 cubic feet of sand is equal to about 4 ½ five gallon buckets.

3-1.6.4 *Proper Mixing Procedures*

Due to the fact that there are many types of mixers, this procedure refers to mixing masonry mortars in a mechanical mixer.

1. Add 2/3 of required water to an empty, clean mixer and start the mixer.
2. Add ½ the amount of sand required to the mixer
3. Add any coloring pigments to the mixer (where applicable).
4. Add lime to the mixer (if applicable).
5. Add cement to the mixer: (Cement, Masonry Cement, or Mortar Cement).
6. Add remaining sand to the mixer.
7. If necessary, add remaining water to the mixer until proper consistency is achieved.
8. Mix between 3 minutes (minimum)* and 15 minutes (maximum) after adding the last of the water in step (7) above.

(* Additional mixing time up to ten minutes may be required when using mortar materials containing oven dried sand.)

Note: Completely empty mortar contents into wheelbarrow or container.

3-1.6.5 *Retempering*

Fresh mortar should be prepared at the rate it is used to maintain workability and consistency on the job site. Mortar that has been mixed but not used immediately will experience stiffening as the product dries out. To reduce this evaporation effect, you may wet the mortar board and cover the mortar in the tub or wheelbarrow. If necessary to restore workability, mortar may be retempered by adding small amounts of water. In general, mortar may be retempered up to 2 ½ hours after original mixing. Mortar over 2 ½ hours old should be discarded.

3-2 **GROUT**

- Preblended Grout: A dry mixture of Portland Cement, Oven Dried Masonry Sand and Aggregate formulated and blended in a manufacturing facility to meet the requirements of ASTM C476.

3-2.1 Grout may be pre-blended, proportioned on-site, or delivered by ready-mix truck and should meet ASTM C476.

3-2.2 **Pre-Blended Grout**

3-2.2.1 *Proper Mixing Procedures*

Due to the fact that there are many types of mixers, this procedure refers to mixing masonry mortars in a standard mechanical mixer.

1. Add 2/3 of required water to an empty, clean mixer and start the mixer.
2. Add Grout to the mixer.
3. If necessary, add remaining water to the mixer until proper consistency is achieved.
4. Mix between 3 and 10 minutes.

Note: Completely empty grout contents into wheelbarrow or container.

3-2.3 **Proportioned On-Site Grout**

3-2.3.1 *Proportions for Fine Grout*

Use 1 part cement mixed with 2 ¼ to 3 parts sand.

3-2.3.2 *Proportions for Coarse Grout*

Use 1 part cement mixed with 2 ¼ parts sand and 1 to 2 parts 3/8" aggregate.

3-2.3.3 *Proper Mixing Procedures*

Due to the fact that there are many types of mixers, this procedure refers to mixing masonry mortars in a mechanical mixer.

1. Add 2/3 of required water to an empty, clean mixer and start the mixer.
2. Add sand and 3/8" aggregate to the mixer and mix for 30 seconds.
3. Add cement to the mixer.
4. If necessary, add remaining admixtures and water to the mixer until proper consistency is achieved.
5. Mix between 3 minutes (minimum)* and 15 minutes (maximum) after adding the last of the water in step (4) above.

3-3 **PROTECTING MASONRY MATERIALS**

Bagged Materials

- Store on pallets off the ground
- Completely cover to protect from rain or snow
- Stockpile on opposite side of mixer from water supply and sand

Sand (On-site proportioning)

- Place stockpile on tarp to protect from contamination from below
- Cover with tarp when not in use to maintain consistent moisture content and avoid contaminants
- Store on opposite side of mixer from bagged materials
- Store different aggregates separately to avoid cross contamination of stockpiles

Concrete Masonry Units (CMU or Block)

- Cover stockpiles to keep dry and clean.
- Store away from mixing site and/or cement materials

3-4 HOT WEATHER MORTAR AND GROUT ISSUES

Hot weather construction occurs when the ambient temperature exceeds 90˚F with a wind velocity of greater than 8 mph.

Potential problems of hot weather construction:

- Rapid loss of workability
- Rapid evaporation of water required for cement hydration and curing.

Procedures to follow when working with masonry in hot weather:

- Keep mortar, grout and CMU's as cool as practical using techniques such as placing materials in the shade and using cool water when mixing.
- Keep any surface that comes in contact with the mortar or grout such as mixers, wheelbarrows, shovels, mortar boards, trowels damp.
- Limit the amount of mortar that is spread on the bed joints to 4 feet ahead of the CMU. Place CMU within one minute of spreading the mortar.
- In hot, dry and windy weather, lightly fog or mist the finished wall, if possible.

3-5 PROTECTION OF UNFINISHED WALLS

All unfinished walls should be covered with weather-resistant material, on both sides, from the top of the wall down to the footings for 48 hours after construction. Where necessary, install wind breaks when wind velocity exceeds 15 mph (6.7 m/s).

4. CONCRETE BLOCK WALL CONSTRUCTION

4-1 MATERIALS

4-1.1 Concrete block used for residential foundations should comply with ASTM C90. Proper care should be taken to maintain dry concrete block prior to building the wall.

4-2 DESIGN

4-2.1 Prior to laying the first course of concrete block, review the layout, dimensions and locations of all wall openings. Determine if shorter concrete block lengths (cuts) are required. Starting your wall with the cuts (if bond will allow) or placing cuts on either side of wall openings will make for a more attractive wall.

4-2.2 Structural foundation blocks must be a minimum 6" width. Where a wall changes width, the top course of the wider block should be either a solid unit or grouted solid.

4-2.3 Minimum vertical reinforcement bar size and spacing for 8", 10" and 12" nominal wall thickness should comply with Tables R404.1.1 (1), R404.1.1 (2), R4041.1 (3) or R404.1.1 (4) of the 2006 International Residential Code™ (IRC). Refer to pages J-P for tables 1-4. Alternate reinforcing bar sizes and spacing having an equivalent cross-sectional area of reinforcement per lineal foot of wall should be permitted provided the spacing of the reinforcement does not exceed 72 inches. See Appendix for Tables 2, 3, and 4 on pages K-P with alternate bar sizes, spacing and soil classes.

Permanently supported foundation walls which are supported at the top by floor members shall have reinforcing bars positioned toward the inside face shell of the concrete block core. By positioning the reinforcing bars in this manner, the walls will have greater resistance to lateral earth pressures. The distance from the face of the soil side of the wall to the center of vertical reinforcement should be the minimum specified at each table: 8" CMU= 5", 10" CMU = 6.75" and 12" CMU = 8.75". Soil classes are in accordance with the Unified Soil Classification System referenced in IRC Table R405.1 on page B.

4-2.4 Foundation walls which are not permanently supported at the top by floor members are considered "cantilevered walls." Refer to Footnote C on Tables 6, 7, and 8 on Appendix pages Q-T for wall reinforcement requirements for 8", 10" and 12" walls. Note footnotes (g) and (h) for conditions which may require "propped cantilevered walls" (see diagram 4 on page E) or may require doweling to the footings. Special Design is always an alternative to the tables. Another alternative is to build the wall full height to floor bearing and reinforce to Tables 2, 3 or 4 on pages K-P. Note that short walls typical to frost footing or look-out foundations do not require reinforcement.

4-2.5 The wood sill plate should be anchored to the foundation with anchor bolts spaced a maximum of 6 feet on center. See Appendix page G for maximum bolt spacing. When vertical reinforcing is required, the anchor bolts or straps should align with the reinforcing. *Note: Not all bolts or straps need to be placed at corefills.* Anchor bolts should also be located within 12 inches from the ends of each plate section. *Note: Where longer walls require multiple sill plate sections, consider installing an additional bolt at anticipated joint locations.* Bolts should be at least ½ inch in diameter and should extend a minimum of 7 inches into masonry or concrete. **Anchor Bolts require a 2" diameter by 0.125" galvanized thick washer counter sunk 0.25" into top of sill plate.** *Foundation anchor straps may be used when spaced as required to provide equivalent anchorage to 1/2 –inch diameter (12.7 mm) anchor bolts. When vertical reinforcing is required by other sections of this code, the foundation anchor straps should align with the reinforcing.*

4-3 CONSTRUCTION

4-3.1 The top of the footing must be clean, free of dirt, mud, ice or any material which might weaken the bond between the mortar and footing.

4-3.2 Lay first course of concrete block on the center line of the footing. All face shells of the concrete block should be set in mortar. Where the wall is to be grouted, mortar should be placed so it does not severely project into the cores to be grouted which will permit the grout to make full contact with the footing.

4-3.3 Lay concrete block in a running bond with a 3/8" mortar joint covering the horizontal and vertical face shells.

4-3.4 All head joints and bed joints should be filled solid with mortar for a distance measured in from the face of the unit not less than the thickness of the concrete block face shell.

4-3.5 Exterior mortar joints over which the dampproof or waterproof coating is applied should be cut flush or tooled and be without voids.

4-3.6 Interior mortar joints should be firmly tooled after the mortar has become thumb print hard (when a clear thumb-print can be impressed and the cement paste does not adhere to the thumb when removed). If color consistency of the mortar joint is important, remember wet tooling will result in a light color. Dry or stiff tooling will result in dark colored mortar joint.

5. DAMP PROOFING

5-1 DESIGN AND CONSTRUCTION

5-1.1 Damp proofing is a minimum requirement for basement walls where hydrostatic pressure does not occur. Dampproofing consists of applying materials to prevent the passage of water vapor through the walls.

5-1.2 Various dampproofing products or systems may be used when approved by the building official. Manufacturer's recommendations should be consulted for product limitations and proper installation requirements. Parging on masonry foundation walls is not required when the dampproofing product is approved for direct application.

6. WATERPROOFING

6-1 DESIGN

6-1.1 Waterproofing is required where the foundation wall will be partially or fully below the ground water table or where poorly drained or impermeable soils (clay and some silts) are present. Either condition can result in the formation of hydrostatic pressures on the exterior surface of the foundation. Various waterproofing systems or products may be used when approved by the building official. Manufacturer's recommendations should be consulted for product limitations and proper installation

requirements.

6-1.2 Areas of the basement wall where porch, garage, fireplace or other walls intersect should be waterproofed. *Contact the product manufacturer or distributor for specific recommendations.*

6-2 CONSTRUCTION

6-2.1 Apply waterproof coating to concrete block walls that are clean, free of dirt, mud, ice or any material which might reduce the bond between the coating and the concrete block surface.

6-2.2 Cover the base intersection of the exterior concrete block wall and the concrete footing surface.

6-2.3 Most coatings require modified mixing and application procedures when temperatures drop below 20° F. *Contact the coating manufacturer or distributor for specific recommendations.*

7. INSULATION

7-1 DESIGN AND CONSTRUCTION

7-1.1 All foundation walls should have exterior, integral or interior insulation conforming to the requirements of the Minnesota Energy Code. Refer to the Minnesota Energy Code for specific requirements.

7-1.2 Integral insulation includes plastic foam and rigid polystyrene inserts. Rigid polystyrene inserts, designed to be continuous, allow for grout and reinforcing in the insulated cores. To verify system R-values, reference the National Concrete Masonry Association "NCMA Concrete Masonry R-Value Evaluation."

8. DRAINAGE

8-1 DESIGN AND CONSTRUCTION

8-1.1 There are two purposes of a drainage system:

1. Relieve the walls and floor slab of hydrostatic pressure by drawing down subsurface water to a

level which is below the floor slab.

2. Collect and drain away water that seeps down through the backfill from rainfall, snow melt and roof run-off.

8-1.2 Drains should be provided around masonry foundations that retain earth and enclose habitable or usable spaces located below grade. Drainage tiles, gravel or crushed stone drains, perforated pipe or other approved systems or materials should be installed at or below the area to be protected and should discharge by gravity or mechanical means into an approved drainage system. Gravel or crushed stone drains should extend at least 1 foot beyond the outside edge of the footing and 6 inches above the top of the footing and be covered with an approved filter membrane material . The top of open joints of drain tiles should be protected with strips of building paper, and the drainage tiles or perforated pipe should be placed on a minimum of 2 inches of washed gravel or crushed rock at least one sieve size larger that the tile joint opening or perforation and covered with not less that 6 inches of the same material. *Exception: A drainage system is not required when the foundation is installed on well-drained ground or sand-gravel mixture soil is according to the Unified Soil Classification System, Group I Soils, as detailed in Table-IRC R405.1 on page B.*

9. BACKFILLING

9-1 PREPARATION

9-1.1 Do not place backfill material before concrete block walls have been properly cured and braced or the subfloor system is in place.

9-1.2 A minimum wood bracing system is suggested to consist of 4" x 4" beams, one placed vertically against the wall and the other set at a 45 degree angle against the vertical at the 7th or 8th concrete block course on a 12 course wall, secured to the vertical with a 2" x 4" tie and anchored by driving 2" x 6" stakes at least 12" into the ground. If the 4" x 4" inclined brace is longer than 8', an additional 2" x 4" brace should be secured to the bottom of the vertical brace and nailed into the inclined brace. If using a mechanical bracing system, follow manufacturer's recommendations. **NOTE**: Bracing should remain until

subfloor system is in place.

9-1.3 Bracing should be positioned at a maximum of 8' on center with offsets braced at one side of all inside corners, preferably, and where possible brace walls at corefill locations.

9-1.4 Backfill only after the waterproofing and drainage systems is in place.

9-2 **EXECUTION**

9-2.1 Backfilling should take place in several lifts using material which is free of large stones, frozen earth, organic materials or construction debris.

9-2.2 Care must be taken not to damage the drainage system, waterproof coating or exterior insulation during backfilling.

9-2.3 Do not backfill with water saturated dirt, soil, or other materials (especially soils with high clay contents) or place backfill where any appreciable amount of water is standing. Wet materials may create excessive hydrostatic pressure and could lead to wall failure.

9-2.4 Avoid subjecting the walls to high impact loads like earth sliding down a steep slope or boulders rolling into the wall.

9-2.5 **Do not operate equipment over the backfill during the backfilling operation or after construction operations. Equipment should never be operated within 3 feet of any basement wall system. Compaction of backfill near the structure must not be done with heavy equipment.**

9-2.6 Do not operate heavy equipment at a perpendicular or 90° angle to the wall when backfilling. Operating equipment at a 45° reduces pressure against the wall.

9-2.7 Masonry foundation walls should extend above finished grade a minimum of 6 inches. Reference IRC R404.1.6. See diagram 1 on page C.

9-2.8 Backfill around the foundation should be covered with a low permeability soil sloping away from the wall a minimum of 6 inches in the first 10'.

References:

1. "Building Foundation Design Handbook", prepared by the Underground Space Center at the University of Minnesota, for Oak Ridge National Laboratory and the U.S. Department of Energy, 1988.

2. "Recommended Practices for Masonry Basement Wall Construction", by the concrete and masonry committee of the North Star Chapter (Minnesota) of ICBO, 1983.

3. "Recommended Practices for Construction of Residential Masonry Basements", by New York State Concrete Masonry Association, 1994.

4. International Residential Code 2006™

5. National Concrete Masonry Association Publication TR 68B

6. Recommended Practices for Construction of Residential Masonry Basements in Minnesota 4th Edition

7. Minnesota State Building Code

8. Minnesota State Energy Code

9. MCMA Mortar Cards

Tables

Unified Soil Classification Chart

Table 2-1 Minimum Concrete Temperatures

Maximum Anchor Bolt Spacing for Supported Foundation Wall

Appendix Table 1 [Based on the 2006 IRC Table R404.1.1(1) Plain Masonry Foundation Walls]

Appendix Table 2 [Based on the 2006 IRC Table R404.1.1(2)] 8 Inch Masonry Foundation Walls with Reinforcing [d > 5 inches (a)]

Appendix Table 3 [Based on IRC Table R404.1.1(3)] 10 Inch Masonry Foundation Walls with Reinforcing [d>6.75 inches (a)]

Appendix Table 4 [Based on IRC Table R404.1.1(4)] 12 Inch Masonry Foundation Walls with Reinforcing [d>8.75 inches (a)]

Appendix Table 6 [Based on IRC Table R404.1.1(6)] 8" Cantilevered Concrete and Masonry Foundation Walls

Appendix Table 7 [Based on IRC Table R404.1.1(7)] 10" Cantilevered Concrete and Masonry Foundation Walls

Appendix Table 8 [Based on IRC Table R404.1.1(8)] 12" Cantilevered Concrete and Masonry Foundation Walls

Diagrams

Minnesota Frost Depth Map

Diagram 1- Foundation Wall (upper section)

Diagram 2- Foundation Wall (lower section)

Diagram 3- Cantilever Wall Section

Diagram 4- Typical Propped Cantilevered Wall Section

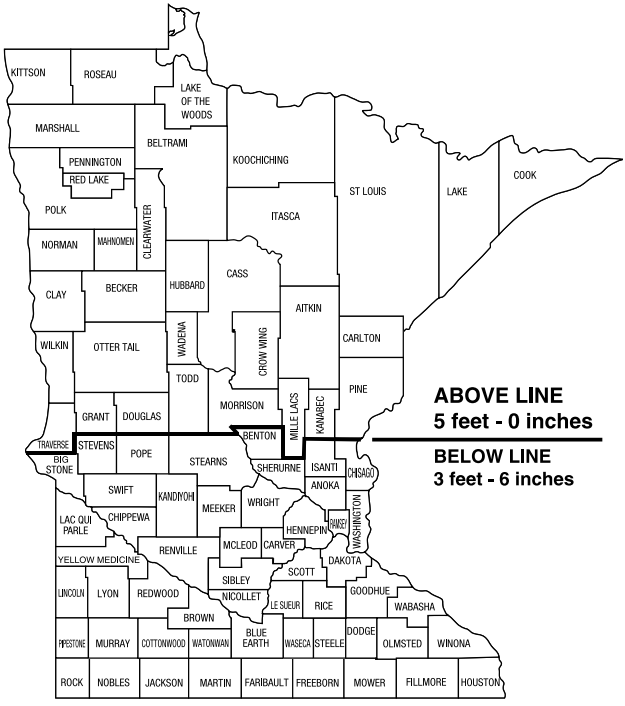
Mortar Cards

1) Mortar Cement and Masonry Cement

2) Portland Cement and Lime

FROST DEPTH

MSBC RULES 1303.1600



ABOVE LINE
5 feet - 0 inches

BELOW LINE
3 feet - 6 inches

UNIFIED SOIL CLASSIFICATION CHART

Properties of Soils Classified According to the Unified Soil Classification System
From the IRC Table R405.1

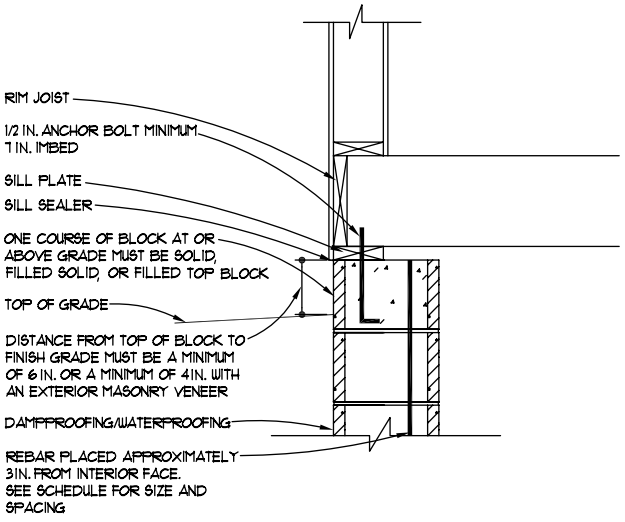
Soil Group	Unified Soil System Symbol	Solid Description	Drainage Characteristics (a)	Frost Heave Potential	Volume Change Potential Expansion (b)
Group 1	GW	Well-graded gravels, sand mixtures, little or no fines.	Good	Low	Low
	GP	Poorly-graded gravels or gravel sand mixtures, little or no fines.	Good	Low	Low
	SW	Well graded sands, gravelly sands, little or no fines.	Good	Low	Low
	SP	Poorly-graded sands or gravelly sands, little or no fines.	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures.	Good	Medium	Low
	SM	Silty and sand-silt mixture.	Good	Medium	Low
Group 2	GC	Clayey gravels, gravel-sand-clay mixture.	Medium	Medium	Low
	SC	Clay sands, sand-clay mixture.	Medium	Medium	Low
	ML	Inorganic silts and very fine sand, rock flour, silty or clay fine sands or clayey silts with slightly plasticity.	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium	Medium	Medium to Low
Group 3	CH	Inorganic clays of high plasticity, fat clays.	Poor	Medium	High
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, classic silts.	Poor	High	High
Group 4	OL	Organic silts and organic silty clays of low plasticity.	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts.	Unsatisfactory	Medium	High
	PT	Peat and other highly organic soils.	Unsatisfactory	Medium	High

(a). The percolation rate for good drainage is over 4 inch per hour, medium drainage is 2 inches to 3 inches per hour, and poor is less than 2 inches per hour.

(b). Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with a high potential expansion have a PI greater than 20.

DIAGRAM 1

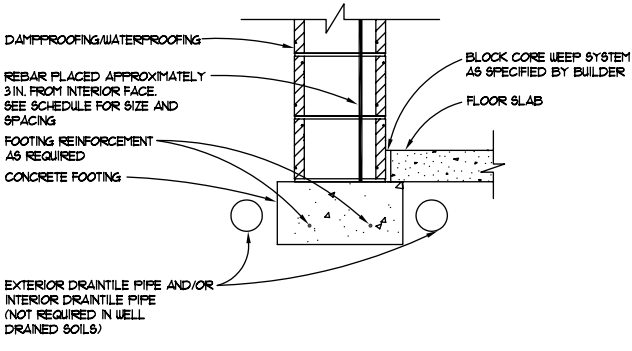
FOUNDATION WALL (UPPER SECTION)



NOTE: FOR FURTHER REQUIREMENTS SEE THE MINNESOTA RESIDENTIAL ENERGY CODE OR THE FIELD GUIDE TO THE MINNESOTA RESIDENTIAL ENERGY CODE.

DIAGRAM 2

FOUNDATION WALL (LOWER SECTION)



NOTE: FOR FURTHER REQUIREMENTS SEE THE MINNESOTA RESIDENTIAL ENERGY CODE OR THE FIELD GUIDE TO THE MINNESOTA RESIDENTIAL ENERGY CODE.

DIAGRAM 3
TYPICAL CANTILEVER WALL SECTION

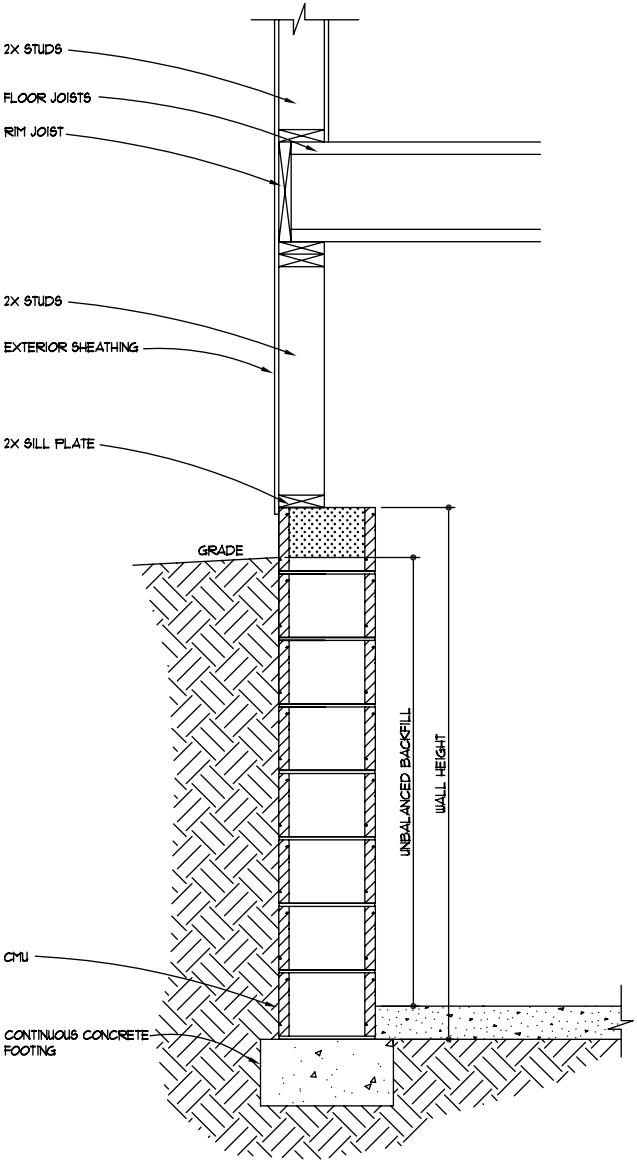
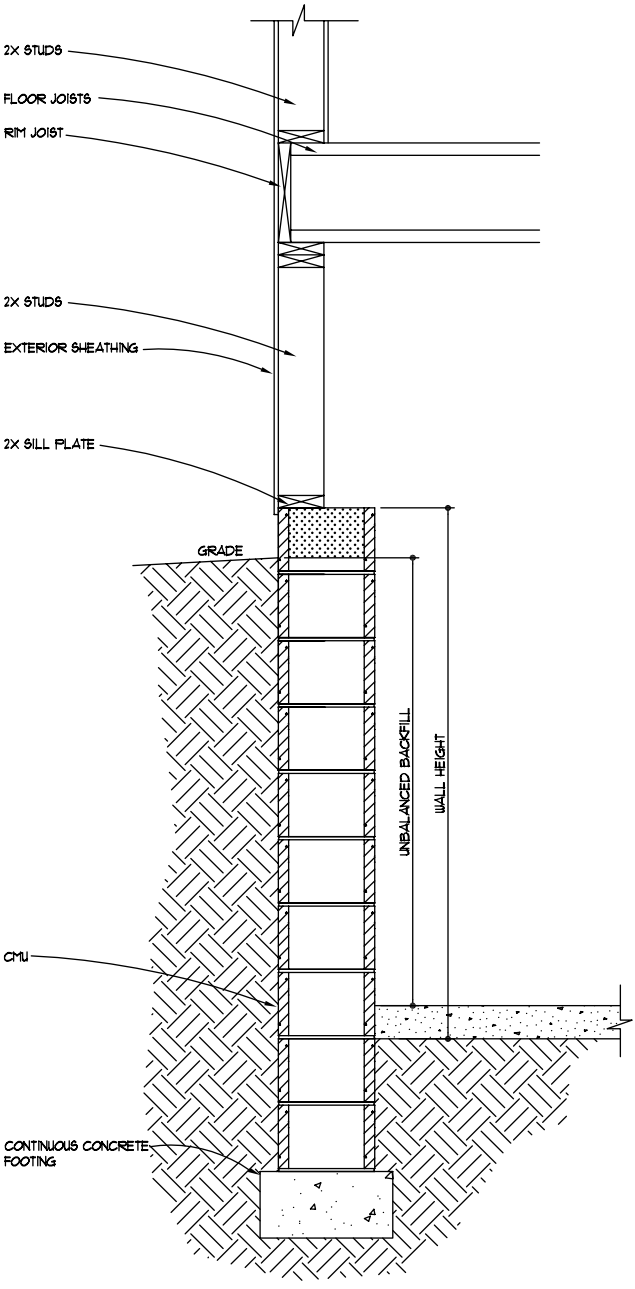


DIAGRAM 4
TYPICAL PROPPED CANTILEVER WALL SECTION



Portland Cement and Lime

Proportion Specifications

Type	Cementitious (bags)	Sand-damp and loose (5 gallon buckets)	Water*
M	Type I Portland 1 / Lime ¼	5½	1
S	Type I Portland 1 / Lime ½	6¾	1¼
N	Type I Portland 1 / Lime 1	9	1½

* Approximate

Note: 1½ 5 Gallon Buckets = 1 Cubic Foot of Sand

Mortar Cement and Masonry Cement

Proportion Specifications

Type	Cementitious (bags)	Sand-damp and loose (5 gallon buckets)	Water*
M	Type M Mortar/Masonry 1	4½	1
S	Type S Mortar/Masonry 1	4½	¾
N	Type N Mortar/Masonry 1	4½	1

* Approximate

Note: 1½ 5 Gallon Buckets = 1 Cubic Foot of Sand

TABLE R404.1 (2)
Maximum Anchor Bolt Spacing For Supported Foundation Wall

Maximum Wall Height	Maximum Unbalanced Backfill Height	Soil Classes	Soil Load (pdf/ft)	Top of Wall Reaction (plf)^b	1/2" diameter Anchor Bolt Spacing (inches)^a
8'-0"	7'-4"	GW, GP SW, & SP	30	250	72
		GM, GC, SM-SC, & ML	45	370	72
		SC, MH, ML-CL, & I-CL	60	490	48
9'-0"	8'-4"	GW, GP, SW, & SP	30	320	72
		GM, GC, SM-SC, & ML	45	480	48
		SC, MH, ML-CL, & I-CL	60	640	40

2006 INTERNATIONAL RESIDENTIAL CODE (TM) REQUIREMENTS FOR FOUNDATION WALLS WITH MINNESOTA BUILDING CODE AMENDMENTS

The following information has been edited from the 2006 International Residential Code and the Minnesota Building Code. These sections are essential to meet the requirements for masonry and concrete foundation walls constructed in Minnesota. The 2006 International Residential Code and the Minnesota Building Code should be consulted for complete requirements and details.

SECTION R404 (Minnesota 1309.0404) FOUNDATION AND RETAINING WALLS

R404.1 Concrete and masonry foundation walls. Concrete and masonry foundation walls shall be selected and constructed in accordance with the provisions of Section R404 or in accordance with ACI 318, ACI 332, NCMA TR68-A, ACI 530/ASCE 5/TMS 402 or other approved structural standards. When ACI 318, ACI 332 or ACI 530/ASCE 5/TMS 402 or the provisions of Section R404 are used to design concrete or masonry foundation walls project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the jurisdiction having authority. Foundation walls that meet all of the following shall be considered laterally supported:

1. Full basement floor shall be 3.5 inches thick concrete slab poured tight against the bottom of the foundation wall.
2. Floor joist and blocking shall be connected to the sill plate at the top of the wall by the prescriptive method called out in Table R404.1(1), or; shall be connected with an approved connector with listed capacity meeting Table R404.1(1).
3. Bolt spacing for the sill plate shall be no greater than per Table R404.1(2).
4. Floor shall be blocked by perpendicular to the floor joists. Blocking shall be full depth within two joist spaces of the foundation.
5. Where foundation walls support unbalanced load on opposite sides of the building, such as a daylight basement, the rim board shall be attached to the sill with a 20 gage metal angle clip at 24 inches on center, with five 8d nails per leg, or an approved connector supplying 230 pounds per linear foot capacity.

R404.1.1 Masonry foundation walls. Concrete masonry and clay masonry foundation walls shall be constructed as set forth in Tables R404.1.1(1), R404.1.1(2), R404.1.1(3) or R404.1.1(4) and shall also comply with the provisions of Section R404 and the applicable provisions of Sections R606, R607 and R608. Rubble stone masonry foundation walls shall be constructed in accordance with Sections R404.1.8 and R607.2.2. Cantilevered masonry foundation walls shall be constructed as set forth in Table R404.1.1(6), R404.1.1(7), or R404.1.1(8). Cantilevered means: foundation walls that do not have permanent lateral support at the top.

R404.1.2 Concrete foundation walls. Concrete foundation walls shall be constructed as set forth in Tables R404.1.1(5), and shall also comply with the provisions of Section R404 and the applicable provisions of Section R404.2. Cantilevered concrete foundation walls shall be constructed as set forth in Table R404.1.1(6), R404.1.1(7), or R404.1.1(8). Cantilevered means: foundation walls that do not have permanent lateral support at the top.

R404.1.3 Design required. Concrete or masonry foundation walls shall be designed in accordance with accepted engineering practice when either of the following conditions exist:

1. Walls are subject to hydrostatic pressure from groundwater.
2. Walls supporting more than 48 inches of unbalanced backfill that do not have permanent lateral support at the top and bottom. Exception: Cantilevered concrete and masonry foundation walls constructed in accordance with Table R404.1.1(6), R404.1.1(7), or R404.1.1(8).

R404.1.5 Foundation wall thickness based on walls supported. The thickness of concrete and masonry foundation walls shall not be less than the thickness of the wall supported, except that foundation walls of at least 8-inch nominal thickness shall be permitted under brick-veneered frame walls and under 10-inch wide cavity walls where the total height of the walls supported, including gables, is not more than 20 feet, provided the requirements of Sections R404.1.1 and R404.1.2 are met.

R404.1.6 Height above grade. Concrete and masonry foundation walls shall extend above the finished grade adjacent to the foundation at all points a minimum of 4 inches where masonry veneer is used and a minimum of 6 inches elsewhere.

R404.1.7 Backfill placement. Backfill shall not be placed against the wall until the wall has sufficient strength and has been anchored to the floor above, or has been sufficiently braced to prevent damage by the back fill.

Exception: bracing is not required for walls supporting less than 4 feet of unbalanced backfill.

TABLE 1
PLAIN MASONRY FOUNDATION WALLS
[Based on the 2006 IRC table R404.1.1(1)]

Maximum Wall Height (feet)	Maximum Unbalanced Backfill Height (feet)	Plain Masonry Minimum Nominal Wall Thickness (inches)		
		Soil Classes		
		GW, GP, SW, & GP	GM, CG, SM, SM-SC, & ML	SC, MH, ML-CL, and Inorganic CL
5	4	6 solid or 8	6 solid or 8	6 solid or 8
	5	6 solid or 8	8	10
6	4	6 solid or 8	6 solid or 8	6 solid or 8
	5	6 solid or 8	8	10
	6	8	10	12
7	4	6 solid or 8	8	8
	5	6 solid or 8	10	10
	6	10	12	10 solid
	7	12	10 solid	12 solid
8	4	6 solid or 8	6 solid or 8	8
	5	6 solid or 8	10	12
	6	10	12	12 solid
	7	12	12 solid	Footnote e
	8	10 solid	12 solid	Footnote e
9	4	6 solid or 8	6 solid or 8	8
	5	8	10	12
	6	10	12	12 solid
	7	12	12 solid	Footnote e
	8	12 solid	Footnote e	Footnote e
	9	Footnote e	Footnote e	Footnote e

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch - 6.895 Pa.

a. Mortar shall be Type M or S and masonry shall be laid in running bond. Ungrouted hollow masonry units are permitted except where otherwise indicated.

b. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1

c. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

d. Solid grouted hollow units or solid masonry units.

e. Wall construction shall be in accordance withe Table R404.1.1(2) or a design shall be provided. When the maximum unbalanced backfill height exceeds 6 feet consider using reinforcement schedules from tables 2, 3, or 4. Variables in backfilling conditions and wall bracing may make wall reinforcement advisable under these conditions.

TABLE 2
8" MASONRY FOUNDATION WALLS WITH REINFORCING

[Based on the 2006 IRC table R404.1.1(2)]

Where d > 5 inches (a)

Wall Height	Height of Unbalanced Backfill (e)	Minimum Vertical Reinforcement (b,c)		
		Soil Classes and lateral load (d) (psf per foot below grade)		
		GW, GP, SW, & SP Soils	GM, CG, SM, SM-SC, & ML Soils	SC, ML-CL, and Inorganic CL Soils
6 ft. 8 in.	4 ft. (or less)	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	5 feet	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	6 ft. 8 in.	#4 @ 48" (#5 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")
7 ft. 4 in.	4 ft. (or less)	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	5 feet	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	6 feet	#4 @ 48" (#5 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")
	7 ft. 4 in.	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")
8 feet	4 ft. (or less)	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	5 feet	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	6 feet	#4 @ 48" (#5 @ 72")	# 5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")
	7 feet	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	# 6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")
	8 feet	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 32" (#5 @ 16") (#7 @ 40")
8 ft. 8 in.	4 ft. (or less)	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	5 feet	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @72")
	6 feet	#4 @ 48" (#5 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")
	7 feet	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")
	8 ft. 8 in.	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 32" (#5 @ 16") (#7 @ 40")	#6 @ 24" (#5 @ 16") (#7 @ 32")
9 ft. 4 in.	4 ft. (or less)	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	5 feet	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")
	6 feet	#4 @ 48" (#5 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")
	7 feet	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")
	8 feet	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")	#6 @ 24" (#5 @ 16") (#7 @ 32")
	9 ft. 4 in.	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")	#6 @24" (#5 @ 16") (#7 @ 32")	#6 @ 16"

10 feet	4 feet (or less)	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")
	5 feet	#4 @ 48" (#5 @ 72")	#4 @ 48" (#5 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")
	6 feet	#4 @ 48" (#5 @ 72")	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")
	7 feet	#5 @ 48" (#4 @ 24") (#6 @ 64") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 32" (#5 @ 16") (#7 @ 40")
	8 feet	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 32" (#5 @ 16") (#7 @ 40")	#6 @ 24" (#5 @ 16") (#7 @ 32")
	9 feet	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")	#6 @ 24" (#5 @ 16") (#7 @ 32")	#6 @ 16"
	10 feet	#6 @ 32" (#5 @ 16") (#7 @ 40")	#6 @ 16"	#6 @ 16"

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. The first reinforcing bar size and spacing is as prescribed in the IRC tables and is followed by alternative bar sizes and spacing having an equivalent cross-sectional area of reinforcement per lineal foot of wall as permitted, providing the spacing of the reinforcement does not exceed 72 inches.

c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be at least 5 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table 1.

e. Unbalanced backfill height is the difference in height of the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

TABLE 3
10" MASONRY FOUNDATION WALLS WITH REINFORCING

[Based on the 2006 IRC table R404.1.1(3)]

Where d > 6.75 inches (a)

Wall Height	Height of Unbalanced Backfill (e)	Minimum Vertical Reinforcement (b,c)		
		Soil Classes and lateral load (d) (psf per foot below grade)		
		GW, GP, SW, & SP Soils	GM, CG, SM, SM-SC, & ML Soils	SC, ML-CL, and Inorganic CL Soils
6 ft. 8 in.	4 ft. or less	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	5 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	6 ft. 8 in.	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")
7 ft. 4 in.	4 ft. (or less)	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	5 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	6 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")
	7 ft. 4 in.	#4 @ 56" (5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")
8 feet	4 ft. (or less)	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	5 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	6 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")
	7 feet	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")
	8 feet	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")
8 ft. 8 in.	4 ft. (or less)	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	5 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	6 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")
	7 feet	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")
	8 ft. 8 in.	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 32" (#5 @ 16") (#7 @ 40")
9 ft. 4 in.	4 ft. (or less)	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	5 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	6 feet	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")
	7 feet	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")
	8 feet	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")
	9 ft. 4 in.	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")	#6 @40" (#4 @ 16") (#5 @ 24") (#7 @ 48")	#6 @ 24" (# 5 @ 16") (#7 @ 32")

10 feet	4 feet (or less)	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	5 feet	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")	#4 @ 56" (#5 @ 72")
	6 feet	#4 @ 56" (#5 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")	#5 @ 56" (#4 @ 32") (#6 @ 72")
	7 feet	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")
	8 feet	#5 @ 56" (#4 @ 32") (#6 @ 72")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")
	9 feet	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")	#6 @ 24" (#5 @ 16") (#7 @ 32")
	10 feet	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 32" (#5 @ 16") (#7 @ 40")	#6 @ 24" (#5 @ 16") (#7 @ 32")

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. The first reinforcing bar size and spacing is as prescribed in the IRC tables and is followed by alternative bar sizes and spacing having an equivalent cross-sectional area of reinforcement per lineal foot of wall as permitted, providing the spacing of the reinforcement does not exceed 72 inches.

c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be at least 3.75 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. See Table R405.1

e. Unbalanced backfill height is the difference in height of the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

TABLE 4
12" MASONRY FOUNDATION WALLS WITH REINFORCING

[Based on the 2006 IRC table R404.1.1(4)]

Where d > 8.75 inches (a)

Wall Height	Height of Unbalanced Backfill (e)	Minimum Vertical Reinforcement (b,c)		
		Soil Classes and lateral load (d) (psf per foot below grade)		
		GW, GP, SW, & SP Soils	GM, CG, SM, SM-SC, & ML Soils	SC, ML-CL, and Inorganic CL Soils
6 ft. 8 in.	4 ft. or less	#4 @ 72"	#4 @ 72"	#4 @ 72")
	5 feet	#4 @ 72"	#4 @ 72"	#4 @ 72"
	6 ft. 8 in.	#4 @ 72"	#4 @ 72"	#5 @ 72" (#4 @ 40")
7 ft. 4 in.	4 ft. (or less)	#4 @ 72"	#4 @ 72"	#4 @ 72"
	5 feet	#4 @ 72"	#4 @ 72"	#4 @ 72"
	6 feet	#4 @ 72"	#4 @ 72"	#5 @ 72" (#4 @ 40")
	7 ft. 4 in.	#4 @ 72"	#5 @ 72" (#4 @ 40")	#6 @ 72" (#4 @ 32") (#5 @ 48")
8 feet	4 ft. (or less)	#4 @ 72"	#4 @ 72"	#4 @ 72"
	5 feet	#4 @ 72"	#4 @ 72"	#4 @ 72"
	6 feet	#4 @ 72"	#4 @ 72"	#5 @ 72" (#4 @ 40")
	7 feet	#4 @ 72"	#5 @ 72" (#4 @ 40")	#6 @ 72" (#4 @ 32") (#5 @ 48")
	8 feet	#5 @ 72" (#4 @ 40")	#6 @ 72" (#4 @ 32") (#5 @ 48")	#6 @ 64" (#4 @ 24") (#5 @ 40") (#7 @ 72")
8 ft. 8 in.	4 ft. (or less)	#4 @ 72"	#4 @ 72"	#4 @ 72"
	5 feet	#4 @ 72"	#4 @ 72"	#4 @ 72"
	6 feet	#4 @ 72"	#4 @ 72"	#5 @ 72" (#4 @ 40")
	7 feet	#4 @ 72"	#5 @ 72" (#4 @ 40")	#6 @ 72" (#4 @ 32") (#5 @ 48")
	8 ft. 8 in.	#5 @ 72" (#4 @ 40")	#7 @ 72" (#4 @ 24") (#5 @ 32") (#6 @ 48")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")
9 ft. 4 in.	4 ft. (or less)	#4 @ 72"	#4 @ 72"	#4 @ 72"
	5 feet	#4 @ 72"	#4 @ 72"	#4 @ 72"
	6 feet	#4 @ 72"	#5 @ 72" (#4 @ 40")	#5 @ 72" (#4 @ 40")
	7 feet	#4 @ 72"	#5 @ 72" (#4 @ 40")	#6 @ 72" (#4 @ 32") (#5 @ 48")
	8 feet	#5 @ 72" (#4 @ 40")	#6 @ 72" (#4 @ 32") (#5 @ 48")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")
	9 ft. 4 in.	#6 @ 72" (#4 @ 32") (#5 @ 48")	#6 @48" (#4 @ 16") (#5 @ 32") (#7 @ 64")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")
10 feet	4 feet (or less)	#4 @ 72"	#4 @ 72"	#4 @ 72"
	5 feet	#4 @ 72"	#4 @ 72"	#4 @ 72"
	6 feet	#4 @ 72"	#5 @ 72" (#4 @ 40")	#5 @ 72" (#4 @ 40")
	7 feet	#4 @ 72"	#6 @ 72" (#4 @ 32") (#5 @ 48")	#6 @ 72" (#4 @ 32") (#5 @ 48")
	8 feet	#5 @ 72" (#4 @ 40")	#6 @ 72" (#4 @ 32") (#5 @ 48")	#6 @ 48" (#4 @ 16") (#5 @ 32") (#7 @ 64")
	9 feet	#6 @ 72" (#4 @ 32") (#5 @ 48")	#6 @ 56" (#4 @ 24") (#5 @ 32") (#7 @ 72")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")
	10 feet	#6 @ 64" (#4 @ 24) (#5 @ 40") (#7 @ 72")	#6 @ 40" (#4 @ 16") (#5 @ 24") (#7 @ 48")	#6 @ 32" (#5 @ 16") (#7 @ 40")

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. The first reinforcing bar size and spacing is as prescribed in the IRC tables and is followed by alternative bar sizes and spacing having an equivalent cross-sectional area of reinforcement per lineal foot of wall as permitted, providing the spacing of the reinforcement does not exceed 72 inches.

c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be at least 8.75 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. See Table R405.1

e. Unbalanced backfill height is the difference in height of the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

TABLE 6
8" CANTILEVERED CONCRETE AND MASONRY FOUNDATION WALLS
[Based on the 2006 IRC table R404.1.1(6)]

Maximum Wall Height (j) (feet)	Maximum Unbalanced Backfill (e) (feet)	Minimum Vertical Reinforcement Size and Spacing for 8-INCH Nominal Wall Thickness (a)(b)(c)(e)(f)(i)(k)		
		Soil Classes (d)		
		GW, GP, SW, & SP Soils	GM, GC, SM, SM-SC, & ML Soils	SC, MH, ML-CL, and Inorganic CL Soils
4	3	None Required	None Required	None Required
	4	None Required	None Required	#2 @ 72" o.c.
5	3	None Required	None Required	None Required
	4	#4 @ 72" o.c.	#4 @ 56" o.c. (h) (#5 @ 72" o.c.)	#4 @ 40" o.c. (g) (#5 @ 56" o.c.) (#6 @ 72" o.c.)
	5	#4 @ 72" o.c.	#4 @ 56" o.c. (h) (#5 @ 72" o.c.)	#4 @ 40" o.c. (g) (#5 @ 56" o.c.) (#6 @ 72" o.c.)

a. Mortar shall be Type M or S and masonry shall be laid in running bond. Minimum unit compressive strength is 1900 PSI.

b. The first reinforcing bar size and spacing is as prescribed in the IRC tables and is followed by alternative bar sizes and spacing having an equivalent cross-sectional area of reinforcement per lineal foot of wall as permitted, providing the spacing of the reinforcement does not exceed 72 inches.

c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be no greater than 2.5 inches.

d. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

e. Interior concrete floor slab shall be placed tight to the wall. The exterior grade level shall be 6: minimum below the top of wall. Maximum height from top of slab to bottom of floor joist is 10'-0". Unbalanced backfill height is the difference in height of the exterior finish ground levels and the top of the interior concrete slab-on-grade.

f. Minimum footing size of 20" by 8" shall be placed on soil with a bearing capacity of 2000 psf. Minimum concrete compressive strength of footing shall be 3000 psi.

g. Provide propped cantilever wall: top of footing shall be 16" below the bottom of the concrete floor slab minimum.

h. Provide #5 Grade 60 dowels, 1'-6" long, to connect footing to wall. Embed dowel 5" into footing. Place dowels in center of wall thickness spaced at 32" o.c. maximum. No dowels are required where length of the foundation wall between perpendicular walls is 2 times the foundation wall height or less.

i. This table is applicable where the length of the foundation wall between perpendicular walls is 35 feet or less, or where the length of the foundation laterally supported on only one end by a perpendicular wall is 17 feet or less.

j. Maximum wall height is measured from top of wall to bottom of floor slab.

k. Install foundation anchorage per R403.1.6.

TABLE 7
10" CANTILEVERED CONCRETE AND MASONRY FOUNDATION WALLS
[Based on the 2006 IRC table R404.1.1(7)]

Maximum Wall Height (j) (feet)	Maximum Unbalanced Backfill (e) (feet)	Minimum Vertical Reinforcement Size and Spacing for 10-INCH Nominal Wall Thickness (a)(b)(c)(e)(f)(i)(k)		
		Soil Classes (d)		
		GW, GP, SW, & SP Soils	GM, GC, SM, SM-SC, & ML Soils	SC, MH, ML-CL, and Inorganic CL Soils
4	3	None Required	None Required	None Required
	4	None Required	None Required	None Required
5	3	None Required	None Required	None Required
	4	None Required	#4 @ 72" o.c.	#4 @ 64" o.c. (h) (#5 @ 72" o.c.)
	5	#4 @ 72" o.c.	#4 @ 72" o.c.	#4 @ 56" o.c. (g) (#5 @ 72" o.c.)
6	3	None Required	#4 @ 72" o.c.	#4 @ 72" o.c.
	4	#4 @ 72" o.c.	#4 @ 72" o.c.	#4 @ 64" o.c. (h) (#5 @ 72" o.c.)
	5	#4 @ 64" o.c. (h) (#5 @ 72" o.c.)	#40 @ 40" o.c. (g)(h) (#5 @ 56" o.c.) (#6 @ 72" o.c.)	#5 @ 48" o.c. (g)(h) (#6 @ 64" o.c.) (#7 @ 72" o.c.)
	6	#4 @ 64" o.c. (h) (#5 @ 72" o.c.)	#40 @ 40: o.c. (g)(h) (#5 @ 56" o.c.) (#6 @ 72" o.c.)	#5 @ 48" o.c. (g)(h) (#6 @ 64" o.c.) (#7 @ 72" o.c.)

a. Mortar shall be Type M or S and masonry shall be laid in running bond. Minimum unit compressive strength is 1900 PSI.

b. The first reinforcing bar size and spacing is as prescribed in the IRC tables and is followed by alternative bar sizes and spacing having an equivalent cross-sectional area of reinforcement per lineal foot of wall as permitted, providing the spacing of the reinforcement does not exceed 72 inches.

c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be no greater than 2.5 inches.

d. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

e. Interior concrete floor slab shall be placed tight to the wall. The exterior grade level shall be 6" minimum below the top of wall. Maximum height from top of slab to bottom of floor joist is 10'-0". Unbalanced backfill height is the difference in height of the exterior finish ground levels and the top of the interior concrete slab-on-grade.

f. Minimum footing size of 20" by 8" shall be placed on soil with a bearing capacity of 2000 psf. Minimum concrete compressive strength of footing shall be 3000 psi.

g. Provide propped cantilever wall: top of footing shall be 16" below the bottom of the concrete floor slab minimum.

h. Provide #5 Grade 60 dowels, 1'-6" long, to connect footing to wall. Embed dowel 5" into footing. Place dowels in center of wall thickness spaced at 32" o.c. maximum. No dowels are required where length of the foundation wall between perpendicular walls is 2 times the foundation wall height or less.

i. This table is applicable where the length of the foundation wall between perpendicular walls is 35 feet or less, or where the length of the foundation laterally supported on only one end by a perpendicular wall is 17 feet or less.

j. Maximum wall height is measured from top of wall to bottom of floor slab.

k. Install foundation anchorage per R403.1.6.

TABLE 8
12" CANTILEVERED CONCRETE AND MASONRY FOUNDATION WALLS
[Based on the 2006 IRC table R404.1.1(8)]

Maximum Wall Height (j) (feet)	Maximum Unbalanced Backfill (e) (feet)	Minimum Vertical Reinforcement Size and Spacing for 12-INCH Nominal Wall Thickness (a)(b)(c)(e)(f)(i)(k)		
		Soil Classes (d)		
		GW, GP, SW, & SP Soils	GM, GC, SM, SM-SC, & ML Soils	SC, MH, ML-CL, and Inorganic CL Soils
4	3	None Required	None Required	None Required
	4	None Required	None Required	None Required
5	3	None Required	None Required	None Required
	4	None Required	None Required	#4 @ 72" o.c.
	5	#4 @ 72" o.c.	#4 @ 72" o.c.	#4 @ 72" o.c.
6	3	None Required	None Required	None Required
	4	None Required	None Required	#4 @ 72" o.c.
	5	#4 @ 72" o.c.	#4 @ 56" o.c. (h) (#5 @ 72" o.c.)	#4 @ 40" o.c. (g) (#5 @ 56" o.c.) (#6 @ 72" o.c.)
	6	#4 @ 72" o.c.	#4 @ 56" o.c. (h) (#5 @ 72" o.c.)	#4 @ 32" o.c. (g)(h) (#5 @ 48" o.c.) (#6 @ 72" o.c.) (#7 @ 64" o.c.)
7	3	None Required	None Required	None Required
	4	None Required	#4 @ 72" o.c.	#4 @ 72" o.c.
	5	#4 @ 72" o.c.	#4 @ 56" o.c. (h) (#5 @ 72" o.c.)	#4 @ 40" o.c. (g) (#5 @ 56" o.c.) (#6 @ 72" o.c.)
	6	#4 @ 48" o.c. (#5 @ 72" o.c.)	#5 @ 48" o.c. (g)(h) (#6 @ 64" o.c.) (#7 @ 72" o.c.)	#6 @ 48" o.c. (g)(h) (#7 @ 64" o.c.)
	7	#4 @ 48" o.c. (#5 @ 72" o.c.)	#4 @ 40" o.c. (g)(h) (#5 @ 56" o.c.) (#6 @ 72" o.c.)	#6 @ 48" o.c. (g)(h) (#7 @ 64" o.c.)

a. Mortar shall be Type M or S and masonry shall be laid in running bond. Minimum unit compressive strength is 1900 PSI.

b. The first reinforcing bar size and spacing is as prescribed in the IRC tables and is followed by alternative bar sizes and spacing having an equivalent cross-sectional area of reinforcement per lineal foot of wall as permitted, providing the spacing of the reinforcement does not exceed 72 inches.

c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be no greater than 2.5 inches.

d. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

e. Interior concrete floor slab shall be placed tight to the wall. The exterior grade level shall be 6" minimum below the top of wall. Maximum height from top of slab to bottom of floor joist is 10'-0". Unbalanced backfill height is the difference in height of the exterior finish ground levels and the top of the interior concrete slab-on-grade.

f. Minimum footing size of 20" by 8" shall be placed on soil with a bearing capacity of 2000 psf. Minimum concrete compressive strength of footing shall be 3000 psi.

g. Provide propped cantilever wall: top of footing shall be 16" below the bottom of the concrete floor slab minimum.

h. Provide #5 Grade 60 dowels, 1'-6" long, to connect footing to wall. Embed dowel 5" into footing. Place dowels in center of wall thickness spaced at 32" o.c. maximum. No dowels are required where length of the foundation wall between perpendicular walls is 2 times the foundation wall height or less.

i. This table is applicable where the length of the foundation wall between perpendicular walls is 35 feet or less, or where the length of the foundation laterally supported on only one end by a perpendicular wall is 17 feet or less.

j. Maximum wall height is measured from top of wall to bottom of floor slab.

k. Install foundation anchorage per R403.1.6.

Recommended One & Two Family Residential Cold Weather Masonry Construction Guidelines

A part of the Recommended Practices Manual, 5th ed.

MMPC

MIDWEST MASONRY PROMOTION COUNCIL

NOTES

1. INTRODUCTION

1-1 Since it is often impractical to enclose and heat masonry construction in a residential setting, the following guidelines were developed to enhance cold weather masonry construction techniques in Minnesota.

1-2 These recommended guidelines should be following in addition to the practices discussed in "Recommended Practices for Construction of Residential Masonry Basements in Minnesota," available from MMPC.

1-3 Prior to or at the time of building permit application, the applicant should submit these cold weather masonry guidelines to the building official for approval. Any other requirements by the building official should be noted and resolved with the building permit applicant prior to issuance of the permit.

2. FOOTING CONSTRUCTION

2-1 Work should not commence, unless at 6:00 a.m., the ambient air temperature is 0° F or higher, and forecast to rise.

2-2 Do not place footings on frozen soil. Protect footings and adjoining soil from frost penetration during freezing temperatures.

2-3 After forming, use adequate insulating blankets to prevent frost from penetrating the soil.

2-4 Immediately after concrete placement, adequate insulating blankets should be placed over the concrete. Straw or hay should not be allowed as an insulating material.

2-5 Concrete delivered in cold weather should have the applicable minimum temperature indicated in table 2-1.

Table 2-1: Minimum Concrete Temperature

Air Temperature	Thin Sections & Unformed Slabs	Heavy Sections & Mass Concrete
30 – 45° F	60° F	50° F
0 – 30° F	65° F	55° F
Below 0° F	70° F	60° F

The maximum temperature of concrete produced with heated aggregates, heated water, or both, should at no time during its production or transportation exceed 90° F.
Note: The temperature of the concrete produced during hot weather should be as low as practical.

3. MASONRY MATERIALS

3-1 Masonry materials (Concrete Block, Brick or Stone) stored on the job should be covered and kept dry.

3-2 All masonry laid should be free from ice and snow.

3-3 When ambient temperatures are 25° F or lower, all walls after construction should be covered with wind-resistant material, on both sides, from the top of the wall down to the footings.

4. MORTAR AND GROUT

4-1 The following recommendations should be met for the following temperatures.

- Temperatures 40°F - 32°F
  Construction Requirements: Heat materials to produce mortar or grout between 40°F - 120°F (4°C - 49°C).
- Temperatures 32°F and below
  Construction Requirements: Heat materials to produce mortar or grout between 40°F - 120°F (4°C - 49°C). Maintain mortar or grout above freezing until used in masonry.

4-2 Additional Comments

a. In cold weather conditions, accelerating the initial set time of mortar or grout materials may be desired. Use one of these methods:

   a. Type III may be used in place of Type I for faster initial set time and faster initial strength gain.

   b. Set accelerated pre-blended mortar may be used for faster initial set time and faster initial strength gain.

   c. A liquid set accelerator may be added to mortar or grout for faster initial set time

and faster initial strength gain.

b. Mortar should be mixed in smaller amounts so it can be used before it cools.

c. Every effort should be made to produce consecutive batches of mortar with consistent temperatures.

d. Cover walls with wind-resistant materials to prevent rapid heat loss or water from entering masonry.

References:

1. "Recommended One and Two Family Cold Weather Masonry Construction Guidelines", Minnesota Codes and Fire Safety Council, 1993.

Tables

Table 2-1 Minimum Concrete Temperatures

Diagrams

Minnesota Frost Depth Map

Mortar Cards

1) Mortar Cement and Masonry Cement

2) Portland Cement and Lime

NOTES

Recommended Radon Guidelines

A part of the Recommended Practices Manual, 5th ed.

MMPC

MIDWEST MASONRY PROMOTION COUNCIL

NOTES

INTRODUCTION

As of June 1, 2009 all new houses built in Minnesota are required to include features designed to resist or reduce the infiltration of radon gas. Radon, an odorless, tasteless gas that forms from the decay of naturally occurring uranium found in rock and soil throughout Minnesota, is the second leading cause of lung cancer in the U.S.

The change to the state building code requires builders to install a "passive" radon mitigation system that does not include a powered exhaust fan. These systems reduce soil gas entry points and provide a route to vent the gases to the outdoors.

For more information on the health risks associated with radon, visit www.health.state.mn.us/radon. For more information on Minnesota building codes related to radon, contact Don Sivigny, MN Department of Labor & Industry, at 651-284-5874 or e-mail don.sivigny@state.mn.us.

1322.2100 INCORPORATION BY REFERENCE

Appendix F, Radon Control Methods, of the 2006 edition of the International Residential Code (Appendix F) as promulgated by the International Code Council, Inc. (ICC), Falls Church, VA 22041, is incorporated by reference and made part of the Minnesota State Building Code except as qualified by the applicable provisions in chapter 1300, and as amended in parts 1322.2101 to 1322.2103. Appendix F is not subject to frequent change and a copy of Appendix F, with amendments for us in Minnesota, is available in the office of the commissioner of labor and industry. Portions of parts 1322.2101 to 1322.2103 reproduce text and tables from Appendix F, which is copyrighted by the ICC. All rights reserved.

Statutory Authority:
MS s 326B.02; 326B.101; 326B.106; 326B.13

History:
33 SR 1480

Posted:
June 17, 2009

1322.2101 SECTION AF101, SCOPE

Subpart 1. **General.** Appendix F, Section AF101, is amended to read as follows:
The purpose of parts 1322.2101 to 1322.2103 is to establish requirements for radon-resistant construction in new residential construction built to the requirements of Minnesota Rules, chapter 1305 or 1309.

Subp. 2. **Figure AF101.** Appendix F, Figure AF101, is deleted in its entirety.

Subp. 3. **Table AF101(1).** Appendix F, Table AF101(1), is deleted in its entirety.

Statutory Authority:
MS s 326B.02; 326B.101; 326B.106; 326B.13

History:
33 SR 1480

Posted:
June 17, 2009

1322.2102 SECTION AF102, DEFINITIONS

Subpart 1.

General.

Appendix F, Section AF102, is amended to read as follows: **AF102.1 General.** The definitions in this part apply to Minnesota Rules, parts 1322.2101 to 1322.2103.

SUB-SLAB DEPRESSURIZATION SYSTEM (Passive). A system designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a vent pipe routed through the conditioned space of a building and connecting the sub-slab area with outdoor air, thereby relying on the convective flow of air upward in the vent to draw air from beneath the slab.

SUB-SLAB DEPRESSURIZATION SYSTEM (Active). A system designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a fan-powered vent drawing air from beneath the slab.

DRAIN TILE LOOP. A continuous length of drain tile or perforated pipe extending around all of the internal perimeter of a basement or crawl space.

RADON GAS. A naturally occurring, chemically inert, radioactive gas that is not detectable by human senses. As a gas, it can move readily through particles of soil and rock and can accumulate under the slabs and foundations of homes where it can easily enter into the living space through construction cracks and openings.

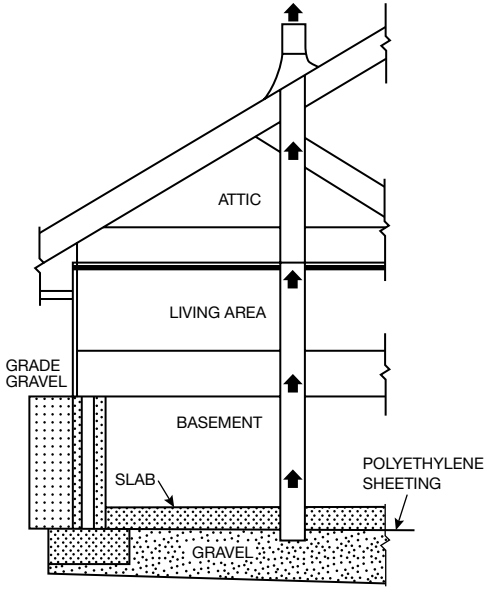
SOIL-GAS RETARDER. A continuous membrane of 6-mil (0.15 mm) polyethylene, 3-mil (0.075 mm) cross-laminated polyethylene, or other equivalent material used to retard the flow of soil gases into a building.

SUB-MEMBRANE DEPRESSURIZATION SYSTEM. A system designed to achieve lower sub-membrane air pressure relative to crawl space air pressure by use of a vent drawing air from beneath the soil-gas-retarder membrane.

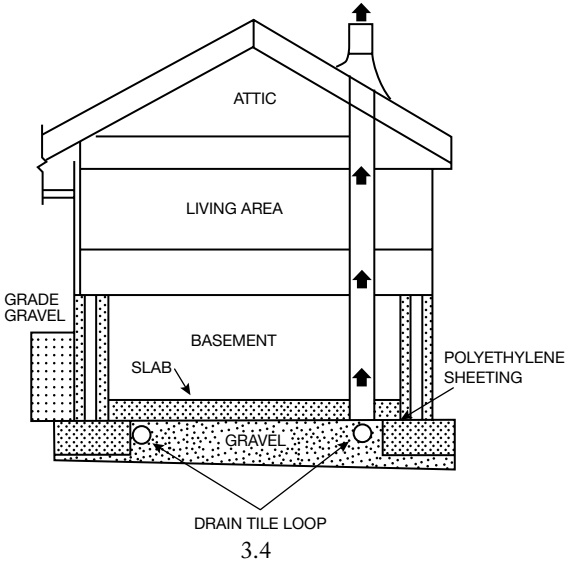
Subp. 2. **Figure AF102.**

FIGURE AF102
RADON-RESISTANT CONSTRUCTION DETAILS FOR FOUR FOUNDATION TYPES

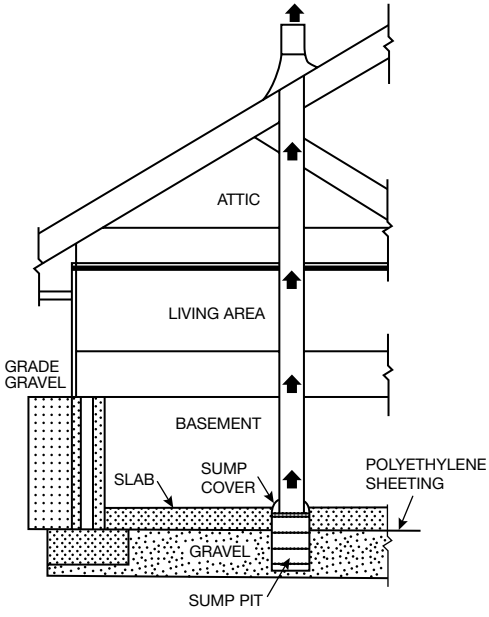
TYPICAL SUB-SLAB DEPRESSURIZATION PASSIVE RADON SYSTEM



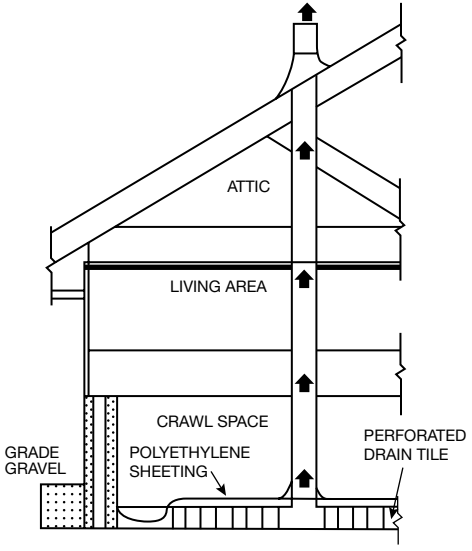
PASSIVE RADON SYSTEM USING DRAIN-TILE LOOP



PASSIVE RADON SYSTEM VENTED THROUGH SUMP



SUB-MEMBRANE DEPRESSURIZATION SYSTEM FOR CRAWL SPACE



1322.2103 SECTION AF103, REQUIREMENTS

Appendix F, Section AF103, is amended to read as follows:

AF103.1 General. The following passive construction techniques are intended to resist radon entry and prepare the building for post construction active radon mitigation. (see Figure AF102).

AF103.2 Subfloor preparation. A layer of gas-permeable material shall be placed under all concrete slabs and other floor systems that directly contact the ground and are within the walls of the living spaces and conditioned crawl spaces of the building, to facilitate the installation of an active sub-slab depressurization system if needed. The gas-permeable layer shall consist of one of the following:

1. A uniform layer of clean aggregate, a minimum of 4 inches (102 mm) thick. The aggregate shall consist of material that will pass through a 2-inch (51 mm) sieve and be retained by a 1/4-inch (6.4 mm) sieve.
2. A uniform layer of sand (native or fill), a minimum of 4 inches (102 mm) thick, overlain by a layer or strips of geotextile drainage matting designed to allow the lateral flow of soil gases.
3. Other materials, systems, or floor designs with demonstrated capability to permit depressurization across the entire sub-floor area.

AF103.3 Soil-gas-retarder. A minimum of 6-mil (0.15 mm) [or 3-mil (0.075 mm) cross-laminated] polyethylene or equivalent flexible sheeting material shall be placed on top of the gas-permeable layer prior to casting the slab or placing the floor assembly to serve as a soil-gas-retarder by bridging any cracks that develop in the slab or floor assembly and to prevent concrete from entering the void spaces in the aggregate base material. The sheeting shall cover the entire floor area with separate sections of sheeting lapped at least 12 inches (305 mm). The sheeting shall fit closely around any pipe, wire, or other penetrations of the material. All punctures or tears in the material shall be sealed or covered with additional sheeting.

AF103.4 Entry routes. Potential radon entry routes shall be closed in accordance with Sections AF103.4.1 through AF103.4.10.

AF103.4.1 Floor openings. Openings around bathtubs, showers, water closets, pipes, wires, or other objects

that penetrate concrete slabs or other floor assemblies shall be filled with a polyurethane caulk or equivalent sealant applied in accordance with the manufacturer's recommendations.

AF103.4.2 Concrete joints. All control joints, isolation joints, construction joints, and any other joints in concrete slabs or between slabs and foundation walls shall be sealed with a caulk or sealant. Gaps and joints shall be cleared of loose material and filled with polyurethane caulk or other elastomeric sealant applied in accordance with the manufacturer's recommendations.

AF103.4.3 Condensate drains. Condensate drains shall be trapped or routed through nonperforated pipe to daylight.

AF103.4.4 Sumps. Sump pits open to soil or serving as the termination point for sub-slab or interior drain tile loops shall be covered with a gasketed or otherwise sealed lid. Sumps used as the suction point in a sub-slab depressurization system shall have a lid designed to accommodate the vent pipe. Sumps used as a floor drain shall have a lid equipped with a trapped inlet.

AF103.4.5 Foundation walls. Hollow block masonry foundation walls shall be constructed with either a continuous course of solid masonry, one course of masonry grouted solid, or a solid concrete beam at or above finished ground surface to prevent passage of air from the interior of the wall into the living space. Where a brick veneer or other masonry ledge is installed, the course immediately below that ledge shall be sealed. Joints, cracks, or other openings around all penetrations of both exterior and interior surfaces of masonry block or wood foundation walls below the ground surface shall be filled with polyurethane caulk or equivalent sealant. Penetrations of concrete walls shall be filled.

AF103.4.6 Waterproofing/dampproofing. The exterior surfaces of portions of concrete and masonry block walls below the ground surface shall be dampproofed or waterproofed in accordance with Section R406 of this code.

AF103.4.7 Air-handling units. Air-handling units in crawl spaces shall be sealed to prevent air from being drawn into the unit.

Exception: Units with gasketed seams or units that are otherwise sealed by the manufacturer to prevent leakage.

AF103.4.8 Ducts. Ductwork passing through or beneath a slab shall be of seamless material unless the air-handling system is designed to maintain continuous positive pressure within such ducting. Joints in such ductwork shall be sealed to prevent air leakage.

Ductwork located in crawl spaces shall have all seams and joints sealed by closure systems in accordance with Minnesota Rules, chapter 1346.

AF103.4.9 Unconditioned crawl space floors. Openings around all penetrations through floors above unconditioned crawl spaces shall be caulked or otherwise filled to prevent air leakage.

AF103.4.10 Unconditioned crawl space access. Access doors and other openings or penetrations between basements and adjoining unconditioned crawl spaces shall be closed, gasketed, or otherwise filled to prevent air leakage.

AF103.5 Passive sub-membrane depressurization system. In buildings with crawl space foundations, the following components of a passive sub-membrane depressurization system shall be installed during construction.

AF103.5.1 Ventilation. Unconditioned crawl spaces shall be provided with vents to the exterior of the building. The minimum net area of ventilation openings shall comply with Section R408.1 of this code.

AF103.5.2 Soil-gas-retarder. The soil in crawl spaces shall be covered with a continuous layer of minimum 6-mil (0.14 mm) polyethylene soil-gas-retarder. The ground cover shall be lapped a minimum of 12 inches (305 mm) at joints and shall extend to all foundation walls enclosing the crawl space area.

AF103.5.3 Vent pipe. A plumbing tee or other approved connection shall be inserted horizontally beneath the sheeting with one 10-foot section of a perforated pipe connected to each side of the "T" fitting and then connected to a 3- or 4-inch diameter (76 mm or 102 mm) fitting with a vertical vent pipe installed through the sheeting. The vent pipe shall be of solid piping

material and shall be extended up through the building floors, terminated at least 12 inches (305 mm) above the roof in a location at least 10 feet (3,048 mm) away from any window or other opening into the conditioned spaces of the building that is less than 2 feet (610 mm) below the exhaust point, and 10 feet (3,048 mm) from any window or other opening in adjoining or adjacent buildings.

AF103.6 Passive sub-slab depressurization system. In buildings with basements, foundations, and/or conditioned crawl spaces, or slab-on-grade buildings, the following components of a passive sub-slab depressurization system shall be installed during construction.

AF103.6.1 Vent pipe. A minimum 3-inch diameter (76 mm) ABS, PVC, or equivalent gastight pipe shall be embedded vertically into the sub-slab aggregate or other permeable material before the slab is cast. A "T" fitting with one 10-foot section of a perforated pipe connected to each side of the "T" fitting or equivalent method shall be used to ensure that the pipe opening remains within the sub-slab permeable material. Alternatively, the 3-inch (76 mm) pipe shall be inserted directly into an interior perimeter drain tile loop or through a sealed sump cover where the sump is exposed to the sub-slab aggregate or connected to it through a drainage system.

The pipe shall be extended up through the building floors, terminate at least 12 inches (305 mm) above the surface of the roof in a location at least 10 feet (3048 mm) away from any window or other opening into the conditioned spaces of the building that is less than 2 feet (610 mm) below the exhaust point, and 10 feet (3048 mm) from any window or other opening in adjoining or adjacent buildings.

Exception: If an active sub-slab depressurization system is installed, the vent pipe may be routed through unconditioned space within the building or garage, provided the vent pipe is insulated to a minimum of R-4. Radon vent pipes shall terminate at least 12 inches above the roof or shall be connected to a single vent that terminates at least 12 inches above the roof. For active systems, a system monitoring device must also be installed. All other requirements of this section apply.

AF103.6.2 Multiple vent pipes. In buildings where interior footings or other barriers separate the sub-slab

aggregate or other gas-permeable material, each area shall be fitted with an individual vent pipe. Radon vent pipes shall connect to a single vent that terminates at least 12 inches above the roof or each individual vent pipe shall terminate separately at least 12 inches above the roof.

AF103.7 Vent pipe drainage. All components of the radon vent pipe system shall be installed to provide positive drainage to the ground beneath the slab or soil-gas-retarder.

AF103.8 Vent pipe accessibility. Radon vent pipes shall provide enough space around the pipe for future installation of a fan system. The space provided for installation of a future fan shall be a minimum of 24 inches in diameter, centered on the axis of the vent stack, and shall extend for a minimum vertical distance of 3 feet.

Exception: The radon vent pipe need not be accessible in an attic space where an approved rooftop electrical supply is provided for future use.

AF103.9 Vent pipe identification. All radon vent pipes shall be identified with at least one label on each floor and in accessible attics. The label shall read: "Radon Reduction System."

AF103.10 Combination foundations. Combination basement/crawl space or slab-on-grade/crawl space foundations shall have separate radon vent pipes installed in each type of foundation area. Each radon vent pipe shall terminate above the roof or shall be connected to a single vent that terminates above the roof.

Exception: A single vent pipe is allowed in a building with a combination foundation as long as soil gases can flow freely between the areas of the combination foundations and it is connected to an approved vent pipe.

AF103.11 Building depressurization. Joints in air ducts and plenums in unconditioned spaces shall meet the requirements of Minnesota Rules, chapter 1346. Thermal envelope air infiltration requirements shall comply with the energy conservation provisions in chapter 1322. Firestopping shall meet the requirements contained in Section R602.8.

AF103.12 Power source. To provide for future installation of an active sub-membrane or sub-slab depressurization system, an electrical circuit terminated in an approved box shall be installed during construction in the attic or other anticipated location of vent pipe fans.

Statutory Authority:

MS s 326B.02; 326B.101; 326B.106; 326B.13

History:

33 SR 1480

Posted:

June 17, 2009

NOTES

NOTES

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