

BEST MANAGEMENT STANDARDS FOR FOUNDATION REPAIR

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These Standards were prepared by a licensed State of Wisconsin registered structural engineer, Jendusa Engineering Associates, Inc. specifically for the Wisconsin Association of Foundation Repair Professionals (WAFRP) in cooperation with the Building Inspectors Association of Southeastern Wisconsin to address various conditions and foundation repair standards.



GLOSSARY OF TERMS

Backfill – Material used to fill in an excavation.

Bleeders – Concrete or plastic pipe that is installed through the footing or foundation wall to allow transfer of water from the exterior drain tile to the interior drain tile.

Concrete Block – Concrete masonry unit used in basement wall construction. Concrete block is commonly used in nominal 8”, 10” or 12” widths and is typically 8” tall by 16” long with 2 open cells in the block. The concrete blocks are stacked with alternating vertical joints using mortar between the joints to hold the block together.

Downspout – Aluminum or galvanized steel pipe that directs water collected in the rain gutters down to the ground and away from the building

Drain Tile (Interior or Exterior) – Concrete or plastic perforated pipe used underground to collect water and direct it to the sump crock. Exterior drain tile is placed on the outside of the building at the elevation of, or on top of the footing, consistent with existing conditions. Interior drain tile is placed around the inside perimeter of the building just below the floor slab. Drain tile is encased in clear aggregate to allow for water drainage to the pipe.

Drain Tile Test – A test of the function of the interior drain tile. The drain tile test is performed by: cutting through the floor slab to access the drain tile, flushing water into the drain tile and observing the amount of water entering the sump crock. A diminished water flow indicates a plugged or crushed drain tile. (See Appendix BB)

Efflorescence (Scale Stains) – White mineral deposits showing on face of masonry due to water leaching through the masonry to the dry surface.

Epoxy - Material used to repair cracks in concrete or masonry. Epoxy is a material that can be injected into wall cracks and when cured forms a very strong bond with the base material. Epoxy can be used for the structural repair of walls.

Grade – Reference to the pitch of the exterior ground surface adjacent to the building.

Horizontal Cracks – Usually associated with bowing or displacement of masonry walls that are not plumb vertically and/or horizontally.

Laser Level – Instrument, which emits a beam of light on a certain horizontal or vertical plane. This plane can be used to measure deflection and/or movement of an adjacent plane.

Level – Instrument used for measuring the plane of a vertical or horizontal surface.

Palmer Valve – Stormwater discharge valve typically located in the side wall of the floor drain, designed to prevent backflow of sanitary sewer into stormwater system.

Pilaster – A projection of masonry or a filled cell area of masonry for the purpose of bearing concentrated loads or to stiffen the wall against lateral forces.

Plumb Line – Tool for measuring wall deflection consisting of a weight and string. The string is attached at the top of the wall and the weight is at the end of the string located near the floor providing a straight vertical reference line. Measurements are taken from the string to the wall to determine the amount of horizontal deflection in the wall.

Polyurethane – Material that can be injected into wall cracks to prevent water leakage. Polyurethane should not be used for the structural repair of walls.

Poured Walls – Solid concrete walls that are constructed by setting concrete wall forms, installing steel reinforcing bars and pouring concrete into the forms to create a wall.

Radon Gas – Odorless and colorless slightly radioactive gas that can seep into basements through floor or wall cracks. At certain concentrations Radon Gas is considered a health hazard.

Seepage – Water infiltration through masonry walls or floor slab. Seepage is evidenced by damp or wet masonry walls or concrete floor and is an indication that the basement drainage system is overloaded or not functioning correctly.

Spud Pipe – Steel pipe, 3/4” to 1” diameter that is driven into the soil around the perimeter of the building. Water is injected into the soil thru the pipe just above the elevation of the drain tile to test the function of the drain tile.

Steel Restraints – Wall reinforcing used to prevent further movement in basement walls. Steel restraints are typically composed of steel tubes placed vertically against the basement walls at a 32” or 48” spacing.

Step Cracks – Cracks in masonry walls that follow the vertical and horizontal joints in the masonry in a stepped fashion. Step cracks can be due to horizontal wall deflection, foundation settlement or shrinkage of concrete masonry.

Stone Backfill – Clear crushed aggregate 3/4” to 1” diameter used to backfill excavations. Stone backfill allows for water to migrate easily towards the drain tile located at the basement footing elevation. Additionally, stone backfill will have minimal settlement around the perimeter of the building after backfilling.

Sump Crock – Concrete, steel or plastic basin placed below the floor slab in the lowest area of the building for collecting water from drain tile. Top rim to extend minimum 1” above floor.

Sump Pump – Submersible or upright pump located in sump crock to pump water out and away from the building.

Tuckpoint – Term used for the repair of cracks that occur in the joints in masonry walls. Tuckpointing involves the removal and replacement of the mortar between masonry units where cracking along the joints has occurred.

Wall Drainage Board – One piece corrugated or ribbed plastic panel that is placed to form an angle on top of the wall footing and against the masonry wall. The panel extends a minimum of 1” above the floor slab elevation. The wall drainage board is used to drain water from the cores of concrete masonry walls to the interior drain tile. (See Appendix C for product listing)

Wall Deflection – The amount of horizontal movement in a basement wall at any given location with respect to its vertical plane.

Wall Irregularities – Masonry wall corners or areas in the wall that have thickened sections. Examples of wall irregularities include foundations for masonry fireplaces and wall pilasters.

Wall Slide – Horizontal movement of basement wall, usually occurring at the bottom section of the wall.

1. **CONDITION: Wet walls / No leakage on floor (NO DISPLACEMENT)**

Characteristics:

Water spots on walls, wet walls, walls periodically dry up usually leaving scale stains, efflorescence, or mildew. Damp spots either high or low on wall. No major cracks or bowing. No significant block deterioration or displacement. No leaning of walls. No movement in footing.

Testing:

1. Check palmer valve or sump pump for correct operation. Check with local jurisdiction if repair of palmer valve is permitted (per local requirements).
2. Break open floor, test interior drain tile for correct flow to palmer valve, or sump pump. See Appendix BB.
3. Use water spud pipe, inserted along outside wall to exterior drain tile, to introduce water to check exterior drain tile operation.
4. Check for proper grade away from exterior walls and adequate gutters & downspouts.

Standard Repairs:

1. Extend downspouts, improve grade by increasing pitch away from buildings to the greatest extent possible.
2. Install, replace, or repair sump pump. Sump pump must meet State and local Plumbing and Electrical Code.
3. Replace some or all of interior drain tile as necessary, drain first block into interior drain tile using an approved one-piece wall drainage board that provides water passage and lateral support to first course of block. Wall drainage board to be 1" minimum higher than floor. Use a wall drainage board that can be caulked for retarding radon migration. Install to manufactures specifications. See Appendix B & C.
4. In some cases it may be necessary to excavate to footing, seal wall, clean out bleeders, replace exterior drain tile, backfill to within 12-18" of grade with clear stone backfill. See Appendix A.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

2. **CONDITION: Water leakage at wall/floor joint**

Characteristics:

Signs of water leakage to a maximum of TWO courses high. Water puddles or streams during or after heavy rains. Walls often have wet or damp areas, presence of mildew or efflorescence. Walls show no cracking, bowing or displacement.

Testing:

1. Check palmer valve or sump pump for correct operation. Check with local jurisdiction if palmer valve is permitted (per local requirements).
2. Break open floor, test interior drain tile for correct flow. See Appendix BB.
3. Use water spud pipe, inserted along outside wall to exterior drain tile, to introduce water to check exterior drain tile operation.
4. Check for proper grade away from exterior walls and adequate gutters & downspouts.

Standard Repairs:

1. Extend downspouts, improve grade by increasing pitch away from buildings to the greatest extent possible.
2. Install, replace, or repair sump pump. Sump pump must meet State and local Plumbing and Electrical Code.
3. Replace some or all of interior drain tile as necessary, drain first block into interior drain tile using an approved one-piece wall drainage board that provides water passage and lateral support to first course of block. Wall drainage board to be 1" minimum higher than floor. Use a wall drainage board that can be caulked for retarding radon migration. Install to manufactures specifications. See Appendix B & C.
4. In some cases, it may be necessary to excavate to footing, seal wall, clean out bleeders, replace exterior drain tile, backfill to within 12-18" of grade with clear stone backfill. See Appendix A.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

3. **CONDITION: Water leakage above wall base**

Characteristics:

Signs of water leakage appear in the middle to upper wall section. Water puddles or streams during or after heavy rains. Walls often have wet or damp areas, presence of mildew or efflorescence. Walls show no cracking, bowing or displacement.

Testing:

1. Check palmer valve or sump pump for correct operation. Check with local jurisdiction if palmer valve is permitted (per local requirements).
2. Break open floor, test interior drain tile for correct flow. See Appendix BB.
3. Use water spud pipe, inserted along outside wall to exterior drain tile, to introduce water to check exterior drain tile operation.
4. Check for proper grade away from exterior walls and adequate gutters & downspouts.

Standard Repairs:

1. Extend downspouts, improve grade by increasing pitch away from buildings to the greatest extent possible.
2. Install, replace or repair sump pump. Sump pump must meet State and local Plumbing and Electrical Code.
3. Replace some or all of interior drain tile as necessary, drain first block into interior drain tile using an approved one-piece wall drainage board that provides water passage and lateral support to first course of block. Wall drainage board to be 1" minimum higher than floor. Use a wall drainage board that can be caulked for retarding radon migration. Install to manufactures specifications. See Appendix B & C.
4. Excavate, seal wall, clean out bleeders and test interior drain tile for correct flow, replace exterior drain tile, backfill to within 12-18" of grade with clear stone backfill. See Appendix A.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

4. **CONDITION: Water seepage through floor slab**

Characteristics:

Water seepage occurs through cracks in the floor slab, away from the basement walls, causing discoloration and dampness.

Testing:

1. Break open floor at site of leakage.
2. Check for defective sump pump or stuck palmer valve (if present). Check with local jurisdiction if palmer valve is permitted (per local requirements).
3. Check for interior drain tile presence and perform interior drain tile test. See Appendix BB.
4. Check sewer system for proper drainage.

Standard Repairs:

1. Remove floor along leak areas.
IF NO DRAIN TILE: Dig out substrate. Install drain tile and approved drainage system, embed in filtering stone, install sump crock and pump (if required), replace floor removed. See Appendix B.
IF DRAIN TILE FOUND: Replace as needed, interior drain tile to provide correct drainage to sump or palmer valve. See appendix B.
IF LEAK NOT ALONG WALL: Install additional interior drain tile lateral for drainage and connect to interior wall perimeter drain tile.
2. Install, replace, or repair sump pump. Sump pump must meet State and local Plumbing and Electrical Code.
3. Replace some or all of interior drain tile as necessary, drain first block into interior drain tile using an approved one-piece wall drainage board that provides water passage and lateral support to first course of block. Wall drainage board to be 1” minimum higher than floor. Use a wall drainage board that can be caulked for retarding radon migration. Install to manufacturers specifications. See Appendix B & C.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

5. CONDITION: Leaning or bowed walls / Wall deflection less than one inch (NO MOVEMENT)

Characteristics:

One or more walls are bowed or leaning, with no signs of current or recent movement. The total amount of wall deflection is less than one inch from the original wall construction. Water seepage may be present at the floor line. Cracks have been patched or tuckpointed 10 years or more in the past*, with no sign of recent painting or patching. Owner indicates no observation of change in crack appearance or width. There may be evidence of prior wall repair/reinforcing or the walls could have been constructed out of plumb.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Do nothing; advise owner to monitor for further movement.

Optional Repairs:

1. Reinforce with recommended engineered steel support restraints every 36 to 50" on center, along bowed wall without excavating, grout behind supports. See Wall Reinforcement Design and Details. See Appendix A & AA.
2. Excavate; straighten as best as possible. Reinforce with recommended engineered steel beam restraints. Reseal wall. Clean out bleeders and test interior drain tile for correct flow, replace exterior drain tile, backfill to within 12-18" of grade with clear stone backfill. See appendix A & AA.
3. Replace any defective interior drain tile to provide adequate drainage to sump or sewer system. See Appendix B & BB.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

* Evidence of work performed 10 years or more prior to date of inspection include: past work orders, old paint – peeled or discolored, dated photographs, past inspection reports, other evidence of work performed prior to 10 years.

6. CONDITION: Wall step cracks with no displacement

Characteristics:

Appearance of cracks that follow the block joints in a diagonal fashion (step cracks). Many step cracks occur at the edge of windows or wall openings. There is no evidence of wall displacement, bowing or water leakage. Step cracks can be associated with minor foundation settlement or shrinkage of the concrete masonry wall. Under this condition there are no continuous horizontal wall cracks, water leakage or displacement.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Tuckpoint the visible cracks and recommend to owner to monitor for further movement.
2. If the crack exceeds 1/4" width, consult engineer for site-specific engineering.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

7. CONDITION: Leaning or bowed walls / Wall deflection less than one inch (SOME MOVEMENT)

Characteristics:

One or more walls are bowed or leaning, with signs of current or recent movement within the past 10 years. Wall cracks are less than 1/4" wide. The total amount of wall deflection is less than one inch from the original wall construction. Water seepage may be present at the floor line. Previously repaired wall cracks show signs of continued cracking. Horizontal wall cracks are usually associated with bowing and may open and close with the seasons. Vertical or step wall cracks are usually associated with leaning walls or wall bowing adjacent to wall irregularities. There is no indication of settlement of the wall footings.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Reinforce with engineered steel support restraints every 36 to 50" on center along bowed wall without excavating, grout behind supports. See Wall Reinforcement and Design. See Appendix A & AA.

Optional Repairs:

1. Excavate; straighten as best as possible. Reinforce with recommended engineered steel restraints. Reseal wall. Clean out bleeders and test interior drain tile for correct flow, replace exterior drain tile, backfill to within 12-18" of grade with clear stone backfill. See Appendix A & AA.
2. If bowing in conjunction with wet walls or seepage, include previous repairs and testing. See Appendix B, C, & BB.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

8. CONDITION: Leaning or bowed walls / Wall deflection one inch or more (SIGNIFICANT MOVEMENT)

Characteristics:

One or more walls are bowed or leaning, with signs of current or recent movement. Wall cracks may be greater than 1/4" wide. The total amount of wall deflection is one inch or more from the original wall construction. Water seepage may be present at the floor line. Previously repaired wall cracks show signs of continued cracking. Horizontal wall cracks are usually associated with bowing and may open and close with the seasons. Vertical or step wall cracks are usually associated with leaning walls or wall bowing adjacent to wall irregularities. There is no indication of settlement of the wall footings.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Excavate; straighten as best as possible. Reinforce with recommended engineered steel restraints. Reseal wall. Clean out bleeders and test interior drain tile for correct flow, replace exterior drain tile, backfill to within 12-18" of grade with clear stone backfill. See Appendix A & AA.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

9. CONDITION: Walls sheared at base / Wall slide less than 1/2"

Characteristics:

Wall shearing or sliding usually occurs at the second course from the bottom block. The bottom block is anchored by the floor. Shearing, however, may occur at any level. This condition indicates one section of the wall is sliding off the remaining wall by less than 1/2". There is no evidence of block face failure.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Reinforce with engineered steel support restraints every 36 to 50" on center along bowed wall without excavating, grout behind supports. See Wall Reinforcement and Design, Appendix A.

Optional Repairs:

1. Excavate; straighten as best as possible. Reinforce with recommended engineered steel restraints. Reseal wall. Clean out bleeders and test interior drain tile for correct flow, replace exterior drain tile, backfill to within 12-18" of grade with clear stone backfill. See Appendix A & AA.
2. If bowing in conjunction with wet walls or seepage, include previous repairs and testing. See Appendix B, C, & BB.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

10. CONDITION: Walls sheared at base / Wall slide 1/2" or more

Characteristics:

Wall shearing or sliding usually occurs at the second course from the bottom block. The bottom block is anchored by the floor. Shearing, however, may occur at any level. This condition indicates one section of the wall is sliding off the remaining wall by 1/2" or more. Excessive wall slide can cause failure in the block face below and potential basement wall collapse.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Excavate along exterior building perimeter. Straighten block basement wall as best as possible. Replace or repair damaged concrete block. Reinforce with recommended engineered steel restraints. Reseal wall. Clean out bleeders and test interior drain tile for correct flow, replace exterior drain tile, and backfill to within 12-18" of grade with clear stone backfill. See Appendix A & AA.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

11. **CONDITION: Dropped, settled or rotated footing**

Characteristics:

Foundation settlement is indicated by wide horizontal or step wall cracking and cracks in the floor slab, usually adjacent to the basement wall. The wall cracks are usually much wider than would be indicated by typical wall bowing. The wall may be tipped in the direction of foundation settlement, with horizontal wall joints being out of level. Door jams and windows in the building may be affected by foundation settlement.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. This repair **REQUIRES SITE SPECIFIC ENGINEERING.**
2. Repair usually accomplished with engineered earth anchors, hydraulically driven pipe piles, drilled caissons, support pads, etc. that are attached to the bottom of the footing.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

SITE SPECIFIC ENGINEERING REQUIRED

12. CONDITION: Poured concrete walls with water leakage (NO WALL DISPLACEMENT)

Characteristics:

Shrinkage of concrete often leads to cracks in poured concrete basement walls. Poured concrete walls with little or no steel reinforcement are more susceptible to shrinkage cracking. During periods of heavy rains, water leakage can occur through cracks in the poured walls. Another cause of cracking in poured walls could be due to excessive pressure during backfilling or winter frost.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Inject cracks from inside without excavating. Inject per manufacturing specifications.
 - a. **STRUCTURAL** REPAIR - epoxy injection for wall repair and water stoppage.
 - b. **NON-STRUCTURAL** REPAIR - polyurethane injection for water stoppage only.
2. Excavate outside, inject cracks or fill cracks with hydraulic cement, seal wall. See Appendix A & B.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

13. CONDITION: Poured concrete walls, leaning or bowed / wall deflection less than 1”

Characteristics:

One or more walls are bowed or leaning, with signs of current or recent movement. Wall cracks are less than 1/4” wide. The total amount of wall deflection is less than one inch from the original wall construction. Water seepage may be present at the floor line. Previously repaired wall cracks show signs of continued cracking. Horizontal wall cracks are usually associated with bowing and may open and close with the seasons. Vertical wall cracks are usually associated with leaning walls or wall bowing adjacent to wall irregularities. There is no indication of settlement of the wall footings.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Inject cracks from inside without excavating. Inject per manufacturing specifications.
 - a. **STRUCTURAL** REPAIR - epoxy injection for wall repair and water stoppage.
 - b. **NON-STRUCTURAL** REPAIR - polyurethane injection for water stoppage only.
2. If wall is leaning, secure top of wall to prevent further movement. Additional wall reinforcement is not required. See Appendix A for detail.
3. If wall is bowed, reinforce with recommended engineered steel restraints. See Appendix A & AA.
4. If bowing is in conjunction with wet walls or seepage, refer to previous interior drain tile repairs and testing procedures. See Appendix B & BB.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

14. CONDITION: Poured concrete walls, leaning or bowed / wall deflection 1” or more

Characteristics:

One or more walls are bowed or leaning, with signs of current or recent movement. Wall cracks may be greater than 1/4” wide. The total amount of wall deflection is one inch or more from the original wall construction. Water seepage may be present at the floor line. Previously repaired wall cracks show signs of continued cracking. Horizontal wall cracks are usually associated with bowing and may open and close with the seasons. Vertical wall cracks are usually associated with leaning walls or wall bowing adjacent to wall irregularities. There is no indication of settlement of the wall footings.

Testing:

Six foot level or plumb line and tape measure to check wall alignment.
Transit or laser level to check wall alignment.

Standard Repairs:

1. Excavate, straighten as best as possible. Reinforce with recommended engineered steel restraints. Reseal wall. Clean out bleeders and test interior drain tile for correct flow, replace exterior drain tile, backfill trench to within 12-18” of grade with clear stone backfill. See Appendix A & AA.
2. Inject cracks or seal cracks with hydraulic cement in accordance with manufacturer specifications.
3. If bowing is in conjunction with floor seepage, refer to previous interior drain tile repairs and testing procedures. See Appendix B & BB.

Maintenance After Repair:

1. Keep downspouts extended.
2. Maintain positive pitch of grade away from house.

NO SITE SPECIFIC ENGINEERING REQUIRED

SITE SPECIFIC ENGINEERING IS REQUIRED FOR ANY REINFORCEMENT OF BASEMENT WALLS WHERE CONDITIONS DO NOT CONFORM TO THE STANDARDS OF THIS DOCUMENT OR ALTERNATIVE REPAIR METHODS ARE UTILIZED AS FOLLOWS:

- Internal core filling with concrete and steel rod
- Installation of an exterior grade beam
- Retention anchors installed outside the wall with wall plates
- Construction of additional masonry pilasters on inside or outside of wall
- Installation of an epoxy fiber membrane on inside or outside of wall across cracked areas
- Any other methods or materials used for foundation repairs

DISCLAIMER: Jendusa Engineering Assoc., Inc., Wisconsin Association of Foundation Repair Professionals (WAFRP), and anyone associated with Jendusa Engineering Assoc., Inc. and WAFRP assumes no liability, damages, or claims arising from any use of these specifications and engineering regarding repair procedures and specifications.

APPENDIX A

PROCEDURE FOR WALL REPAIR INCLUDING: EXCAVATION, WATERPROOFING & REINFORCEMENT

- Excavate a trench on the exterior wall from grade to the top of the footing.
- Haul all excavated clay to an approved landfill.
- Attempt to flush out all bleeders found on exterior footing to sump pump or palmer valve system. Check with local jurisdiction if palmer valve is permitted (per local requirements).
- Flush inside drain tile to sump pump or palmer valve, if applicable, on affected wall.
- Set jacks on the inside of the excavated walls and straighten the walls to the original position, or as close as possible.
- Identify structurally damaged concrete block (exterior and interior). Replace block, or repair with approved epoxy material, or fill block solid with concrete grout.
- Repair all mortar joint cracks on outside of wall with TYPE M masonry cement. Seal coat all excavated walls from the footing to grade with approved below-grade damp proofing material installed per manufacturer's specifications.
- Replace all removed drain tile on excavated wall with "ADS" polypropylene/fiberglass drain tile and connect to existing bleeders found on footing.
- Backfill trench with clear crushed aggregate per specification below to within 12 to 18 inches from finish grade at all grass/dirt areas.
 - 100% of the aggregate shall pass a 1-inch sieve.
 - 90-100% of the aggregate shall pass a ¾-inch sieve.
 - 0-55% of the aggregate shall pass a ⅜-inch sieve.
 - 0-5% of the aggregate shall pass a #8 sieve.
- Install a below grade geotextile filter fabric with minimum 6 oz. density on top of stone backfill at all grass/dirt areas to prevent dirt contamination of the clear stone due to water filtration to exterior drain tile.
- Finish backfilling trench areas with impervious fill to within 6" of ground surface, place topsoil to finish grade height and pitch soil away from building.
- Reinforce all excavated wall with steel reinforcing columns. **(See Appendix AA regarding reinforcement detail for size, spacing, and attachment)** Grout between steel columns and wall with a non-shrink grout to account for wall irregularities and tilt.
- Extend wall reinforcement beam 1 space in each direction beyond damaged section of wall.
- Tuckpoint all interior mortar joint cracks on all walls that are repaired.

APPENDIX B

PROCEDURE FOR INTERIOR DRAIN TILE REPAIR WITHOUT EXCAVATION (See also Appendix BB regarding drain tile testing standards)

- Remove floor along wall area (12" to 18" wide) to be repaired to allow replacement of interior drain tile.
NOTE: Depending on the exterior ground pressure against the wall, bracing of the bottom 1/3 of the wall may be required to prevent the first course from moving after the floor has been removed.
- Remove existing drain tile and flush with water to sump crock or palmer valve. Check for correct drainage. Check with local jurisdiction if palmer valve is permitted (per local requirements).
- Replace drain tile at floor removal area with 3" interior diameter perforated corrugated polyethylene (or other UDC compliant) drain tile and encase new tile with 3/4" diameter filtering stone.
- Drill one (3/4 to 1 inch) drainage hole into the bottom of first course per core, under floor line, for block drainage. Holes shall be cleared for proper drainage.
- Wall drainage board shall be a one-piece unit. Wall drainage board to be installed at least 1" minimum higher than finish floor height and against first course to assure unrestricted passage of water flow. The wall drainage board MUST provide lateral support to first block. Wall drainage board must be able to be sealed off to provide radon mitigation if necessary.
- Test wall drainage board: Drill holes at the third to fourth block above the footing and every 3 to 4 feet horizontally for the entire wall where possible. Flush wall with water by inserting hose into injection holes. Check for unobstructed flow to wall drainage board by observing water flow at the base of the wall.
- Replace floor where removed. Minimum thickness not to be less than 2" thick or at least as thick as what was originally in place.
- If floor is ramped, to obtain minimum floor thickness the original floor must be removed a distance of 24" from the basement wall.
- Site specific engineering is required for conditions that vary from these standards.

Appendix C

Approved Drainage Board Products

Floor Edging, Manufactured by Masonry Technology Incorporated.
SHAD, drainage product

Additional drainage board products may be used with approval from WAFRP and the Building Inspectors Association of Southeastern Wisconsin.
Contact WAFRP representative at (262) 827-5008.



BASEMENT WALL REINFORCEMENT DESIGN TABLES

(Tables based on a 90 PCF soil pressure)

WALL HEIGHT* - 10 COURSES (up to 6'-10")

STEEL SIZE, SPACING and BLOCK SIZE	SINGLE JOIST SIDE MOUNT	DOUBLE JOIST Or 2x8 min. nailed to side of joist.	SINGLE JOIST With SADDLE	TJI JOIST
4" X 2" X 1/4" 36" Max. Spacing 8", 10" or 12"	(2) 1" Dia. Bolts See Details 2-5 on S2-A (4) 1/2" Dia. Bolts See Details 2-5 on S2-B	(2) 5/8" Dia. Bolts See Details 10-13 on S4-A	(2) 1/2" Dia. Bolts See Details 18-22 on S6	(2) 1" Dia. Bolts See Details 6-7 on S3-A
5" X 2" X 3/16" 50" Max. Spacing 10" or 12"	(4) 5/8" Dia. Bolts See Details 2-5 on S2-B	(2) 3/4" Dia. Bolts See Details 10-13 on S4-B (4) 1/2" Dia. Bolts See Details 10-13 on S4-B	(2) 5/8" Dia. Bolts See Details 18-22 on S6	(4) 5/8" Dia. Bolts See Details 6-7 on S3-B

WALL HEIGHT* - 11 COURSES (6'-10" to 7'-6")

STEEL SIZE, SPACING and BLOCK SIZE	SINGLE JOIST SIDE MOUNT	DOUBLE JOIST Or 2x8 min. nailed to side of joist.	SINGLE JOIST With SADDLE	TJI JOIST
5" X 2" X 3/16" 36" Max. Spacing 8", 10", or 12"	(2) 1" Dia. Bolts See Details 2-5 on S2-A (4) 1/2" Dia. Bolts See Details 2-5 on S2-B	(2) 5/8" Dia. Bolts See Details 10-13 on S4-A	(2) 5/8" Dia. Bolts See Details 18-22 on S6	(2) 1" Dia. Bolts See Details 6-7 on S3-A
6" X 2" X 3/16" 50" Max. Spacing 10", or 12"	(4) 3/4" Dia. Bolts See Details 2-5 on S2-B	(2) 1" Dia. Bolts See Details 10-13 on S4-A (4) 1/2" Dia. Bolts See Details 10-13 on S4-B	(2) 3/4" Dia. Bolts See Details 18-22 on S6	(4) 3/4" Dia. Bolts See Details 6-7 on S3-B

WALL HEIGHT* - 12 COURSES (7'-6" to 8'-2")

STEEL SIZE, SPACING and BLOCK SIZE	SINGLE JOIST SIDE MOUNT	DOUBLE JOIST Or 2x8 min. nailed to side of joist.	SINGLE JOIST With SADDLE	TJI JOIST
5" X 3" X 1/4" 36" Max. Spacing 8", 10", or 12"	(4) 5/8" Dia. Bolts See Details 2-5 on S2-A	(2) 3/4" Dia. Bolts See Details 10-13 on S4-B (4) 1/2" Dia. Bolts See Details 10-13 on S4-B	(2) 5/8" Dia. Bolts See Details 18-22 on S6	(4) 5/8" Dia. Bolts See Details 6-7 on S3-B
6" X 3" X 1/4" 50" Max. Spacing 10", or 12"	(4) 3/4" Dia. Bolts See Details 2-5 on S2-B	(2) 1" Dia. Bolts See Details 10-13 on S4-B (4) 5/8" Dia. Bolts See Details 10-13 on S4-B	(2) 1" Dia. Bolts See Details 18-22 on S6	(4) 3/4" Dia. Bolts See Details 6-7 on S3-B

*Wall Height is top of floor to bottom of joist

**Bottom Anchors : Min. (2) 1/2" dia. x 7" long expansion bolts into footing
Or (2) 3/4" dia. x 4" long expansion bolts min. 3" into slab

DRAIN TILE TEST STANDARDS

PURPOSE

The purpose of a drain tile test is to determine whether drain tile replacement is warranted and if so, how much drain tile needs replacing. These are the minimum standards for a drain tile test. A foundation repair contractor or foundation consultant can exceed these standards but never do less than the listed minimum standards.

CONDITIONS THAT MAY WARRANT A DRAIN TILE TEST

- Leakage/seepage on floor
- Wet/damp wall blocks near floor
- Staining/efflorescence on wall blocks near floor
- Iron ochre, tree roots, or mineral/calcium deposits in sump crock or at palmer valve.
- Wetness around floor cracks.
- Not all conditions shall warrant a drain tile test

LOCATION, SIZE AND NUMBER OF TEST HOLES

- The foundation repair contractor or foundation consultant should open a minimum of 3 holes to test interior tiles
- Each interior hole should be at least 12” x 12”
- The ideal location of interior test holes should be:
 - In or near corners
 - At sites where home owner noted leakage
 - Directly under windows (location of bleeders)
- The exterior drain tile test depth is recommended to be within 1-foot above the exterior drain tile. This test is also referred as an outside “spud test”.
- An outside drain tile test is warranted if blockage of outside drain tile is suspected to be clogged due to signs of leakage.
- Test four feet from bleeder if location is known.
- At least two test spud sites are recommended per wall(s) in question.

TEST PROCEDURES

- Homeowner should remove personal property at all test site locations
- Open hole in floor, expose inside of drain tile
- Inspect drain tile to determine degree of obstruction if any
- Introduce water into hole to determine if it drains
- Insert running hose into drain tile in both directions if possible to point of blockage
- Clean out bleeders, if found
- Insert running hose in bleeders to determine disbursement to exterior tile
- Check functionality of palmer valve or sump crock
- Drill at least (1) hole in block, where floor is opened up at a wet area in question, on inside to check if wall is holding water.

EVALUATION OF NEED FOR REPAIR

Based upon test results foundation repair contractor or foundation consultant should consider:

- Degree of blockage (less than 30% marginal, more than 50% serious)
- Amount of water sitting in tile
- Condition of drain tile itself
- Actual water flow through inside tile
- Seasonal conditions
- Ground water levels at time
- Special situations (ochre, roots, mineral deposits)
- History and pattern of leakage from homeowner, if available
- Water leakage out of blocks
- Spacing and placement of cement drain tile
- Material around drain tile

Note: If a dry season prevails and/or there is at least 2 to 4 inches of clear gravel under the floor, the use of an air compressor is recommended to be used with water to get water to flow from test hole to test hole.

Due to the severity of the leak, an optional spud test may be recommended to test the outside tile.

REPORT TO HOMEOWNER:

- Drain tile evaluation requires rendering an opinion and reasonable minds may differ
- Foundation repair contractor or foundation consultant shall report areas of blockage and specify what sections of drain tile need repair in writing with a diagram
- Foundation repair contractor or foundation consultant shall not misrepresent condition of drain tile for purposes of persuading homeowners to purchase repairs
- Foundation repair contractor or foundation consultant may give homeowner option of replacing more drain tile than is necessary after explaining present conditions

REPAIR OF HOLE

- Remove debris, damaged tile and old stone
- Replace drain tile in hole with 3" interior diameter perforated corrugated polyethylene drain tile (or Wisconsin Uniform Dwelling Code compliant)
- Install approved drainage board on side of hole
- Encase new tile with ¾" diameter filtering stone
- Close hole with new cement unless homeowner elects to leave open for further inspection
- In the event homeowner elects to leave hole open, foundation repair contractor or foundation consultant shall warn homeowner of risk of injury and possible flooding

PROHIBITED PRACTICES

- A foundation repair contractor or foundation consultant shall not create blockage in drain tile to cause test to fail

- A foundation repair contractor or foundation consultant shall not inform homeowner that open drain tile need replacement because they were placed too tight together or aren't perfectly sloped
- A foundation repair contractor or foundation consultant shall not make any material misrepresentations

Please contact the WAFRP for engineering associated with these standards:

E-mail: info@wafrp.com

Phone: (262) 827-5008.

Thank you.