RESIDENTIAL CONSTRUCTION DETAILS
A visual guide to construction detailing

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PRINCIPLES OF FOUNDATION DESIGN

The main role of foundations is to structurally support the building by transferring the loads of the building through the walls into the surrounding soil. In terms of a stick frame structure, the foundations must also protect the timber from moisture ingress by lifting the members above the ground.

The type of soil on the site will have a strong implication to the foundation design.

Different regions will have different soil types, the table (Figure 1.1) briefly demonstrates the types of soil and its suitability as a foundation material.

From the table you can see how important it is to establish the soil information on the proposed site. This often means a soil study or report is carried out.

The second important site factor to consider when designing foundations is cold and permafrost climates. These climates see a level of ground permanently frozen, and the concern is that the soil under the foundation could thaw and lose strength. Specialists should be consulted if designing foundations in an area of cold or permafrost climate (generally the far north - Canada, Alaska and so on).

The remaining northern half of the United States and mountainous regions are considered a cold or under heated climate where the frost depth is generally 12 in. or greater. The design for this type of climate is a little more straightforward with the following measures taken:

- Providing foundations below the frost depth
- Providing a basement
- Insulating the exterior to reduce the chance of cold ground temperature reaching the structure.

TYPES OF FOUNDATION

There are four common foundation types in residential construction that all work in quite different ways but each requires a support around the outside edge of the building. The four types are:

- Slab on grade
- Pier and grade beam
- Crawl space
- Basement

For the design of foundations, building codes should be consulted along with local codes to determine appropriate frost depths and design requirements. Foundation choice is dependent on many factors, such as soil type, site, climate and the process of choosing your foundation system goes beyond the scope of this book.

FOOTINGS

Footings lie under the basement, crawl space or foundation walls and transfer the structural load from the walls to the supporting ground. Typically these footings are cast in place concrete. In order to prevent damage or heaving that can be caused by freezing water in the soil, the footings must be cast below the frost depth.

Footings should be aligned so that the supported wall is as close as possible to the center line of the footing.
### Minimum width of concrete footings (in.)

<table>
<thead>
<tr>
<th>Load-bearing value of soil (psf)</th>
<th>1,500</th>
<th>2,000</th>
<th>3,000</th>
<th>≥4,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>4in. brick veneer over light frame or 8in. hollow concrete masonry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-story</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>2-story</td>
<td>15</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>3-story</td>
<td>23</td>
<td>17</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>8in. solid or fully grouted masonry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-story</td>
<td>16</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>2-story</td>
<td>29</td>
<td>21</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>3-story</td>
<td>42</td>
<td>32</td>
<td>21</td>
<td>16</td>
</tr>
</tbody>
</table>

Rule of thumb for estimating height of footing: the footing should be at least twice as wide as high.

*Figure 1.2 - Minimum width of concrete footings*

*Figure 1.3 - Examples of footings*
SLAB ON GRADE

Slab on grade consists of a shallow footing perimeter, with a concrete slab as the ground floor. This type of foundation is common in warmer climates, where the frost line is close to the surface and therefore the footing is usually shallow - with the ground floor a concrete slab. A slab on grade system often sees the footing, foundation and sub-floor cast in place at the same time.

A stem wall with slab on grade supports the wall above and can also provide a ledge to support an exterior masonry veneer. The wall is exposed to soil on both sides, so waterproofing or damp proofing is generally not required.

Insulation to a stem wall is often situated on the exterior of the masonry. If insulation is placed on the interior, care must be taken to insulate the joint between the slab edge and the foundation wall to avoid thermal bridging.

The build up for a slab on grade system can vary, but the key is to provide a solid support for the slab and to control the ground moisture.

Soil can require compaction to ensure a solid base. It can also be chemically treated to prevent issues with termites in certain regions. The gravel layer is a porous layer that is used to level the ground and assist with draining water away from the slab. The moisture barrier is the moisture defense for the slab.

Slabs require expansion joints which will allow the slab to expand and contract with the changes in temperature without causing any cracking or damage to the slab itself.

Figure 1.4 - Examples of slab on grade foundations
CRAWL SPACE FOUNDATION - CONCRETE BLOCK WALL
VENTED, UNINSULATED

Detail G1 - Crawl space foundation, cmu wall, vented, uninsulated
3D Detail G1 - Crawl space foundation, cmu wall, vented, uninsulated
CRAWL SPACE FOUNDATION - BRICK VENEER LEVEL WITH MUDSILL UNVENTED, INTERNAL INSULATION

Detail G12 - Crawl space foundation, brick veneer level with mudsill, unvented, internal insulation
3D Detail G12 - Crawl space foundation, brick veneer level with mudsill, unvented, internal insulation
BASEMENT - CMU WALL, INTERNAL INSULATION
FLOOR SLAB UNINSULATED

Detail B1 - Basement - CMU wall, internal insulation, floor slab uninsulated
3D Detail B1 - Basement - CMU wall, internal insulation, floor slab uninsulated
JOISTS AT EXTERIOR WALL, PERPENDICULAR TO WALL

wall system, with insulation, vapor retarder, moisture barrier and siding
internal wall finish
rim joist
internal floor finish
sub flooring
floor joist
wall insulation with vapor retarder on warm side of insulation
framed wall

Detail F7 - Joists at exterior wall, perpendicular to wall

3D Detail F7 - Joists at exterior wall, perpendicular to wall
NOTES ON THE CODE

FLOORS
The following information is a partial list of requirements from the 2015 International Residential Code (IRC) - for full and detailed explanations and requirements please consult the full publication.

GENERAL REQUIREMENTS (R501)
Floor construction must be capable of accommodating all loads in accordance with section R301 and of transmitting resulting loads to the supporting structural elements.

WOOD FLOOR FRAMING (R502)
Lumber to be identified by a grade mark of an accredited lumber grading or inspection agency. Any preservative treated lumber shall be identified as required by section R317.2.

DESIGN AND CONSTRUCTION
Spans for floor joists must be in accordance with Tables R502.3.1(1) and R502.3.1(2)

Floor cantilever spans not to exceed nominal depth of the wood floor joist
Joists under parallel bearing partitions shall be of adequate size to support load. Bearing partitions perpendicular to joists shall not be offset from supporting girders, walls or partitions more than joist depth unless such joists are of suitable size to carry additional load.

End of each joist, beam or girder shall not have less than 1 1/2 inches of bearing on wood or metal and not less than 3 inches on masonry or concrete. The bearing on masonry or concrete must be direct or a sill plate of 2 inch min nominal thickness provided under the joist beam or girder.

Joists shall be supported laterally at the ends by full depth header, band or rim joist or to an adjoining stud.

FLOOR SHEATHING (R503)
Maximum allowable spans for lumber used as floor sheathing must conform to tables R503.1, R503.2.1.1(1) and R503.2.1.1(2).

End joints in lumber used as sub flooring shall occur over supports unless end-matched lumber is used.

Wood structural panel sheathing
Panels must be identified for grade, bond classification and performance category. Maximum span for structural panel used as sub-floor must conform to table R503.2.1.1(1).
• If you are using a SIP panel, or OSB sheathing that has closed cell spray foam on the interior, a gap is recommended to allow the panels to dry to the exterior as they won’t be able to dry to the interior.
• If your walls are sheathing with rigid foam, most sidings would require vertical furring strips.
• Brick veneer will always require a ventilation gap, minimum 1 inch.
• Rainscreen gaps are always beneficial, and provide a more durable solution to external wall finish.

The rain screen gap can range from 1/4 inch to 1 inch, depending on the system. The gaps are created using furring strips installed vertically directly over the studs, or using a drainage mat, which is a three dimensional plastic mesh, that allows liquid to drain down the face of the mat. The system will require weep holes or drainage openings at the bottom of the rain screen gap.

Horizontal siding
Horizontal siding, usually cedar, redwood or pine, is a common form of siding. Profiles are also made of composite hardboard or cement board.

Vertical wood siding
Vertical wood siding is a tongue and groove or channel system where the boards are attached to sheathing or horizontal nailing strips.

Vinyl siding
Vinyl siding is a low maintenance alternative to the popular wood options. The siding is installed over sheathing.

Wood shingle siding
Shingle siding is a popular option. It is considered durable, low maintenance and can be installed painted, stained or left natural. It is often red cedar, but can also be seen as redwood or cypress. Shingles are installed over a moisture barrier to the external wall sheathing so that two layers of the shingles are always covering the wall.
CEMENT BOARD LAP SIDING - JUNCTION WITH FLOOR/FOUNDATION

Detail W1 - Cement board lap siding - junction with floor/foundation
3D Detail W1 - Cement board lap siding - junction with floor/foundation
WOOD SHINGLE ROOF - VENTED ATTIC SPACE
WOOD LAP SIDING WALL

Detail R1 - Wood shingle roof - vented attic space - wood lap siding wall
3D Detail R1 - Wood shingle roof - vented attic space - wood lap siding wall
R21
ASPHALT ROOF - RIDGE VENT

Detail R21 - Asphalt roof - ridge vent

3D Detail R21 - Asphalt roof - ridge vent
2D Detail Index

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