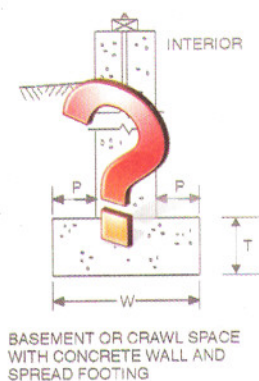


# Clearing the confusion on 'plain concrete'

By Tim Garrison

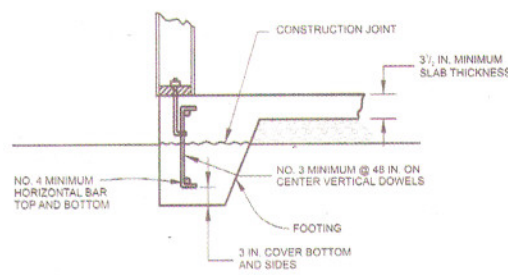
This month, *Structural Engineer* launches a new column, "The builder's engineer" by Tim Garrison, an award-winning author, public speaker, and professional engineer. The column uses a question and answer format. For more on Garrison's writings, visit his blog at [www.BuildersEngineer.com](http://www.BuildersEngineer.com).

## Where's The Beef?



IRC Figure R403.1(1)

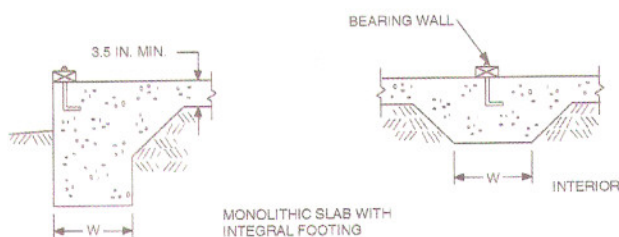
## And then there was some.... rebar.



IRC Figure R403.1.3.2

*I'm pretty sure that footings may be completely unreinforced in certain cases. I say pretty sure due to the ambiguity of the oft-used phrase "plain concrete" in the various codes. Plain concrete generally means unreinforced, but not always.*

## Rebar or no rebar? That is the question.



IRC Figure R403.1(1)

rebar in footings 11-16-12

**Q:** Dear builder's engineer,

I've heard that rebar is not required by code in foundations and basement walls yet I've never seen a plan that leaves it out. If true, what a great way to save money in this economy. What's the straight scoop on this?

Bill S., Edgerton, Wisconsin

**A:** Dear Bill,

Before I jump into the answer per code, if I happen to be the engineer on a project, all concrete will contain a fair amount of rebar. This is a rare case where I exceed minimum code. I'll explain why at the end of the article.

Your question is actually two questions, one concerning footings and one concerning walls. Building codes treat each differently so the answers are different too.

Here are my summary answers:

Footings first. I'm pretty sure that footings may be completely unreinforced in certain cases. I say pretty sure due to the ambiguity of the oft-used phrase "plain concrete" in the various codes. Plain concrete generally means unreinforced, but not always.

The certain cases in which footings may be of plain concrete are:

- If you're using the International Residential Code (IRC) and you're in Seismic Design Categories A, B, or C, your footings may be of plain concrete. But if you are in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub>, or D<sub>2</sub>, and you use footings with stem walls, or thickened edge slab footings, those require some rebar, the amount is described in R403.1.3.1 and R403.1.3.2.
- If you're using the International Building Code (IBC) and your project is a one- or two-family dwelling, three stories or less, with stud-bearing walls, any seismic design category, the requirements of ACI 318 apply, which allow plain concrete footings.

I think one could interpret plain concrete in the above cases to mean unreinforced but I wouldn't stake my license on it.

Regarding walls, it doesn't matter whether you use the IBC or IRC, all concrete walls and stem walls require some rebar.

Those are the short answers. If you are only interested in the Reader's Digest version of this topic, you should stop reading now. If, on the other hand, you're more bored than a fence plank or are a zealot for torture, read on.

Rooting out the straight scoop in our byzantine international codes is not uncomplicated. My use of a double negative here and the word byzantine reminds me of the humorous saying, 'Eschew obfuscation,' which means avoid confusion. Byzantine means tortuous, convoluted. I use it so that I might craftily steal the opportunity for a few more adjectives describing our wonderful (meaning, literally, Full of Wonder) building codes.

Our bafflement starts with the definition of plain concrete. In my way of thinking, and how I learned in school, concrete is either reinforced (contains rebar) or plain (does not contain rebar.) This concept is kind of like a hamster; it's either alive or dead, there's not much middle ground. However, the IBC, IRC, and ACI manage to muddle the matter nicely. You won't find the definition of "plain concrete" in the international codes, though they bandy the term about generously. For example, here is the title of section 1909.

## Section 1909

### Structural Plain Concrete

I expect this section would be all about concrete with no rebar used in structural situations. That expectation would be wrong.

To find the definition of plain concrete you must go to ACI 318 (American Concrete Institute, Building Code Requirements for Structural Concrete), one of the 500 or so publications the International codes adopt by reference. In ACI 318, Chapter 2 you will find this:

**Plain Concrete** – Structural concrete with no reinforcement or with less reinforcement than the minimum amount specified for reinforced concrete.

Now that we have a vise grip understanding of this critical terminology, let's dig deep and root out some facts. Since the lynchpin of the entire matter concerns plain concrete, and ACI 318 is the only place it is defined, let's start there.

Chapter 15 of ACI 318 is entitled, FOOTINGS. There is no mention therein of minimum rebar for pad or continuous footings. There is a requirement, however, in Chapter 10, FLEXURE AND AXIAL LOADS, Section 10.5.4, which says, "For structural slabs and footings of uniform thickness (you shall use the minimum reinforcement required for temperature and shrinkage per Chapter 7.)" I used (parenthesis) there to simplify the text's real codespeak.

Chapter 7 is titled, DETAILS OF REINFORCEMENT. The pertinent section is 7.12, which deals exclusively with elevated slabs (not slabs on grade). There is no mention of footings, so unless you came from Chapter 10 you would not know that this section applies to footings. I'll spare you the complexities of how much rebar is required here but it's an amount greater than zero.

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At this point we might think that the concrete code requires a minimum amount of rebar in *all* footings of uniform thickness. But if we thought that we'd be wrong because we haven't yet looked in Chapter 22, STRUCTURAL PLAIN CONCRETE.

That chapter specifically allows, "...structural plain concrete members that are continuously supported by soil..." (Section 22.2.1).

Then in Section 22.10.1, we find that foundations of structural plain concrete are *not* allowed in Seismic Design Categories D, E, or F, *except* for "detached one- and two-family dwellings three stories or less, with stud bearing walls."

So to summarize the concrete code, ACI 318, which is part of the International codes by reference, we may use plain concrete footings for detached one- and two-family dwellings three stories or less with stud bearing walls, regardless of the seismic risk. Other types of construction in low seismic risk areas may also use plain concrete footings if they comply with Chapter 22 (the footing is proportioned so that it is entirely in compression). Footings for everything else must be reinforced. I'm still wondering whether plain concrete here means unreinforced or minimally reinforced.

Now let's check the IRC (International Residential Code). Of course, the IRC only applies to one- and two-family residential dwellings, three stories and less (IRC R101).

Section R403.1 indicates that footings may be masonry, concrete, crushed stone, or wood. So right out of the chute, rebar is looking like an overkill extravagance. But let's dig deeper.

There is no section entitled "Minimum Reinforcement." No, that would be too easy. Instead minimum reinforcement is hidden in section R403.1.3: Seismic reinforcing. Concrete footings located in Seismic Design Categories, D<sub>0</sub>, D<sub>1</sub>, and D<sub>2</sub> [map reference] shall have minimum reinforcement...."

The next few paragraphs go on to describe such minimum reinforcement. However, at the end of the section is this:

**Exception:** In detached one- and two- family dwellings which are three stories and less in height and constructed with stud bearing walls, plain concrete footings without longitudinal reinforcement supporting walls and isolated plain concrete footings supporting columns or pedestals are permitted.

So if you're a residential stick-frame builder and you stop reading here, you'll think that you don't have to provide rebar in your footings. But if you're in Seismic Design Categories (SDC), D<sub>0</sub>, D<sub>1</sub>, or D<sub>2</sub> and you build stem walls on your footings or if you use slabs on grade with turned-down footings (around here we call them "thickened edges") you'll have thought wrongly. You're required to use rebar as described in the very next sections, R403.1.3.1 and R403.1.3.2. In my SDC, D<sub>0</sub>

neck of the woods, these two types of footing assemblies are the only kind of continuous footings ever used.

*One good thing about the IBC is you don't have to worry whether your construction fits the restrictions of the IRC; the IBC applies to any building.*

To summarize the IRC, if your building meets the requirements of the IRC to begin with, and it is in Seismic Design Categories A, B, or C, it would appear that no rebar is required in your footings. But if you are in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub>, or D<sub>2</sub>, and you use footings with stem walls or thickened edge slab footings, those will need some rebar, the amount is described in R403.1.3.1 and R403.1.3.2. Just to be sure that no one gets too biggety that they really understand the above, there are several nice footing details in Figure R403.1(1) on page 24 that show all the normal types of footings, none with any rebar. There is footing rebar, however, in the detail shown in Figure R403.1.3.2.

Now, what does the International Building Code (IBC) dictate? One good thing about the IBC is you don't have to worry whether your construction fits the restrictions of the IRC; the IBC applies to any building. I use the IBC exclusively in my designs because it allows greener, less expensive construction.

IBC Section 1809.7, "Prescriptive footings for light-frame construction," displays a table with minimum dimensions for up to three-story buildings. There is a half page of footnotes below the table in font so tiny it would be small to an aphid, which do not mention rebar except in footnote g, which makes reference to plain concrete footings for Group R-3 occupancies. I think the intent of this section is to allow plain concrete footings for light-frame construction up to three stories. Once again we're left wondering what "plain concrete" really means.

Maybe our anxiety will be allayed in the very next section, 1809.8, "Plain concrete footings"? Not the case. This section and its "Exception" discuss the allowed thickness of plain concrete footings in various situations but does not say how much rebar, if any, *plain* indicates.

*Part II of this article delves into IBC Chapter 19, CONCRETE, and then closes with a riveting investigation of minimum reinforcement in concrete walls.*



Tim Garrison is an award-winning author, public speaker, and professional engineer. He welcomes correspondence via his blog at [BuildersEngineer.com](http://BuildersEngineer.com).