

Continuing to clear the confusion on 'plain concrete'

By Tim Garrison, P.E.

In Part One we dredged the International Residential Code (IRC), the International Building Code (IBC) and the American Concrete Institute ACI 318, for minimum allowable reinforcement in footings. Here we conclude that investigation and then tackle the thorny issue of minimum reinforcement in concrete walls. Finally, we wrap up with my reasons for using more rebar than minimum code requires.

Our next stop on the “code train to enlightenment” takes us to IBC, Chapter 19, CONCRETE.

This chapter officially adopts ACI 318 but contains many pages of superseding modifications. Chief in our quest is Section 1908.1.8, which deletes ACI 318, Section 22.10, Plain concrete in earthquake-resisting structures, and replaces it with an IBC version. This section applies to Seismic Design Categories C, D, E, or F and allows plain concrete *isolated* footings with certain provisions and exceptions. But again there's no mention of what *plain* means.

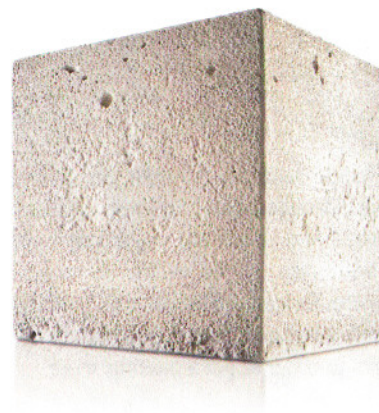
I must digress here and ponder why the IBC and IRC use different letters for Seismic Design Category. Recall that the “bad” seismic areas in the IRC are D₀, D₁, or D₂, while the bad ones in the IBC are C (sometimes), D, E, and F.

Section 22.10.1(c) finally gives a hint about rebar in plain concrete footings. It is so stunning I will repeat it here: “Plain concrete footings supporting walls are permitted, provided the footings have at least two continuous longitudinal reinforcing bars. Bars shall not be smaller than...”

Of course there are exceptions, three of them. The first does away with the above longitudinal rebar requirement for one- and two-family dwellings, three stories and less, with stud-bearing walls. The second exception requires rebar in the footing and stemwall if a stemwall is used. Does this trump the first exception? The third exception “permits” rebar at either the top or bottom of footing of a thickened edge slab on grade. Does “permit” mean “shall”?

The last stop on our IBC Foundation soul train takes us to Section 1909, Structural Plain Concrete. This section appears to mirror the general requirements of ACI 318, Chapter 22, STRUCTURAL PLAIN CONCRETE, which are recapped above.

To summarize the IBC, for one- and two-family dwellings, three stories and 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” in this case to mean unreinforced but I wouldn't bet the farm on it.



At this point my answer is 1,878 words long and I haven't even begun to unravel the mystery of reinforcement in walls. Rather than go through the above convolutions again, I'll try to cut to the chase.

ACI 318, Chapter 14, WALLS, contains this verbiage: “14.3.5 – Vertical and horizontal reinforcement [in walls] shall not be spaced farther apart than three times the wall thickness, nor farther apart than 18 in.”

For my entire career this is the code provision I've hung my hat on when specifying minimum rebar in walls. But the ACI undoes this understandable and succinct clause in Chapter 22, STRUCTURAL PLAIN CONCRETE, by allowing plain concrete walls, though with the following limitations: “22.6.6.5 - Not less than two No. 5 bars shall be provided around all window and door openings. Such bars shall extend...”

So it would appear that ACI allows plain concrete walls but with some minimal rebar at window and door openings.

The IRC requires *horizontal* reinforcement in all basement walls per Table R404.1.2, but does not require *vertical* reinforcement in certain walls depending on thickness, height, restraint at top, retained height, door and window openings, and Seismic Design Category.

The IBC adds to ACI 318's plain concrete wall requirements a bit of in-wall vertical and horizontal reinforcement and reinforcement at ends and corners for all Seismic Design Categories, no exceptions: IBC Section 1908.1.7, ACI 318 Section 22.6 – added Section 22.6.7.

Final summary

- I'm pretty sure that footings may be completely unreinforced in certain cases. I hedge here due to the ambiguity of the phrase *plain concrete* in the various codes.
- For sure, basement walls and stem walls require some rebar. If you're using the IRC you need, at a minimum, horizontal rebar per Table R404.1.2. You might also need more rebar depending on wall thickness, height, restraint at top, retained height, door and window openings, and Seismic Design Category. If you're using the IBC you need, at a minimum, both vertical and horizontal rebar per Section 1908.1.7, ACI 318 Section 22.6 – added Section 22.6.7.

Now, here are my answers to the burning question, "Why would Tim Garrison, a.k.a. The Green Engineer, a.k.a. The Builder's Engineer *exceed* code and use more rebar than required?"

- Naked concrete (I would have said *plain concrete*, but we've learned that that term is complicated) is intended to resist compression and shear, not tension. Tension is rebar's job. I believe that, over the course of a building's life, all concrete will experience some tension due to wind, earthquake, soils, accidents, flood, etc.
- Soils under footings and basement walls are never perfect; not in their natural state and not in the state that the earthwork contractor leaves them. Rebar helps concrete bridge bad spots in soils.
- Concrete is almost never batched and installed perfectly. Rebar does a great job of compensating for these shortcomings.
- Concrete by itself is brittle. Concrete with rebar is ductile and tough.

- Concrete shrinks and expands with temperature and moisture changes, two naturally-occurring phenomena everywhere on Earth. Shrink/swell induces tensile stresses that unreinforced concrete handles poorly but reinforced concrete handles well.
- Most buildings, at one time or another, will undergo a remodel, expansion, or structural repair. In such cases it's so nice when the foundation contains rebar.
- And last but not least, I readily confess that after spending the better part of seven lifetimes researching this, I'm still not sure what the code really says concerning unreinforced and minimally reinforced foundations. Thus, it is with a measure of self-defense that I specify ample rebar so as not to risk lawsuit by someone with a Ph.D. in Building Code Deciphering.

Editor's note: Clarification of building code requirements, if necessary, can be readily obtained by contacting the building code authority having jurisdiction.



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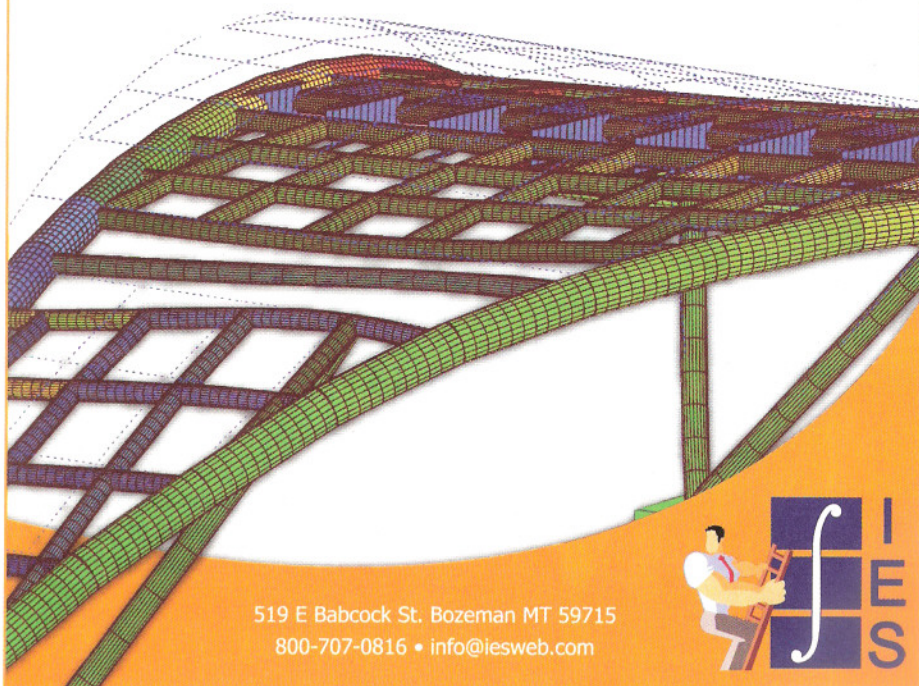


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