For What Planet Is This Code Written?

By Richard L. Hess, A.E., S.E., SECB, F. ASCE, CSI, CCCA

Members of the SEAOC Code Committee (as well as others) are busy calculating. They are trying to come up with an allowable shear value for a wood sill plate anchor bolt that will facilitate construction of a single-story wood-frame house with anchor bolts greater than one foot apart or multi-story wood-frame buildings under any conditions. They are trying to figure out what approach will produce the best result from ACI 318 Appendix D, which is required by the 2006 International Building Code. Others, sensing the profit potential in this new complication, are developing software that solves the problem for you.

And then there is the question of ductility: How to make the steel bolt yield before the concrete fails in a non-ductile manner. Section D.3.3.4 instructs us to have failure occur by yielding in the bolt. Alternatively, Section D.3.3.5 tells us that "the attachment that the anchor is connecting to the structure [which is the wood structural panel] shall be designed so that the attachment will undergo ductile yielding at a load level corresponding to anchor forces no greater than the design strength of anchors specified in D.3.3.3." These provisions are important when they apply to the connections between two concrete elements or between concrete and steel elements, but not for light frame construction. It would be possible to develop a pre-engineered light-gauge steel panel to do this based on a thorough test program. However, wood frame panels constructed on-site – as found in most light frame buildings – are not that predictable, and they generally fail by splitting of the wood or plywood edges, causing a sudden collapse rather than a ductile failure.

I do not criticize the mathematical correctness of the work that went into this Appendix, only its application in the International Building Code to types of construction where it is not appropriate. I know from my own experience how devoted the committee members are to improving engineering design to protect life and property. However, someone has to ask the question: Why discard a practice that works and replace it with one that is not only expensive and time consuming, but also would make it impossible to construct buildings similar to those that have stood for over fifty years without experiencing damage to their anchor bolts? Where is the recognition that we are dealing with real materials put together by people of varying capacities in the field, often under less-than-optimum conditions, rather than on a computer screen?

The 1952 Uniform Building Code that I have in my office has a Section 2805 that requires mudsills to be anchored to the foundation with ½-inch minimum anchor bolts embedded 7 inches at no more than 6 feet on center. It also has Section 2626 in the concrete chapter referring to Table 26D, which has values for several bolt sizes, including ⅝-inch bolts with 4-inch embedment being good for 1,000 pounds in shear with no edge distance restrictions.

The 6d (d = bolt diameter) minimum edge distance was not added until 1970. In 1979, after the 1971 San Fernando earthquake, the values for ⅝-inch anchor bolts were increased from 1,750 to 3,000 pounds. Subsequently, those values required a 12d edge distance with a 50% reduction allowed, which was maintained in the 1997 UBC three years after the Northridge earthquake. Section 1806.6 of that code required ⅝-inch anchor bolts to be used in seismic zone IV and specified an increased sill plate thickness and washers, but this was due to concerns about the bearing capacity of the wood and not because of the possibility of concrete breakout.

I remember participating in one of the committees set up by the City of Los Angeles after Northridge to develop recommendations for code changes. The section concerning the spacing of light frame mudsill anchor bolts was not changed because, I believe the failures that occurred at the sill plate were due to splitting of the wood plate or breaking of the connection of the sheathing to the sill plate, and not due to concrete breakout.

The engineers who wrote the 1997 UBC and the 1998 Los Angeles Building Code knew something about earthquakes. We lived through them and personally examined the structural failures that ensued. The house in which I live was built in 1958 and is 3 kilometers from the Palos Verdes fault and 15 kilometers from the Newport-Inglewood fault, which caused tremendous damage in 1933. Its mudsills are anchored with ½-inch bolts at 6 feet on center. Because of its construction and because of the location where it is situated, I do not have earthquake insurance. Being conservative, I have no problem with the increase from ½-inch to ⅝-inch minimum. However, I would not rebuild my house using ACI 318-05 Appendix D.

Is it surprising, then, that someone could ask for which planet our present building code was written? Apparently many other engineers feel the same way, because some building departments have already decided to instruct designers to use the 1997 UBC table for their light frame anchor bolt designs. That does not engender respect for our latest building code. If you disagree with me, please write to STRUCTURE® and tell me why. If you agree, let's work together to correct this problem.▪

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