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Is Code Simplicity Necessary?

Contributed by Williston L. Warren, IV – S.E., SECB, Treasurer

As time goes on, more and more people ask my opinion. As a Structural Engineer of my vintage in California, I have seen a lot. When my undergraduate class was graduating and interviewing for our first graduate professional positions, our conversations included discussions on how many of the interviewers asked us what we were taught about reinforced concrete design. We had many chuckles discovering that most firms that interviewed us were still using working stress concrete design instead of ultimate strength. When I was asked about reinforced concrete class work and training, I conveyed that we learned ultimate strength procedures. The interviewer commented, "Well I guess all my buildings are about to fall down because they were designed with working stress."

In California, the loading condition that receives the most attention is the lateral forces from ground motion or earthquake loadings. As part of the building code development population, I have watched the code evolve over the past 40 years. What I find funny is that as the wind loading provisions of the code have evolved and become more complicated, I hear engineers that routinely include seismic analysis and design complain about the new wind provisions, commenting how all their buildings must be on the verge of collapse due to the "NEW" wind loads.

More than 10 years ago when the three building code groups merged in the U.S. into what we now know as the IBC, the commentary throughout the Midwest and East Coast was that projects were now ALL OF A SUDDEN in an earthquake zone. A lot of us from the West Coast chuckled and replied, "That is not the problem…the problem is that you always have been in an earthquake zone and you just know about it now." Those of us from the West Coast cannot understand how engineers from an area of the country that has experienced the largest levels of ground motion in the country's history are unaware of it.

Is this a result of the "la la la" factor or is it something else? I hear that the code is too complicated, and the portion that is too complicated is the portion relatively new to that region. Let's take the ACI 318 code as an example. In 1956, the 318 document was the small format size, 5.5" x 8.5", and was about 73 pages. The 1963 version was the same size format but had expanded to about 144 pages or 97% increase. I pulled off the shelf the 2008 edition, and it is 8.5" x 11" with 447 pages, including commentary and appendices. If half the 2008 edition is commentary, then it is more than six times the size.

Have all the material codes become more complicated? Yes. Why? I call it the Structural Engineer's Full Employment Act. I understand that most engineering clients do not see it that way. They see it as money spent for a reason they do not understand. However, think about the fact that the Midwest experienced three earthquakes with magnitudes of 7.3+ more than one hundred years ago.

Looking at the entire country…in California, we experienced an earthquake in 1994 in Northridge with a magnitude of 6.7. Studies expect that Southern California should experience a 7.8 in the not so distant future, which would be about 12.5 times larger than Northridge.

This year in Charleston, South Carolina, there have been a magnitude 2.4 earthquake and in 1886 there was a 7.0, or almost 40,000 times larger than the 2.4. This year, according to the USGS, Oklahoma has experienced many earthquakes, one having a magnitude of 4.4, which is about 800 times smaller than any one of the three in 1811-1812. Just this month, Oklahoma experienced a 5.6 earthquake, which is about 15 times larger than the 4.4 and is about 50 times smaller than the 7.3 in 1812. So should the wind loading requirements for a building be only what the location has experienced in the last 20 or 30 years, or should it be what is statistically likely to occur in its lifetime? Where would the intent of the code fall into this discussion?

In a related topic, engineers strive to provide the most economical engineering designs possible and as allowed by the Code. But what does this statement mean? Is an economical engineering design as described by the current code adequate? Is a building structurally designed by the 1956 ACI code less safe that one designed by the 2008? In some cases, the answer is yes as a lot of knowledge has been developed between the writing of those two codes (just think of seismic). But for gravity loads, I am not sure the answer is so clear. There are a lot of factors beyond the structural design and materials that influence the resiliency of a structural design.

The public does not see the value of resilient structural engineering of buildings until they really need it. Our profession attempts to provide this resiliency without the public knowing it until they need it. Examples of this can be seen in the last month in Italy and in the last few years in South America. In addition, it can be seen in the U.S. from the effects of flooding and climate change. This country's infrastructure was originally built using criteria similar to what we are currently using. Some improvements have been made, but if you think the current code is over complicated, then the next real jump might be even worse.

All structural engineers must read FEMA P-58 "https://www.fema.gov/media-library-data/1396495019848-0c9252aac91dd1854dc378feb9e69216/FEMAP-58_Volume1_508.pdf. This link gives you the first volume of technology developed by the Applied Technology Council (ATC) funded by a 10-year contract with FEMA. It addresses the elephant in the room. How do you structurally design a building and its systems and components to perform to specific requirements? The FEMA P-58 project is a description of the development of the next generation performance-based seismic design procedures for new and existing buildings. Several companion publications exist as well as electronic supporting documents and tools. All of this information is free on the website. FEMA has been interested in this topic for a long time. This document addresses seismic loads but sets the framework for other loadings such as wind, hurricane, tornados, flooding and snow.

The current Code and its requirements do not require your design comply with specifics of the code, just the intent and the Code, and contents are one way you can demonstrate this compliance. You can completely skip these procedures in the code if you can convince your building official that your design exceeds the intent of the code. For most engineers, this is a steep task, but using the technology described in FEMA P-58 you can actually specify structural components of a building with a design that is intended to resist lower levels of loads than what are described in the code. How? Because your analysis shows that the performance of your building design exceeds the intent of the Code, just imagine.

So is it time to retire? No, because this technology and all it will bring with it for all the other loadings will actually provide you a way to give clients and building owners what they want but do not know is possible. And what is that? That structural engineering has revolutionized the construction of buildings. This will not occur tomorrow (or for many years) but those of us working on code development and technology development similar to what is provided by ATC have started the process. While actually doing this could be orders of magnitude more difficult and time consuming, the hope is that it really improves the built environment, makes the systems far more resilient and delivers buildings whose structural construction cost could actually go down.