



Simplicity

By Robert H. Lyon, P.E.

Most of us would agree that simplicity is an admirable characteristic of design. Indeed, simplicity has historically been considered a virtue. This article considers the question of simplicity in structural engineering practice. It concludes by critiquing the advancement of the profession in the area of design specifications.

I distinctly remember two things about my first week as a practicing bridge engineer fresh out of college. The first was the awe I had of an experienced designer's ability to see simplicity in complicated details. The second was the reaction of a colleague as he watched me perform my first design. I started with a blank sheet of paper, and methodically worked my way through the code equations, until I had enough information to proportion and detail a sign support structure. What my colleague said at that time has stayed with me: always draw your finished product first, and then merely confirm your solution by the code equations. How simple!

More recently, I have been reading about some of the great structural engineers in history – the elegance and simplicity of Gustave Eiffel's famous tower and less well-known railroad bridges, and Robert Maillart's ability to justify the design of his deck-stiffened arch on only a page and a half of paper. Simplicity of design returned to my mind. I am not the first.

Blaise Pascal said in one of his letters, "I have made this longer than usual because I have not had time to make it shorter." Antoine de Saint-Exupery said, "A designer knows he has achieved perfection not when there is nothing left to add, but when there is nothing left to take away." The grandfather of structural mechanics, Isaac Newton, said, "Truth is ever to be found in the simplicity, and not in the multiplicity and confusion of things." To prevent any confusion about where he stood on this issue, Newton also said, "Nature is pleased with simplicity. And nature is no dummy." Newton was no dummy, either. Another pretty good designer, Leonardo da Vinci, said, "Simplicity is the ultimate sophistication".

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In what direction is our practice heading – towards greater simplicity, or greater complexity? There seems to be a natural tendency that prompts us to find unnecessarily complicated answers to simple problems. As a result, there seems to be a need for greater clarity – greater simplicity – in our profession today. Perhaps there is a link with the amount of information available to us now, such that we more easily feel overwhelmed and confused.

Since I am a bridge engineer, consider as an example the AASHTO LRFD Specifications. Twenty-five years ago, the objectives of developing a new bridge specification included being technically state-of-the-art, as comprehensive as possible, yet readable and easy to use. How did we do? Experienced designers have always lamented the fact that young engineers have the tendency to follow code equations blindly, without having a solid sense of what they represent. Interestingly enough, inexperienced engineers are now recognizing the same thing. Read this excerpt from an online forum (www.eng-tips.com/viewthread.cfm?qid=207593), written by a young engineer giving counsel to another young engineer who was contemplating a switch from building to bridge engineering:

"I am pretty young and made the switch from bridge to building in very short time, but here is what I disliked about bridge work. AASHTO LRFD Manual is a beast. Have you ever seen it? It's huge. There's no way possible to get a firm grasp on the equations in the steel section. Each equation has about 10 different variables that need to be determined from other longer, iterative equations. Long story short: you will flip through the whole steel section just to successfully complete one equation. Basically, as I was once told by someone with the DOT: you better have some good

computer programs if you want to use this code. For a young engineer, I hated being so heavily reliant on computers to do my analysis for a bunch of code equations that it was hard to get a good physical grasp of."

How sad. I remember being astonished by the speed with which AASHTO adopted the LRFD Specifications. It is certainly true that any change will prompt at least some opposition from experienced designers. I am willing to acknowledge that perhaps I am just a stodgy old designer who does not properly appreciate the comprehensive, state-of-the-art advancements of the new code. But I am sure that we have lost simplicity.

Given that structural engineering is still "the art of molding materials we do not really understand into shapes we cannot really analyze, so as to withstand forces we cannot really assess" (Jon A. Schmidt, "The Definition of Structural Engineering," January 2009), does it warrant a system complexity that is predicated on establishing mathematically uniform probabilities of failure?

Have we struck the appropriate balance between comprehensiveness and ease of use? I think not. The time is right for a pilot research project to restore a greater degree of simplicity in our design specifications. The goal of the project would be to reduce multiplicity and confusion, to simplify the complicated, and to do the hard work of shortening the specifications such that there is nothing left to take away. ■

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