Five Tips for Young Engineers

By Stan R. Caldwell, P.E., SECB

After forty-five years of managing and mentoring dozens of young structural engineers, I have seen firsthand the various struggles they face in building successful careers in our high-liability profession. To assist a larger group of young engineers, I would like to offer advice on five important topics.

Mind the Gap

Always track your load paths and close any gaps you find. Reliable load paths are essential for all structures, and their absence is one of the leading causes of failures. A complete load path defines how your carefully calculated vertical and lateral loads are going to find their way to the foundation of your structure. Recently, I witnessed a project with multiple lateral load path issues. While failure had not occurred, more than $12M in repairs was necessary to bring the structure up to code. Do not rely on computer software to detect gaps. That is your job as a structural engineer.

Think about nature. It is all about first principles and could care less about codes and equations. Unlike humans, it always chooses the path of most resistance. That is, stiffer elements always receive proportionally more load than relatively flexible elements nearby, regardless of your design intent.

Ensure Stability

You have been trained to size beams and columns accurately, but the devil is not there – it is in the details. Structures rarely fail because beams or columns are substantially undersized. More often, failure is due to unanticipated loads, inadequate load paths, inadequate connections, or instability – especially instability, which can take many forms.

Stability is essential, not just when a structure is in service, but also during construction. Last year, I witnessed steel structures that failed due to missing or insufficient diagonal braces, lateral braces, bridging, and local stiffener plates. Five years ago, I witnessed a seven-level precast concrete parking garage collapse like a house of cards. At the time of the collapse, lateral bracing had not been installed and the intended moment connections between the precast beams and columns had not been grouted. You will likely find yourself in an uncomfortable situation if your structure becomes unstable while it is being built. So pay attention to the stability of your structure, not just when it is completed, but also while it is under construction.

Design First, Then Compute

You should deliberately avoid your computer until after you have manually designed your structure. Lay out the geometry and initially size all of the principal elements. If you are not able to roughly design your structure by hand, you certainly have no business relying on your computer to do so. After you have completed an initial design, then turn on your computer, access your favorite structural engineering software, and verify or refine the design as appropriate.

After decades of looking, I have yet to find any structural engineering software that can actually think. Thinking, after all, is your primary responsibility as a structural engineer. No one should ever mistake computing for engineering.

Be a Sponge

In college, you learned how to analyze and design beams, columns, connections, and other structural elements. You probably did not learn how to design economical buildings and bridges, comprehend the project workflow process from concept through completion, or understand the role of a structural engineer within a firm and within a multi-discipline design team. All of this and more must be learned in the workplace. Mentoring is arguably the most important aspect of workplace training. This is the process by which young engineers are actively coached by the experienced engineers around them. It is a critical process because it is the most effective way to transfer knowledge and wisdom from one generation to the next.

Unfortunately, formal mentoring is not always available, so be proactive and absorb knowledge like a sponge. Start asking questions of those around you from the moment you walk in the door. While "how" questions are obviously necessary, "why" questions usually yield better learning opportunities. Other than questions asked repeatedly, the only dumb questions are those not asked. Keep an old-fashioned notebook handy and write down every tip and trick you learn. Your notebook will become a helpful resource, and it might come in handy in a few years when you become a mentor.

Own Your Work

Hopefully, you have one or more mentors and your work is being regularly reviewed – that is, after all, the way the system is supposed to work. I was supervised by two structural engineers during my first year after college. Then I was promoted, and the oversight ended. Working in industry, there were no peer reviews, plan checks, or P.E. seals; I was on my own. Whatever I designed would go to the drafting room at the end of the hall, and then straight out to the field for construction. If I made an error, I would have to face the consequences. Lacking any opportunity for further mentoring, and working in an environment where overdesign was frowned on, I quickly became self-reliant.

I encourage you to adopt a self-reliant attitude and to "own your work." Invest the time necessary to be sure of yourself and your designs. Structural engineering is a high-liability profession. Accept that reality, and act accordingly.▪

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