Professional Issues

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Passing the New Structural Exam

You Too Can Do It after Turning 40

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As more states move toward separate licensure for structural engineers, proving your competency means taking the new NCEES Structural exam. For those of us who are later in our careers, the requirement to pass such a test can bring extreme anxiety and prompt comments such as: "I've been doing this all my career, I don't need another exam to prove my competency;" "I spend most of my time managing my office and staff, I'm not sure my experience is current enough to pass the SE exam;" and, "I just don't have the time to study for the SE exam."

This article is intended to take the "fear" out of the new SE exam, which can be passed no matter how old you are or how long it has been since you passed your original PE exam. I am proof that it can be done. Although I live in Florida, I do a significant amount of work in the western United States, especially California, and I realized that obtaining SE registration there would be very helpful in securing future projects. In April 2009, I made the decision to take both the NCEES Structural II and California Structural III exams.

Almost immediately, I felt a knot begin to form in pit of my stomach. What if I did not pass either exam? How embarrassing would that be? More importantly, what would my colleagues think of my structural engineering capability? I had taken the Structural II exam in 2005 and did not pass it then; what made me think that I could pass it now?

As I look back, there are three components that I believe are critical to passing the exam. The first is commitment. Once you have made the decision to take the exam, you need to be "all in" and devote yourself 100% for a minimum of two months leading up to the test date. Think about it – you have been designing buildings or bridges for many years now, so you clearly have the expertise; you just need to convince yourself that you can *and will* pass the exam. You use the codes on a regular basis, and you know how to design with steel, concrete, masonry and wood – well, maybe not all of them, but hopefully at least two of them. In my case, I believed that my steel and concrete experience was adequate, but I had limited masonry and almost no wood experience. Even so, the general concepts are similar and, with adequate preparation, you can fill in the gaps.

In fact, preparation is the next step to passing the exam. When I reflected upon why I did not pass the Structural II exam in 2005, I realized that my preparation was inadequate. I spent too much of my time lightly reviewing the subject matter and not enough time working detailed problems. How you prepare for the exam is critical to your success. I suggest the following:

1) Go to the NCEES website and look up all available information on the Structural exam. There you will find specific information on each section including content, design standards, study materials, exam day policies and scoring information.
2) Obtain copies of all applicable codes and standards to which the exam will be written.
3) Obtain several good reference books to study, and verify that they are written to the version of the codes being tested. Studying ASCE 7-02 will be of little value if the test is written around ASCE 7-05. There are numerous materials out there, some of which are very good. It is up to each examinee to determine which ones work best for him or her. Each fall, the Structural Engineers Association of Illinois conducts a six-month seminar series which covers all topics included in the Structural exam. This series is currently being upgraded to include the new high seismic component. NCSEA has recently partnered with Kaplan AEC Education to produce a similar seminar series.
4) Find a location away from your regular workstation where you can lay out these materials for a long period of time. Make this your "Study Area". Set a rule for yourself that when you are in the "Study Area", you cannot be interrupted for any reason. You will need to get used to being in this environment for four hours at a time to mimic the length of the exam segments.
5) Prepare a work plan and stick to it. When I first began studying, I created a rough schedule of which subjects I would study and when. After a week or so, I found that I needed to stick to that plan if I was going to be adequately prepared. It was not long before I found myself following it religiously. I suggest something along these lines:
   a. General structural analysis: Re-learn how to do calculations by hand that you typically rely on the computer to perform, such as the portal method for frames. Know how to quickly determine the shears and moments in beams and columns due to gravity loads; how to distribute lateral loads via diaphragms to resisting elements (element rigidity for rigid diaphragms vs. tributary area for flexible diaphragms); and how to determine the worst-case load combinations.

b. Wind loads: Be prepared to answer questions for hurricane-prone regions and areas requiring design for windborne debris. Know how to quickly determine the wind pressures on enclosed, partially enclosed and open structures and parapets at various heights using proper values for K_h, K_z,and GC_{pi}. Understand the differences between main wind force resisting systems and components and cladding, and include the importance factor based on occupancy type.

c. Earthquake loads: Know how to calculate seismic forces and understand the design spectral curves. Understand the implications of the various Site Classes and Seismic Design Categories. Know the difference between buildings and non-building structures. Remember the importance factor and the event for which you are designing: MCE or Design Earthquake. Develop a basic understanding of how to deal with non-structural components. Be familiar with high seismic design requirements for all four building materials as defined in AISC 341, ACI 318 Chapter 21, ACI 530 Chapter 3, and AF&PA *Special Design Provisions for Wind and Seismic*. Devote at least 30% of all your study time to this area, and be ready to answer questions regarding Seismic Design Category D, E or F.

d. Wood: Understand the general content of the NDS. Work problems to become familiar with all Load Adjustment Factors (C_x) and how to quickly eliminate those whose value is unity. Understand shear and diaphragm capacities for various decking types and nailing patterns. Understand the provisions of Chapter 23 of IBC and the relevant sections of ASCE 7, especially those addressing seismic considerations.

e. Masonry: Understand how to calculate capacities using ACI 530. Learn shear wall design methods and the special seismic provisions. Understand the provisions of Chapter 21 of IBC and the relevant sections of ASCE 7, especially those addressing seismic considerations.

f. Concrete: Familiarize yourself with ACI 318. Know how to quickly calculate the flexural and shear reinforcing in beams and walls, including retaining walls. Understand axial and biaxial column bending and reinforcing requirements, and be able to check for minimum and maximum reinforcing limits. Understand the provisions of Chapter 19 of IBC and the relevant sections of ASCE 7, especially those addressing seismic considerations. Spend significant time understanding the seismic provisions of Chapter 21 in ACI 318. Understand how to design and detail both shear walls and moment frames in high seismic zones; you may be asked to sketch a detail as part of your solution.

g. Steel: Familiarize yourself with both AISC 360 (steel manual) and AISC 341 (seismic manual). Be able to size beams and columns for a variety of loading conditions. Know all the steel seismic lateral force resisting systems and how to design each of the elements using AISC provisions. Understand the provisions of Chapter 22 of IBC and the relevant sections of ASCE 7, especially those addressing seismic considerations. It is very likely that you will be required to design or evaluate a high seismic joint detail.

Review these subjects in order of familiarity, with the most familiar element coming first. I focused on doing the seismic components last so it would be freshest in my mind during the exam. Exam preparation is daunting, but done systematically and with diligence it will be the largest contributing factor for success.

6) Ask for help, especially in areas where your experience is lacking. Other structural engineers will gladly share shortcuts and other tips and tricks with you that are not provided in exam preparation materials.

7) If you get stuck on a subject or do not understand a concept, go to a different subject and come back to it later. If necessary, get up and walk away from your "Study Area"; you will be amazed at how taking a break will relax you and help you refocus on a difficult topic.

8) As the week of the exam approaches, take some practice exams under test conditions. Use four-hour blocks of time and try to answer questions as if the exam was really taking place.

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With commitment and preparation behind you, and exam day around the corner, what can you expect? The most important thing the examinee must realize is that the exam is very long, and while you are taking it you will feel like you are racing against the clock. Remember, because of your preparation, you have sharpened you expertise and can solve almost all of the questions; you just need to focus, put on your game face, and work quickly. Here are some tips:

1) If possible, visit the exam site the day before. Know where to park and how to get to the room where the exam will be held.
2) On exam day, arrive early; give yourself plenty of time to set up for the exam. Organize your reference materials for quick accessibility. I have seen examinees bring in plastic milk crates filled with books that they set up library-style, which struck me as very efficient.
3) The exam materials will require you to fill out some information prior to starting the exam; this will not count against your testing time. For the essay questions you will have to place your answers in the solution pamphlet. There is a separate solution pamphlet for each essay question.
4) If you get stuck, skip the question and come back to it later. For the essay questions, if you get stuck on one part, simply state an assumption for that portion and continue accordingly. If you make a mistake in an early portion of a problem and solve the rest of it correctly, you may only lose points for that part and still earn full credit for the later portion.
5) Do not over-think the problem. The exam committee is testing if you understand the fundamentals, so do not make the problems harder than they really are. I found myself doing this repeatedly when I took the exam, and lost precious time as a result.
6) On the multiple-choice section, remember to guess if you do not know the answer, especially if you can eliminate an option or two. It is important to recognize that the exam writers likely established the incorrect choices based on typical mistakes that an examinee might make. Make a note of the problems you guessed at in case there is time to come back later. Pace yourself; if there are 40 questions in 4 hours, that gives you 6 minutes to answer each problem, so make sure you are near problems 10, 20, 30 and 40 at the end of each hour. If you get behind in the first hour, you have three more hours to pick up the pace; just make sure that you stay on track.
7) At the end of each exam session, you will be given 15, 5 and 1 minute warnings. When time is called, you must put your pencil down immediately, so use the warning time effectively. At the 15-minute warning of the essay questions, I had to decide whether to finish the problem on which I was working, or go back and review my work on problems where I was not sure of the answer.

Once the exam is over, what happens next?

1) Try to put the test out of your mind. You will constantly think of mistakes that you made during the exam, but just let it go. This is much more easily said than done!
2) It takes several months to grade the exam and provide results to the examinee. April results typically come out in July and October results in January. Although it takes a while, when you finally are notified that you passed, you will realize that the time investment was well worth it.
3) I have had the opportunity to be an exam grader, and the one thing I learned is that this group will do everything they can to give the examinee the benefit of the doubt. The main goal of the grading process is to ensure that those who demonstrate an adequate level of knowledge are given a passing grade.

You can pass the new Structural exam no matter how long it has been since you passed the PE exam. It requires serious commitment, preparation and effective use of exam time. I wish each of you who attempt the new Structural exam the very best. Demonstrating your capabilities to your peers and the public through this examination serves to strengthen our profession.▪