

Engineering Ethics Cases with Numerical Problems

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Civil Engineering Case 1

Parking Structure Foundation

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Suggested Courses:

Reinforced Concrete Design

Level:

Senior

I. Narrative

Mary Johnson has recently passed the PE exam. She works for Spire Engineering as a structural design engineer. For her first project as lead engineer, she designs a parking structure in an area where the soil is poor. She requests a detailed soils report, and the geotechnical engineer recommends continuous footings. Mary designs a reinforced concrete section according to the prevailing ACI standards. The design is reviewed by another of Spire's PE's and Mary proudly stamps and signs her first set of plans.

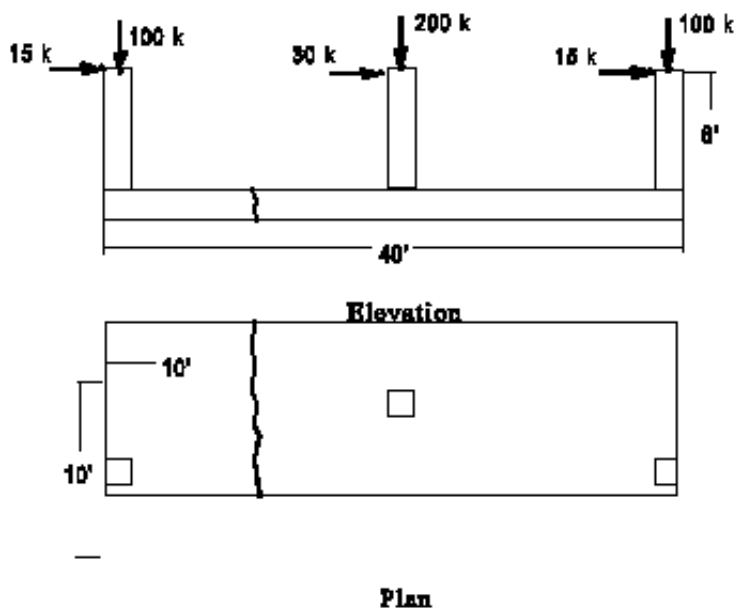
The owner of the structure engages Spire to monitor and inspect the construction process, take concrete samples, etc. Since Mary is the engineer of record, she visits the construction site during the site preparation phase. Although she has heard about the way in which women are sometimes treated by construction workers, she was unprepared for what she encountered. The whistling, taunting and general crudeness made her very uncomfortable, but she was determined to follow through.

Mary is relatively inexperienced in dealing with contractors. Thus, in the eyes of the superintendent and construction workers, her credibility is suspect. On the first day of pouring concrete, Mary is on site, taking cylinder samples, inspecting the placing of reinforcement, and generally getting a feel for the construction process. She notices a few problems and brings them to the superintendent's attention. He accommodates some of her concerns, but also dismisses others as unnecessary, commenting on her lack of familiarity with day-to-day construction practices. Mary protests and makes additional suggestions. The superintendent takes advantage of

her inexperience and ignores her concerns. When she gets back to the office, she talks to some of her more experienced colleagues and they give her some additional advice about construction and contractors.

The following day is a warm one, and after about half the concrete pour is completed, the batch plant breaks down and the trucks stop coming. Mary knows from school and the previous evening's discussion that if more than an hour or two passes, the poured concrete will begin to set up and will not bond well with newly poured concrete, forming a "cold joint." She discusses the problem with the superintendent who assures her that the plant will be up soon and tells her not to worry. After an hour and a half has passed, the batch plant is not yet on line. Mary tells the superintendent that the already placed concrete will have to be removed. A protracted discussion ensues in which the superintendent says such a drastic action is unnecessary and that if Mary knew anything about construction, she would understand. He also makes several other derogatory comments about her level of knowledge and competence. He says that he can simply agitate the already poured concrete and produce a structurally sound joint. At that instant, the first concrete truck arrives, and Mary must decide right away.

Mary is not sure about the nuances of placing concrete and does not want to risk further abuse from the superintendent and construction workers. Thus she decides to trust the experience of the superintendent and continue the pour. The finished product looks OK, and the rest of the construction is completed without incident.



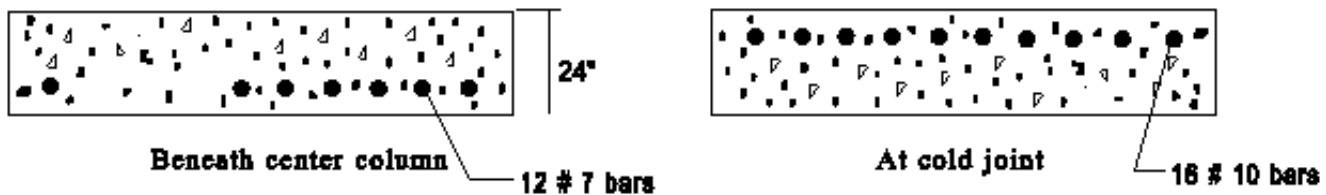
After about two years of service, the parking garage is severely damaged in an earthquake. In the failure some cars are crushed and, unfortunately, three people are permanently crippled. The injured parties and the car owners sue the owner of the parking structure who in turn sues the contractor and Spire Engineering.

An evaluation by a forensic engineering firm shows that the proximate cause of the failure was a break that occurred in the footing at the point where the cold joint was. (See Figure 1) At the trial several people who rent space in the garage testify that a large crack had developed in the foundation about six months after the garage was opened. The owner admits he had an employee fill the crack with driveway patching compound; saying he thought it was just a minor settlement crack, typical of concrete slabs. The owner did not inform anyone else of the patch.

The contractor claimed that Spire Engineering, through its agent, Mary, had approved the construction process and that since the superintendent was not a professional engineer, his recommendations should not have legal weight in determining liability. Spire Engineering claimed that the superintendent had engaged in deliberate deception and that the contractor should share liability.

II. Numerical and Design Problems

1. Determine the factored pressure diagram on the bottom of the footing using the unfactored loads (Assume 60% DL and 40% LL.) shown in Figure 1. Also draw the factored moment and shear diagrams for the continuous footing.
2. Select the reinforcement for a 24" square tied column to carry the loadings shown on the center column. Assume a short column and single axis bending.
3. Given the two footing cross-sections shown, determine the moment and shear capacities of the footing at the following points: a) immediately beneath the center column; b) at the point of the alleged cold joint. Use $f_y = 40$ ksi and $f_c = 3.5$ ksi.



4. If a "cold joint" actually existed at the point shown in Figure 1, assume the footing will behave as if a hinge were there. Write a brief qualitative description of the likely result of such a hinge if an earthquake produces the lateral loads shown in Figure 1.
5. Compute the size of the bars and give the location of the dowels needed to transfer the moment and shear from the center column to the footing. Provide a detailed scale drawing.

III. Questions about Ethics and Professionalism

1. Consider Mary's preparation before visiting the site. Did Mary fulfill her professional obligation to her employer? Give an argument for your answer with reference to the ASCE code of Ethics.
2. What about Mary's actions on the site the second day? Did she behave in a professional, ethical manner? Cite the relevant ethical references in formulating your answer. If you think her actions should have been different, describe what you would do in similar circumstances.
3. Should Mary's boss have let her inspect the construction job without supervision? Be sure to substantiate your answer with reference to the ASCE Code of Ethics.
4. Suppose that Mary's boss, after hearing of her experiences on the first day, assigns Alex, a more experienced engineer, to accompany her to the site. Rather than simply advising and supporting her, Alex takes over the

inspection process, ignoring Mary but also preventing the cold joint problem. Analyze the ethical positions of Mary, Alex and their boss.

5. Imagine yourself as an expert witness for Spire Engineering. How would you assess the actions of Mary and her boss with respect to the firm's liability.

IV. Answers to Ethical Questions:

1. Consider Mary's preparation before visiting the site. Did Mary fulfill her professional obligation to her employer? Give an argument for your answer with reference to the ASCE code of Ethics.

There are several items noted in the ASCE code of ethics that are relevant to this case:

1. "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties."

2. "Engineers shall perform services only in areas of their competence."

3. "Engineers whose professional judgment is overruled under circumstances where the safety, health, and welfare of the public are endangered, shall inform their clients of the possible consequences."

4. "Engineers who have knowledge or reason to believe that another person or firm may be in violation of any of the provisions of Canon 1 (to hold paramount the safety, health, and welfare of the public) shall present such information to the proper authority in writing and shall cooperate with the proper authority in furnishing such further information or assistance as may be required."

Mary's preparation before the visit is suspect. Mary seems to have the technical knowledge to handle this case. However, Mary's knowledge about practical construction techniques and ability to deal with the contractor are in question. Mary has probably not been trained to deal with contractors. However, she was aware of the way women were sometimes treated at construction sites. She was not prepared for the abuse she received at the sight. Is she expected to prepare herself for this abuse? Mary should not have been subjected to the 'whistling, taunting, and general crudeness'. However, Mary shouldn't allow that to affect the way that she performs her job. Is Mary's preparation at fault? If it is, is this a case of Mary acting outside of her expertise.

2. What about Mary's actions on the site the second day. Did she behave in a professional, ethical manner? Cite the relevant ethical references in formulating your answer. If you think her actions should have been different, describe what you would do in similar circumstances.

The same codes that applied to question 1 apply to question 2. Mary's foremost obligation is to the public. It is questionable whether Mary was competent in this situation. She did not know the 'nuances of placing concrete.' One might ask if she is acting out of her area of expertise, which would be a direct violation of the ASCE codes. Also, she allows herself to be overruled in this situation which involves the safety of the public. Is Mary only responsible for technical expertise, suggestions, and consultation, or is Mary on sight to police the contractor and make sure he doesn't cut corners? Mary has voiced her concerns about the 'cold joint', however she is badgered into backing down from that recommendation. In this situation Mary has some different options. She could refuse to back down from her recommendation. Mary could notify her employer of the contractor's actions. If it is determined that there is a problem with the 'cold joint', Mary could notify the owner of the structure. If there was

any criminal action by the contracting firm then the appropriate government officials could be notified.

3. Should Mary's boss have let her inspect the construction job without supervision? Be sure to substantiate your answer with reference to the ASCE Code of Ethics.

In hindsight, it appears that Mary was not quite ready to deal with the contractor. If Mary's boss foresaw problems in the relation between Mary and the contractor, he might have chosen to ease her transition by allowing her to go with a supervisor. On the other hand, it seems that Spire Engineering had confidence in Mary's abilities. Perhaps they thought that Mary was qualified to go into the field, and that this would be the best way to give her experience. If Spire sent Mary into a situation that they knew she would not be able to handle, then that might be considered equivalent to practicing outside of your area of expertise, which the ASCE code explicitly forbid.

4. Suppose that Mary's boss, after hearing of her experiences on the first day, assigns Alex, a more experienced engineer, to accompany her to the site. Rather than simply advising and supporting her, Alex takes over the inspection process, ignoring Mary but properly handling the cold joint problem. Analyze the ethical positions of Mary, Alex, and their boss.

The ASCE Code of Ethics also states:

"Engineers shall give proper credit for engineering work to those to whom credit is due, and shall recognize the proprietary interests of others. Whenever possible they shall name the person or persons who may be responsible for designs, inventions, writings or other accomplishments."

By ignoring Mary's recommendations on a project Mary designed, Alex might be trying to take credit for Mary's work. This is a violation of the ASCE code. However, Alex's primary obligation is to the public's safety, and he has apparently lived up to that obligation. Mary has an obligation to herself to get credit for her work. If she feels that she is not given credit for her work, she might voice that opinion to her employer. The boss in this situation has an obligation to his client and to the public. By sending Alex with Mary he has prevented possible problems resulting from Mary's inexperience. The boss also has an obligation to maintain a good working environment for his employees. In this situation Mary's opinions were valuable, and she should have been able to voice them. The boss might make the working environment more open, to allow Mary room to express her views.

5. Imagine yourself as an expert witness for Spire Engineering. How would you assess the actions of Mary and her boss with respect to the firm's liability.

Mary has put her company in a very precarious position. By allowing the contractors to go against her better judgment, she may have incurred liability for the company. She was on sight to make sure that construction would go as expected and she failed to do so. So, she has put her company in a position where they are liable. The question is raised again: is Mary only responsible for technical expertise, suggestions, and consultation, or is Mary on sight to police the contractor and make sure he doesn't cut corners?

V. Answers to Numerical Problems

