ASCE PNW Regional Conference 2014 – Daniel Mead Student Paper Contest

Worst-Case Scenario

The civil engineer's ethical responsibility to prepare for natural disasters

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Contents

Introduction

Nearly all inhabited areas on Earth are prone to some form of natural disaster. Whether by severe weather, wildfire, flood, or seismic activity, the human-built environment is susceptible to events that pose harm to public well-being and property. Buildings and infrastructure are constructed to make life safer and easier. Unfortunately, natural disasters occasionally wield such power that these structures can be damaged to a point where they pose more risk than benefit to the public. Events such as Hurricane Sandy, which slammed into coastal New England in the fall of 2012, illustrate how even the world's most fully developed regions are susceptible to catastrophic natural disasters. In the aftermath of the storm surge, much of the greater New York City metropolitan area was flooded and left in shambles by wind damage. Fortunately, the city's major bridges and iconic skyline endured the storm with little structural damage.

Although Sandy claimed several lives, the outcome could have been far worse had the storm caused more infrastructure failures. Unfortunately, catastrophic damage does sometimes occur in both international and domestic disaster zones. The code of ethics set forth by the American Society of Civil Engineers (ASCE) stipulates that it is the duty of the engineer to "hold paramount the safety, health and welfare of the public… in the performance of their professional duties" (ASCE, 2009). Though the ASCE code of ethics was originally written as a guide for American civil engineers, it can be viewed as a collection of professional standards that any engineer in the world should strive to meet. As such, civil engineers from all disciplines have an ethical obligation to protect public well-being in disaster situations through the technical planning of their projects, their communication with the public, and their commitment to lifelong professional improvement.

Technical Planning

Civil engineers have an ethical responsibility to design projects and systems with the primary goals of protecting the public's safety, health and welfare. In the United States and many other nations, strict building codes stipulate the performance criteria for most building and infrastructure projects. Unfortunately, in many developing regions of the world building codes are largely ignored or nonexistent. As P.V. Patel asserts in the *Indian Concrete Journal* (2010):

> The majority of damage during natural disasters is caused due to the improper planning of cities and various infrastructure facilities, lack of site investigations, improper structural planning and design, violation of specifications, poor quality control at construction works, and lack of coordination between the various agencies involved in a project.

The technical performance of any civil engineering project during a disaster should be the engineer's fundamental concern during all phases of the design process. Engineers drawing and reviewing structural plans are morally (and legally) obligated to comply with building codes and standards that aim to protect the public. Although it may seem trivial to the American reader, this ethical responsibility should be applied to engineers practicing in any region of the world. However, corruption and non-compliance with building codes place the public in serious peril during natural disasters in many parts of the world.

The recent devastation in the Philippines caused by Typhoon Haiyan and its immediate aftermath has illuminated the critical need for structural code compliance. As with many developing nations, corruption at local and national levels is a problem in the Philippines. Funds intended to improve infrastructure are often diluted or entirely diverted into private hands by a system that lacks accountability. In the days following Haiyan, the Associated Press reported that, "corruption probably has already made this typhoon worse. Money for roads was diverted, giving people less ability to evacuate. Hospitals didn't get the resources they should have," (Cerajano, Gomez, 2013). The authors

go on to describe that more than $20 million of the reconstruction aid provided for recovery after a 2007 storm that ravaged northern Luzon was embezzled by local officials. Such acts of corruption not only fail to help recovering communities in the short run, but they also deny civil engineers the funding necessary to protect the public from future events. These acts of corruption are compounded by a laissez-fare approach to building codes. Cerajano and Gomez (2013) reported that most middle- and lower-class homes in the Philippines are not built to safely withstand a typhoon, though, "some houses might not have been flattened if they had been built to code."

No savings of time or money is worth risking the safety or well-being of people in a natural disaster. Indeed, the ASCE code of ethics dictates that engineers must "realize that the lives, safety, health and welfare of the general public are dependent upon engineering judgments, decisions and practices" (2009). Canon 6 of the code of ethics stipulates that "engineers shall not… knowingly engage in business or professional practice s of a fraudulent, dishonest or unethical nature," (2009). Thus, acts of corruption by engineers unacceptable. Furthermore, knowingly associating with officials embezzling public funds intended for development projects is a breach of the civil engineer's ethical responsibilities. Just as much of modern society depends upon the structures and systems designed by civil engineers, the very lives of the public can be at stake should an engineer disregard the technical performance of his/her designs during a disaster.

Effective Communication

The ASCE code of ethics gives civil engineers an ethical charge make the public aware of potential threats posed by natural disasters through effectively communicating the dangers of inadequate design or substandard emergency planning. Canon 1 of the code asserts that when an engineer is aware of a potentially dangerous circumstance, he/she should "inform [his/her] clients or employers of the possible consequences" (ASCE, 2009). This duty can manifest itself in a variety of

ways. Engineers aware of hazards related to a specific development site selection (e.g. hazardous geotechnical exposure to liquefaction in a seismic event) should act in the best interest of the public by immediately voicing these concerns to their superiors. Effective communication of such matters is critically important, as a failure to clearly identify a known risk could pose dire consequences to public safety and well-being. Clarity, precision and accuracy in both written and verbal communication are exceptionally important to an engineer's ability to meet the ethical demands of his/her profession. This is true not just for communication with clients and coworkers. Rather, civil engineers are encouraged to "seek opportunities to be of constructive service in civic affairs and work for the advancement of health, safety and well-being of their communities" (ASCE, 2009). An engineer's knowledge in highly technical matters gives the charge to serve public interest as an expert in his or her field. Community involvement provides a platform for a civil engineer to communicate directly with the public regarding disaster preparedness. Effectively communicating technical knowledge empowers the public to demand safer, better-planned developments. However, an engineer should never give case-specific advice for a project he or she is not working on in a professional capacity as doing so carries severe liability implications.

Lifelong Learning

New advancements in technology and material science will push the boundaries of construction and infrastructure possibilities throughout a civil engineer's career. An engineer is ethically obliged to remain abreast of proven, tested technological advancements that will further safeguard the public in extreme or disaster conditions. The ASCE code of ethics asserts that civil engineers "should keep current in their specialty fields by engaging in professional practice, participating in continuing education courses, reading in the technical literature, and attending professional meetings and seminars" (ASCE, 2009). As with any of the sciences, the common civil engineering practices of today will likely be

replaced in the future by safer, more effective methods. Complacency and appeals to tradition are unacceptable in an industry where the safety of the general public depends upon the performance of one's product.

Following the catastrophic 7.0 magnitude earthquake (and subsequent aftershocks) that befell Haiti in 2010, a large proportion of all buildings in Port-au-Prince were destroyed or damaged to a severely hazardous extent. An influx of aid workers, including many civil engineers, traveled to Haiti to provide assistance with the island's long recovery process. Ilya Leybovich's article, "Engineering for Disaster" (2010), illuminates that during this time several engineers reflected upon the dire level of Haitian seismic preparedness. Instead of simply rebuilding homes with the same unreinforced methods as before the earthquake, Leybovich writes that in the earthquake's aftermath, "several engineering and industry groups [were] attempting to create cost-effective materials solutions for disaster relief" (Leybovich, 2010). The author describes replacing concrete and masonry homes with houses constructed with steel frames. Further, some homes were built in a compact modular fashion using strong, lightweight steel tubes in both structural and cladding applications. Leybovich cites a *New York Times* interview with Scott Chubbs, an engineer and aid worker in Haiti:

> There are cheaper houses using traditional materials, but they won't have the same fit and finish and the engineering as these steel houses and, remember, they have been designed to withstand earthquakes in a way that houses built 30, 40, 50 years ago would not.

Scott's quote reveals a commitment to using new methods to protect public safety without ethically compromising on account of the expense of doing so. It is always important to balance economic interests with the overall execution of a project, though this should not be done at the expense of public safety.

Summary and Conclusions

While engineers cannot be held responsible for the natural disasters that occur, the projects they design and build must not place the public in peril during these events. A civil engineer should never approach his or her career with a careless attitude. Rather, civil engineering demands a high-level of commitment, passion and motivation to improve public life. Every civil engineer has the ethical responsibility to protect public well-being in the course of his or her work. Building and infrastructure projects must be designed and planned to technical standards that prevent threats to public safety. Civil engineers are ethically charged to effectively communicate and engage with the public concerning potential safety threats and disaster preparedness. Engineers must remain committed to maintaining proficiency with technological advancements that allow for more adequate protection of the public during extreme events. A project designed to improve public life during normal conditions must not pose a threat during a disaster. It is a civil engineer's ethical responsibility to protect the public during the worst-case scenario.

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