

Rana Plaza Structural and Ethical Failure

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On the morning of April 24, 2013, on the outskirts of Dhaka, Bangladesh, a power outage occurred, a generator switched on, a column crumbled, and a building collapsed. Rana Plaza, owned by Sohel Rana, housed four factories, several shops, and a bank on its eight floors. A technical analysis of this structure's collapse, and actions leading up to the event, reveals several missteps in both design and ethical practice which resulted in this historic disaster.

In the days before the incident, factory workers reported cracks two inches deep in the concrete on the seventh floor. The cracks were assessed, but not taken seriously. Managers insisted that employees come in, threatening to withhold pay if they disobeyed. On the morning of the incident, a power outage occurred, so the generators on the roof kicked on. The weak building could not take this final blow to its strength. One of the columns on the seventh floor crumpled into rubble, taking the rest of the structure – and thousands of innocent workers – with it (Motlagh, 2014). The diagram of Rana Plaza in Figure 1 illustrates the building's internal structure, along with the columns that triggered the collapse.

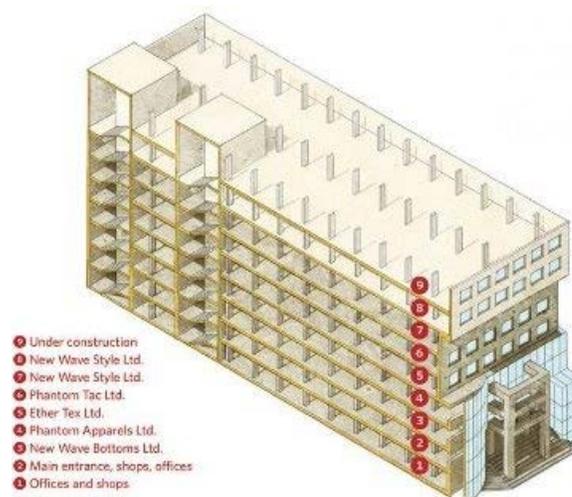


Figure 1. A diagram of Rana Plaza's internal structure and support columns. (Motlagh, 2014).

The composition of Rana Plaza lacked support which would have prevented the fatal cracks in the walls. Oftentimes, buildings are constructed with large amounts of concrete, which needs reinforcing steel called rebar. This is how Rana Plaza was constructed. However, to understand the insufficiencies in the implementation of this structure, it is necessary to understand the basics of how concrete and rebar work together.

Concrete alone is not reliable to support a building. This can be understood using the ideas of compression and tension. When a structure is in compression, it is essentially being squeezed in toward itself. When a structure is in tension, it is being pulled away from itself. Concrete does very well when it is compressed, and is unlikely to fail. However, in tension, it very easily cracks and crumbles apart – similar to a rubber band snapping if it is pulled too hard. Rebar is the support concrete needs when it is put into tension. It is essentially a network of ridged steel bars within the concrete, placed where the structure is most likely to be in tension. This is exemplified in Figure 2. The steel forms a bond with the concrete in a way that allows the rebar to go into tension when necessary instead of the concrete – preventing cracks (Pelger, n.d.)

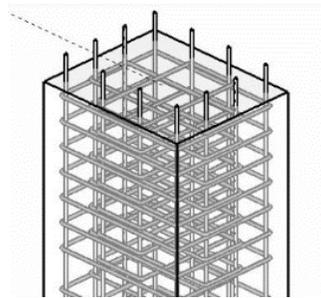


Figure 2.

A diagram illustrating a network of rebar inside a concrete column.
(Concrete Column, n.d.)

Walls of many buildings can be built with concrete, because they are in compression due to the forces of the floor and ceiling. However, both Rana Plaza's walls and columns were repeatedly put into tension by multiple stressors. One of these was the lack of a strong foundation. When a building is constructed, it puts a downward force on the ground. In order to continue standing, the building must have an upward, or reaction, force exerted on it which matches the downward force it produces. This is illustrated in Figure 3 with the book on the table. The book exerts a force on the table, and the table exerts an equal force upward on the book. If the ground is strong enough, it can do this with a building. However, according to an article in *The Guardian*, an investigating committee appointed by the Bangladeshi Interior Ministry found that Rana Plaza was built on swampy land – the site of a filled-in pond (Bangladesh factory collapse, 2013). Because the ground below Rana Plaza was swampy, it was mushy and weak in certain spots, causing the building to sag and contort in those unsupported areas.

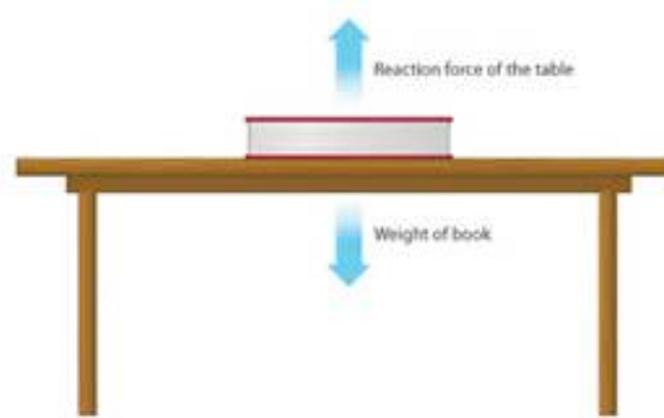


Figure 3. A diagram of the forces between a book and a table (Balanced Forces, 2014)

Additional stressors to the building arose from its use. According to the architect of Rana Plaza, Massood Reza, the building was never designed for factories, but for shopping malls and offices (Burgman, 2013). However, during the time of the collapse, the top four floors were

being used to manufacture garments – Bangladesh’s top export (Burgman, 2013). Such operations required the support of large numbers of sewing machines which produced high levels of vibration. Furthermore, due to frequent power outages – sometimes totaling 50 per day – generators, weighing several metric tons each, were placed on the roof, further increasing weight and vibration (Motlagh, 2014). As offices and malls do not need to carry such loads, Rana Plaza was not strong enough to support the machinery weight and vibration of factories. Consequently, these stressors, combined with a weak foundation, repeatedly put tension on the structure’s walls and support columns. Unfortunately, Rana Plaza did not have enough rebar to absorb this tension and cracks inevitably formed throughout the structure. When the generator was switched on the morning of the incident, the columns gave way, the walls pulled apart, and the building collapsed.

The ethical behaviors of those surrounding the Rana Plaza collapse were despicable. However, circumstances can markedly affect people’s ethical decision making capabilities. In this case, it is particularly important to note Bangladesh’s situation as a developing nation. The restrictions this imposes on workers often loosen their ethics. Lack of funds creates pressure to keep overhead building costs down. This insufficiency challenges designers and contractors to create structures that are safe and adequate, while using only limited amounts of cheap, low quality materials. Builders are easily prompted to cut corners when these challenges become too difficult to overcome.

Heightening even further the complications of engineering in a developing world is the lack of adequate enforcement of building codes. Codes regulate how designers and builders can construct a structure so that it is safe for human use. Bangladesh did indeed have adequate rules in place. However, these rules were hardly enforced:

According to the Ethical Trading Initiative, under Bangladesh building law any new structure, for any purpose, has to obtain an occupancy certificate from a government agency before it can be used; only six certificates have been issued since 2008, although it is estimated 4,000 – 5,000 new buildings come up every year. (Vanstone, 2013)

Unenforced regulations allow violations to multiply and become the norm, making it even easier for builders to ignore codes – an unethical decision sure to endanger public safety.

Sohel Rana is a corrupt man who was only concerned about making money. He exploited Bangladesh's situation as a developing nation and his power over the government in an attempt to make wealth for himself throughout the Rana Plaza project and operation. He chose the inadequate site for the building, facilitated the illegal construction of multiple additional floors, and "used extremely poor quality iron rods and cement," for materials (Building Materials Blamed, 2013). Then, he used his political power to have the mayor sign off on his building, despite its not being up to code, and proceeded to use the structure for operations outside of its intended use, even when its safety was questioned. His continual unethical decision-making killed over 1,100 people (Motlagh, 2014).

While Rana intended to make unethical decisions, there were countless opportunities for many others involved, including engineers, to act ethically, as well as expose Rana. A critical moment was when the cracks on the seventh floor of Rana Plaza were discovered. The engineer of the building, Abdur Razzaque Khan, assessed the situation. Unfortunately, it is not conclusive after the event whether Khan ruled the situation dangerous or relatively safe. Khan argued that it was the former, while Rana and building managers insisted it was the latter (Yardley, 2013). In either case, the managers could not be confident about the building's safety, and they gambled the lives of their workers for money. On the day of the collapse, the managers of the factories

threatened employees with a loss of a month's wages if they did not come into work, essentially forcing them into a life-threatening situation. In contrast, the malls and bank below the factories closed until they had confidence in the building's safety (Motlagh, 2014).

The engineers involved in the Rana Plaza disaster were some of the primary responsible parties. People use the creations of engineers every day in almost everything they do. So, it is the social responsibility of the engineer to create something, whether it be a building, product, or system, which benefits society without putting people at risk. It is additionally their duty to ensure the continued safety of these designs, as they are the ones who possess the knowledge to determine whether a situation has become dangerous. Therefore, engineers were largely obligated to act ethically in the Rana Plaza collapse. They should have spoken up to authorities and the public about the inadequacy of the structure at conception, construction, and in assessing the cracking reports.

Speaking up about unethical situations is easier said than done, as it often occurs in the face of great adversity, and is not guaranteed to yield results. Even if engineers had brought to light Rana Plaza safety concerns, it was improbable that authorities would act on the situation. Moreover, the public would likely overlook the issue – willingly endangering their safety in the face of limited employment opportunities. Corruption is contagious, and in the case of the Rana Plaza disaster, the corruption of the government and businessmen prompted the engineers into making poor decisions, as they did not believe those in power would consider their concerns. Knowing how to recognize when unethical behavior could corrupt oneself is an important skill for engineers, and overcoming this tendency is to uphold the highest standard of ethics, a level of excellence for which engineers should strive relentlessly in all that they do.

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