Big Blue Crane Collapse

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On July 14, 1999, one of the largest construction cranes in the world collapsed at the site of a brand new baseball stadium in Milwaukee, killing three steel-workers and injuring five others. A lawsuit arose aimed at assigning blame for the disaster. On one side, Mitsubishi Heavy Industries, the company subcontracted to build the stadium's retractable roof, blamed Lampson, the company they were leasing the crane from, for providing inaccurate information as to the crane's load capability. On the other side, Lampson defended themselves claiming that the disaster was caused solely due to Mitsubishi's negligence and their operation of the machine under irresponsible conditions (Ross, 2007). The incident got mainstream coverage, becoming a poster boy example of managerial negligence—a serious threat that engineering projects face on a regular basis. Analyzing both the physical and managerial forces that caused the disaster serves as an opportunity to learn from the mistakes made and gain insight into the disparity between the motives of an engineer versus those of a manager.

The physical concepts that came into play that day are really quite simple. There were two main shortcomings that caused the incident. The most fundamental concept that construction cranes employ is equilibrium. A physical object is in equilibrium when all the forces acting on it sum to zero in every direction. We see equilibrium everywhere. One simple example of an object in equilibrium is a person standing on the ground. Gravity has an effect on that person's mass causing a force downward while the ground underneath him pushes with an equal and opposite force upward. As a result, we say that this person is in static equilibrium because they are not accelerating in any direction. When designing a crane, it is the job of the engineer to create a machine that can maintain equilibrium with varying load weights at different arm distances from the crane's operating hub. On this particular crane, a 1150 ton counter weight was used to offset the load weight on the opposite side of the hub (Figure 1a).

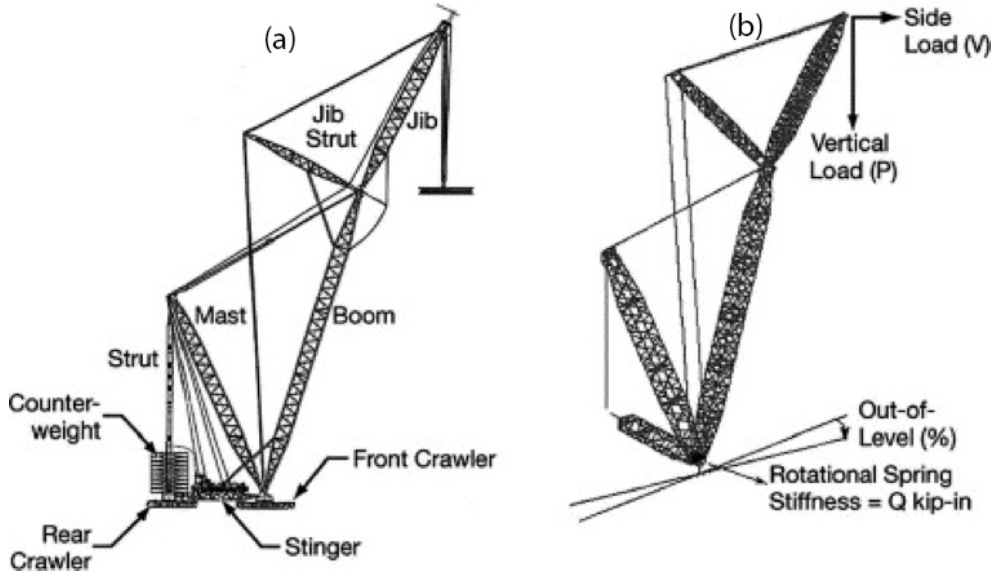

Figure 1a & 1b - Big Blue Crane components diagrams. (Ross, 2007)

On the day of the incident, like any other day, the crane operator inspected the data tables provided by Lampson in reference to the relevant load weight—a 510 ton roof section. The 510 ton load 155 feet from the hub was 97% of the next highest safe lift reading on the reference chart. This might lead a layman to assume that the lift was safe—but it is common practice in crane operation to take into account wind effects, something that, under pressure from Mitsubishi, he neglected to do. The technical specifications provided by Lampson clearly warned that the data from the load tables fully neglected wind effects and that wind should always be analyzed on a lift-by-lift basis. On top of that, the specifications clearly stated not to use the crane at all in wind conditions above 20 mph, a condition that was far surpassed that day. The first crane lift for the project was made in under 10 mph winds. The second lift got delayed for 17 days due to winds around 20 mph (Jagler, 1999). Under risk of financial penalty if not completed on time, Mitsubishi increased the pressure on its workers, ultimately leading to the dangerous decision to make the lift that day regardless of the 26 mph average wind speed with gusts in the mid 30s (Ross, 2007).

The load lifted that day had a lot of surface area facing the wind. Loads like this are called "sail loads" because they cause a large additional force in the direction of the wind. It is named this because, like a sail, it has a lot of surface area for the wind to catch. Lampson specified that the crane can only withstand a side load that is two percent of the total weight being lifted. A side load is any force that acts in the direction perpendicular to the lift—in this case, wind (Figure 1b).

The large force of wind on the roof piece created a side load far surpassing the 2% maximum. It is that sideways force that was the primary cause for the crane collapse and the reason for the warning stated in Lampson's crane specifications. This force caused the carefully balanced crane to fall out of equilibrium. As a result, the connection where the "Boom" and "Mast" met the "Front Crawler," (Figure 1a), began to bend, leading to an even greater break in equilibrium as the weight-forces shifted out of their carefully balanced locations. At this point, the entire crane pulled itself over, cascading as its individual pieces fell out of equilibrium, pulling its connected pieces with it.

Now, we see what caused the incident to happen on a physical level but it was not a physical anomaly that killed three construction workers and injured five others. The incident could have easily been avoided had the proper care been taken. It is the responsibility of engineers to take the utmost care and caution in their decision making. Lampson, the crane company, did its duty in providing accurate information to its clients with the proper warnings, while the crane operator made a rash decision under pressured by Mitsubishi. This conclusion was later confirmed, after extensive investigation, when the courts ruled that Mitsubishi was responsible for 93% of the financial penalty resulting from the disaster, totaling 99 million dollars in various damage claims (Cranes Today, 2000).

This might seem like an isolated instance of irresponsibility and negligence, but things like this actually happen all the time with varying consequences. Mitsubishi put a lot of pressure on its subcontractors to complete construction quickly. The Milwaukee Brewers, the team that the stadium was being built for, stood to lose money in potential profits if the stadium wasn't ready that coming season. As a result, there was a lot of pressure put on Mitsubishi to stay on track regardless of unforeseen roadblocks, such as weather. Mitsubishi would be financially penalized if the roof wasn't done on schedule which caused its managers to put unfair and unsafe pressure on its workers. This lead to the fatal decision to lift the roof section that day.

Engineers are taught to hold the safety of the public paramount while managers are taught to maximize profits. These are two goals that often lead to very different decision making. Even though extra safety precautions and risk prevention can slow progress and cost money, peoples' safety should always be the main priority. The people who understand all the risk factors involved should always have the final say when safety is a concern, and shouldn't be pressured by monetary interest. After the Big Blue crane incident, the National Institute of Occupational Safety and Health (NIOSH) proposed recommendations to help prevent similar incidents in the future (NIOSH, 1999) but they all aimed at improving the ability of people involved to make calculations to more accurately refer to information provided about the crane's loading conditions. These recommendations served little use to the underlying cause which was disregard of the information due to pressure rather than the lack of ability to accurately refer to it. We would do better to figure out how to put more power in the hands of engineers and to protect their decision making from profit-driven pressure.

Works Cited

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