The Structural and Ethical Failures of the *Sewol* Ferry Disaster

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Engineering Fundamentals 1: Statics; Section 35

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On the 16th of April, 2014, a ship that was known at the time as *MV Sewol* capsized while carrying 476 people, resulting in the deaths of 295 people onboard as well as 2 rescue divers; to this day, 9 people are still missing (Yonhap News Agency, 2014). Plastered all over the news for several days after its occurrence, the capsizing of *MV Sewol* was soon mourned all over the world. Blame was quick to be thrown around, of course. Initially, criticism was directed at those in charge of the ferry's operation, but the blame quickly shifted to those who were truly at fault: those involved with the operation of the ferry line and the regulation of its ships. As it turns out, the ship that had come to be known as *MV Sewol* was old and dilapidated before it ever even assumed its final occupation of shuttling passengers between Incheon and Jeju in South Korea. The *MV Sewol*'s capsizing was caused by sudden shift in the ship's weight that was only possible because of a lack of properly communicated and enforced safety standards.

Just one day after the incident, the ROK Coast Guard came to the conclusion that the main cause for the capsizing of the vessel was an "unreasonably sudden" turn made between 8:48 and 8:49 a.m. (Digital News Team, 2014). Indeed, this appears to have been the root cause; however, it may not be apparent to those who are less aware of the underlying forces at play just why such a sharp turn would lead to the capsizing of the vessel. It is logical to assume that if the ship is capable of turning at such an angle, it should be able to handle that turn without tipping over. In most cases, this is true, but in the case of *MV Sewol*, a complete disregard for safety rendered this logic inapplicable to the matter at hand. To better explain why this is the case, it is important to understand a very basic concept in engineering mechanics: equilibrium, and what must be true in order for this state to be realized.

In Figure 1 (pictured below), there is an individual in what is known as static equilibrium—that is to say, he is in a motionless state with no net forces acting upon him. Of course, gravity is pulling the man down, but a reactionary force by the ground is keeping him from moving closer to the center of the earth. Following this logic, in order for an object to be in static equilibrium, the net horizontal and vertical forces (known as the x and y directions) must equal zero. On top of that, a third condition exists: Net moments must equal zero. Essentially, a moment is a rotational tendency about any point on the object in question that comes about from forces acting unchecked; a perfect example would be the rotational tendency created by the turning of a wrench onto a bolt. If moments are not properly cancelled out, then the object cannot possibly remain at rest. The result in such cases will always be rotation, and in the case of *MV Sewol*, the result cost hundreds of lives.

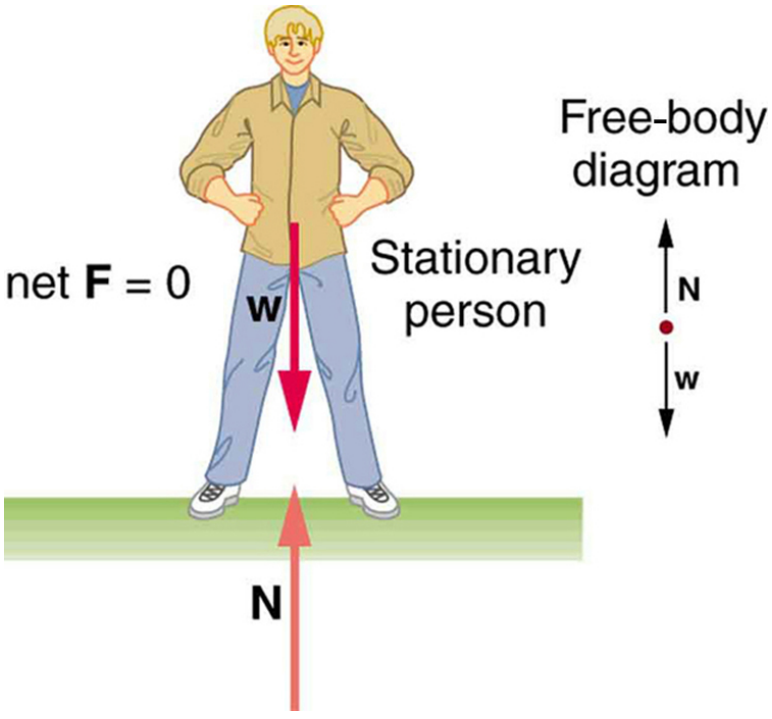

Figure 1: A simple and relatable example of static equilibrium (OpenSTAX, 2012).

In a normal situation such as the one pictured on the left side of Figure 2, a vessel such as the *MV Sewol* would be capable of dealing with any small to intermediate forces acting upon it; in fact, it has been found that the captain of the *MV Sewol* had sufficient time to restore the ship's balance at the first sight of a problem with a swift turn to the left (Gorlov, 2014). The problem that arose with the *MV Sewol* came from an insufficient restoring force to deal with the moment created by the shifting of cargo. This cargo was not properly tied down, and when the ship turned as sharply as it did, the cargo it was carrying shifted the majority of the ship's weight to port. Even still, this seems like it would be something a ferry should be capable of handling. Normally, that would be the case, but the *MV Sewol* was also reportedly carrying more than three times the limit of 987 tons of cargo onboard (Campbell, 2014). On top of that, the *MV Sewol* was only carrying 580 of the recommended 2030 tons of ballast water. Reportedly, the space that would have normally been taken up by ballast water was instead being taken up by additional cargo (Sang-Hun, 2014). In hindsight, it seems that it would have been more surprising if this doomed voyage managed to go without any problems.

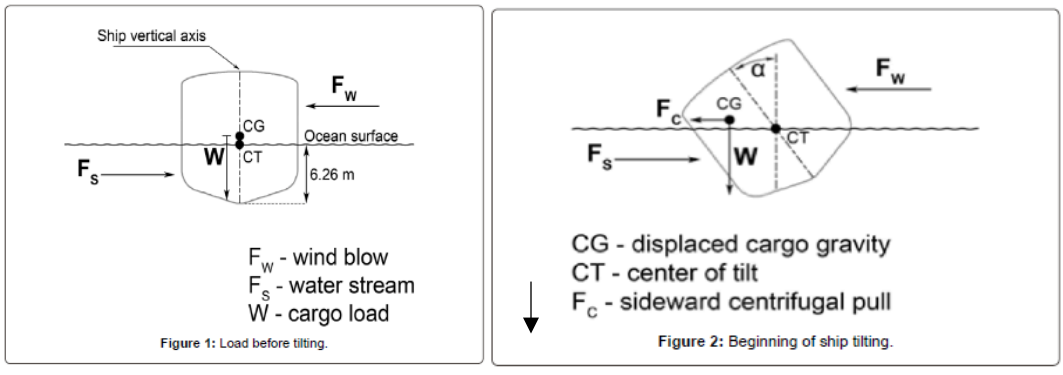

Figure 2: A visualization of the effects of the cargo's movement on the ship's equilibrium (Gorlov, 2014)

It is apparent that those in charge of the management of such things as the cargo and ballast water were not acting in the best interest of the public. It is possible that they did not know the potential ramifications for what they were doing; at the same time, that is no excuse for the sheer lack of any regard for the potential dangers that they introduced into the equation. The concepts of moments and equilibrium are nothing new for engineers like the ones who designed the ship in question; indeed, it is nearly certain that an event very similar to what happened was considered. What may not be well known amongst the general public is that all designs are rigorously examined and analyzed for potential failures; when something, be it a ship, a car, or a space shuttle, is pushed outside of the operating conditions for which it was designed, it can never be known how it might respond (Petroski, 2003). In this particular situation, the engineers involved should not be blamed for this tragedy; instead, the best solution would likely be to at least attempt to hold those involved with all parts of a product's life cycle to the same standards to which engineers hold themselves: the National Society of Professional Engineers (NSPE) Code of Ethics. The Code of Ethics for Engineers are centered on honesty and integrity, and the following of its values might have saved hundreds of lives. The very first fundamental canon states that engineers must "Hold paramount the safety, health, and welfare of the public" (National Society of Professional Engineers, n.d.). At no point should one ever consider sacrificing the safety of passengers in exchange for a bit of extra cash, but that is exactly what happened here.

The company that owns the vessel, Chonghaejin Marine Company, had apparently been consistently overloading the *MV* Sewol and earning an extra $2.9 million since the ship was purchased (Park, 2014). Even still, the cargo may have been able to stay in place; that is, if it had

been properly secured. The lashing devices used by the crew to secure cargo were reportedly being improperly used. In fact, some of the crew had no idea how to use the devices at all (Park, 2014). This does directly against another canon: engineers must "Perform services only in areas of their competence" (National Society of Professional Engineers, n.d.). These crew members were attempting to perform a service without knowing how to properly perform that service, and that only added to the cacophony of issues that lead to the disaster. If these core values had been considered and reiterated at every level of the ferry's life, this massive and terrible loss of life might have been prevented.

This tragedy ultimately arose because of a difficult issue that engineers around the world have to deal with: to simply set standards and tolerances for a particular design is not enough. Instead, those standards and tolerances must be properly communicated and upheld by all individuals throughout the life cycle of the product, whatever that product may be. The captain and crew of the *MV Sewol* may not have followed the guidelines that existed for the vessel, but the blame cannot be placed entirely on them. When avoiding a safety standard leads to an increase in profits and no immediate problems, it is hard to convince anyone that such activities should stop. It also becomes easy to get away with not properly training crew members on all relevant information pertaining to the job at hand when it has never been an issue before. In order to make the best possible attempt to prevent disasters such as the one that befell the *MV Sewol* from happening, a lot needs to change. Of course, there have to be concrete standards in place, but above that, the safety of the public must be paramount. When the potential for the loss of human life is there, one can never be too careful when it comes to ensuring that everything goes according to plan.

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