Good Engineering Practices in a Lift System

by PVN Marar

I remember a lecturer, Mr. Divides, who once asked a question in my engineering class, and nobody could provide a convincing answer. "What is engineering?" was his question, and he answered, "Engineering is the economic extraction of efficiency out of man, money and material." He also asked, "Is there good and bad engineering?" "Yes," he answered, explaining that the basic goal of engineering is to get the maximum efficiency out of resources in terms of money spent on people and material.

In an elevator, safety, quality and aesthetic are the rating factors and, therefore, the installation should have the right man to do the right job with right materials, and this right way of doing things is called "Good Engineering Practice" (GEP).

Is it the right way to keep the bolt upside down in a horizontal application? If no, then this is not a GEP. A GEP goes beyond detailed design calculations. Often, a "Bad Engineering Practice" is something that is difficult to define and is in the "you know it when you see it" category. It is not enough to get the elevator to run up and down, one also needs to follow GEP. The following illustrates some examples.

In a normal concrete structure, the connection of rail brackets with shaft walls is done by using dash fasteners or expanding bolts. It is observed, that in certain installations, a fastener nut has a bearing of two threads on bolt, instead of the right way in which the bolt thread extends from the nut, and, at the same time, the bolt shall

Examples of bolts improperly installed

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have the specified penetration. This may be seen as a small overlooked but major concern, as the brackets that support the entire rail-guiding system may get detached from the structure if the nut gives way due to vibration. While all of the detailed design calculations prove otherwise, a minimum of two full threads of bolt must extend from nut after giving the required torque; this would be a GEP.

Few installations have adopted a single compensating chain (whisper-flex) arrangement instead of two in normal practice. This may be due to design criteria, or nonavailability of material for specific application or, in some cases, the car rail comes in line with the counterweight center, forcing an undesired diagonal connection. A single compensating chain suspended at one side of a counterweight frame can cause the frame to imbalance. As the frame goes up, it becomes more imbalanced due to the weight of the compensating chain and generates an unequal pressure on the guide shoes. More pressure on the shoe creates more wear and tear. Remember that in a 20-stop elevator (with a 1000-kg capacity having 8 # ropes of a 10-mm size) requires a compensating chain or whisper-flex between 250 to 300 kg in weight, depending on the construction and type of hoist rope – enough to imbalance a counterweight frame. This increases when the car travels down. The problem can be eliminated if the compensating chain is installed at the center to balance the entire frame and thus avoid abnormal wear and tear of the guiding systems. The only extra requirement in this arrangement is to have two buffers instead of one. Alternatively, a small size weight (Figure 1) can be added on the normal weight at the opposite side of a compensation chain. Also, a specially designed filler weight (Figure 2) can be used for balancing. However, both arrangements will be inclusive of the total counterbalance weights. Unfortunately, the static balance of counterweight is seldom looked at seriously.

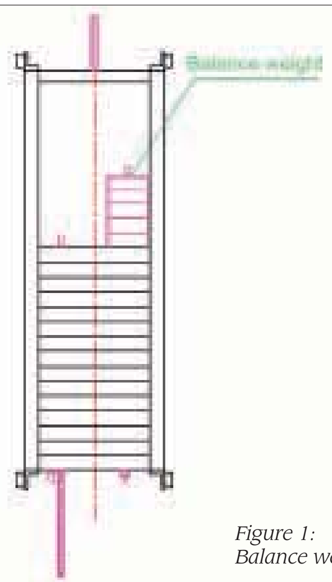


Figure 1: Balance weight

In one routine validation of a lift, I experienced an abnormal sound and vibration while the elevator was in motion. Inspecting from the lift pit, it was found that the whisper-flex (chain) loop (hitch center to center) is more than 1,100 mm. As the whisper-flex is flexible and of a specific bending and stiffness nature, the designed limit of loop is about 457-609 mm (diameter 25.1-45.5 mm) given by manufacturer, depending upon the diameter (Siecor Corp. elevator mechanical design.) In this variation in hitch distance force, both sides of the loop take a "V" shape, which meshes with the "swayless" provided at the bottom and resists the free movement that causes the chain to sway while the lift is in motion.

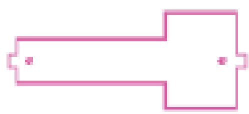


Figure 2: Counterweight filler weight

When the chain fall is perpendicular, swayless or steadier are free from any force or friction, other than from the vibration of the chain due to building sway, abrupt stop and wind pressure, which will happen occasionally for a considerable short time.

This vibration due to the friction of whisper-flex varies as the lift position changes in its travel. The mass and pulling angle, low tension and flexibility of the chain cause more amplitude. This angular pulling also generates extra force on the guide rail by the top and opposite bottom guide shoes. When asked about the anomaly, someone at the site admitted that the shifting of whisper-flex was done to facilitate car static balance, giving scant attention to compensating chain fall.

Recently, there was a traction failure in one of the lifts. The lift slipped and struck the buffer with full load, but, fortunately, nobody was seriously hurt. We were assigned to investigate the incident. After inspecting the machine and deflector placement, we found the arc of contact or angle of wrap was less. By calculating the existing traction, it was found to be 118° where as a good traction should be above 150°. What went wrong here were not the resources, but the installers failed to enforce and apply good engineering, possibly due to ignorance.

I have seen an installation in which two car buffers are used diagonally, where the car frame and car are parallel to the landing sill. When the lift over travels, the platform bottom will directly strike the buffer, and the impact is directly felt in car, causing the platform to bulge, the car panel to deform and even the platform connecting bolt (sound isolation arrangement not used) with car frame to shear. So the impact is absorbed on the car frame, not on the platform.

Continued

A geared machine was placed facing the motor shaft very close to the wall, though there was enough space in the machine room to turn the machine 180°. When I asked the people at the site to demonstrate the rescue operation, the cranking wheel could not be fixed due to lack of space. To my surprise, there was not even a brake release device. They used and adapted a crude method and tools to move the car. The lift had been running for the last six months with some over travel. The reason obviously was that whenever there was an entrapment, the rescuer loosened the brake-arm spring nut to release the brake, which was not set properly after the evacuation.

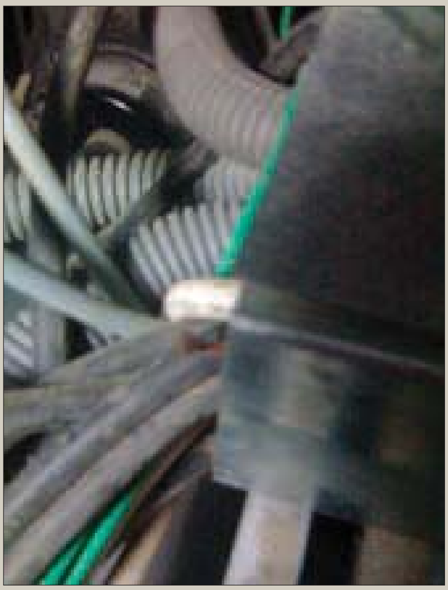
Another example involved an entrapment with the lift above the floor level about one foot. An elderly lady was inside the lift, and the door was partially opened. The rescuers found no locking key (a square pin used to connect the cranking handle with motor shaft), inserted a nail in place of the key and started the rescue operation. As they opened the brake to bring the lift down, the cranking handle slipped (the nail being round and under size) and the lift moved up without any control due to load condition. Fortunately, the lady inside the lift did not attempt to come out, thus a major incident was averted.

How many of us periodically check the calibration of the speed governor? Due to time constraints and the work involved, the conventional method of calibration (keep the lift at top floor, remove both ends of the governor rope from car hitch, join them together and add a small weight, let it go down due to gravity, which makes the governor sheave turn fast exceeding contract speed, causing the governor to trip and subsequently measure the tripping speed with a tachometer) is not possible during routine maintenance, though some suppliers have a governor with a test groove. The normal practice employed is to check the safety gear by actuating governor physically and satisfy with the safety gear grip on car rails, but not the governor for its overspeed mechanism – in a vehicle, brakes applied and found working. Just imagine what the consequences would be if the brake pedal were not applied when the vehicle in front of you stopped suddenly. It is a human error. However, in case of a governor, the failure would be its actuating mechanism resulting in a runaway car.

On the basis of tracking records, the lack of even more accidents does not allow one to presume that there will never be a rope snap or free fall, and, therefore, calibration of the governor is not required periodically. Or are we waiting for somebody to require a complete periodical drop safety test? The option for a well-engineered calibration tool is left with the elevator manufacturer. The point here is to ensure that any system


Wiring done imperfectly





that requires periodical testing shall be easy to check and the necessary changes need to be adapted to make it a well-engineered and prompt analyzing tool.

In another example, an old elevator had four main ropes. When the elevator was reconditioned, the old machine was replaced with a new machine with a three-groove sheave and three ropes. The speed of the elevator also increased. By decreasing the number of ropes and increasing the speed of elevator, the factor of safety decreases considerably and also the specific pressure of ropes on the sheave may exceed the maximum value.

The electrical wiring in an elevator system needs to be concealed or encased by the means of a trough, conduits, flexible pipes and trays. A live wire cannot be left open without protection and the neat dress up of wires and cables is very important. The photographs are self explanatory and indicative for quality analyzes.

In some of the installations, a machine-room trough is fixed on the floor surface, not embedded, to get them flush with floor. The result is a tripping hazard.

Machine-room trough – a serious tripping hazard

A lot of situations mentioned in this article can be seen elsewhere and need correction. A wee-engineered product emerges out of good engineering practices.