

Roping of Elevators

by PVN Marar

Wire ropes are the vital component and lifeline of an elevator system, as they support both the car and counterweight. This roping activity of an elevator involves critical dimensions, skill, and various permutations and combinations.

I recently met an old acquaintance from the elevator industry and we discussed elevators (elevator people always love to speak about elevators). The main topic was the rope stretch and the buffer clearance. During the discussion it also came out that while connecting the rope, he normally assembles the car on the top floor of the shaft and the counterweight frame at the bottom. Though this method is just opposite of the way I was taught, I have seen some people still assemble the car on the top terminal floor.

I asked my acquaintance the benefit of his method, and he did try to reason that the counterweight frame is too heavy to take to the top floor where car slings and panels are light in weight, and it is easy to be shifted (conveniently avoiding the fact that the platform and car frames are also heavy). I rationally questioned him regarding the safety of persons working around the car, fixing car slings and panels. Though he agreed the method is risky, he seemed comfortable as he was getting the desired buffer clearance, otherwise difficult to calculate.

Here again, I had to tell him that it is an easy calculation of the few measurements given in the drawing layout. He was not fully convinced so I had to explain him the simple formula that $X = PD - (A + B + C)$, where X = distance from the top terminal

floor level to the counterweight frame bottom positioning, PD = pit depth, A = height of buffer (stand if any) from pit slab, B = counterweight buffer clearance and C = rope stretch. (This is provided the car platform is level with bottom terminal landing. If the platform is assembled above the floor level, for example at 150 mm, then X distance will be $X + 150$ mm. Likewise, if it is below by 150 mm, the distance will be $X - 150$.)

While I was looking after installations, the people working with me used to have small discussions on various technical subjects, and in one such session the above topic was discussed. Most of the participants understood the simple calculation, but a few could not understand it fully. So I had to take them to top floor where we mapped the pit dimension on the counterweight rail.

First, we transferred the top floor sill level on one of the counterweight rails. From there we marked the pit depth (PD), which is the pit bottom or pit floor. From the pit floor, we marked the buffer height (A), the clearance (B) and the stretch (C). By doing this exercise they understood that the counterweight frame bottom would be located on the line where the rope stretch marking ends. Then it was a clear calculation to find out the position without doing the procedure.

Readers may wonder why so much importance is given to this simple activity. Here, I want to narrate an interesting thing that happened during my tenure as a supervisor. I had an erector who installed an elevator in a seven-story building. When the commissioning team started the elevator in slow speed, they found that



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the counterweight buffer clearance was more than 1.5 m against the 300 mm required. The reason was that the calculation was done incorrectly or not at all. I cautioned him to be more careful next time. The erector was put on another job and after the erection completed, I asked him about the quality and perfection of the roping. He replied with confidence that this time there would not be any problem as he had kept an extra 2-3 m of rope. This happens in many installations.

In the last three years, I have validated more than 500 lifts and, out of these, 60% of the lifts had either an unacceptable level of extra clearance or very little clearance. I agree in certain cases that the abnormal elongation of the rope is also a factor contributing in lesser clearance, but the prime cause is procedures not being followed or installers who are ignorant about the system.

I have seen suppliers use clearance reducers (spacers) at the striking area of the counterweight frame. Some are in the form of wooden block or metal. Both are fine to reduce excess clearance, provided sufficient room for the counterweight is available. These reducers can be removed once the correct clearance is achieved due to gradual elongation.

What happens when there is very little clearance? When the elevator is put into operation and time passes, this may be due to gradual elongation. The counterweight frame will be buffered before the lift reaches the top terminal floor and the machine still running. Elongation is a continuous process even though it is very slow after the initial stretch.

Can we go for an adjustable buffer stand to overcome this problem? Suppliers can keep in mind the sustainability of the impact and feasibility of code compliance until such time as a solution is found. There is no other option but to shorten the rope, resulting in a shutdown, an inconvenience to users with financial implications.

Improper buffer clearance kept in an elevator invites incidents – especially where the overhead is critical – and leads to safety risks, breakdowns and damage to both people and equipment. These factors are due to incorrect clearances. To achieve a perfect predetermined clearance is difficult, considering various elongation factors, but the variation in the clearance can be limited if the above mentioned process and procedures are taken in to consideration.

Elongation or Rope Stretch

Ropes elongate due to constructional stretch, the elastic nature of the material and improper tensioning. Sometimes it also observed that in certain rope, after a period of time and number of operational cycles, in varying load conditions, rope diameter reduces abnormally due to continuing elongation.

The elongation of a particular rope is related to various factors. Most people believe that the elongation is 1% of the total length of the rope. But the question is whether it is applicable to different diameters and brands. Some manufacturers say it is 0.5%, and others 0.75%. What about the prestretched rope? The rope stretch is different for fiber core and steel core. Is there no elongation in preformed or prestretched ropes? Yes, there is, but how much? 0.2%? 0.5%? This needs to be verified.

The stretching or preforming process may be around 50% of the breaking load specified for the rope. Since there are no data readily available (at least people working at site) regarding rope stretch, it is imperative that the manufacturer provide information like breaking load, rope stretch, whether the rope is preformed or not, with the rope it supplies and that this information be made available to the site supervisor or superintendent of installation.

Uncoiling and Rope Connections

It is important to take necessary precautions while preparing for roping. The first step after positioning the car and counterweight is the uncoiling of the ropes. If the ropes are in a separate coil, the coil should be held vertically (not kept on the floor) and uncoiled by rotating the coil. If there is any kink, twist or deformities like bruising, crushing, corrosion or rusting, then the rope should not be used. Avoid releasing the rope through the drive sheave groove, especially when the building is tall. This will have a sawing effect on the rope. Avoid the rope making contact with soil and other loose particles. Any uncontrolled and careless releasing of the rope will become wild and form what looks like a disturbed cobweb that will result in the formation of bird cages. These chances are very high in preformed ropes.

While uncoiling and releasing the rope for termination, it is also important that sufficient manpower, tools and tackles be ready to guide, pull and protect the rope from any type of reverse bending, twirling or twisting. Connecting the rope at one end and hanging the entire length for some time will help in eliminating any twisting considerably. Some of the preformed or prestretched ropes have a blue stripe running down the entire length that can be used as a guide for twist control.

When uncoiling ropes from the reel, it is important to fix the reel on a pipe and support it with reel jacks that have a rotation control mechanism to arrest any uncontrolled movement of the reel. Pull and drop the rope directly into the shaft from the reel without making a further coil. Repetitive coiling will lose the rope's integrity. Before cutting, the rope should be seized at least by 10 mm width at both the ends. Ropes should be cut with a rope cutter (not a chisel and hammer).

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Though there are various methods of rope connection or termination, widely used were babbitted sockets. These days, wedge-type sockets are used by most suppliers. The babbitted sockets are very efficient provided they are soldered well by adhering to all the established practices. The process starts with seizing, checking the socket mouth for correct bore diameter, cleaning the rope strands and straightening them, keeping the required bend length and pouring the Babbitt metal in the socket at the required temperature. The loop portion or flower-bend portion shall be slightly visible after soldering is done, for inspection. If any one of the activities lacks perfection, the connection becomes weak as does the efficiency of the termination. Once terminated, inspection for quality is difficult. It also takes considerable time for any correction.

The wedge-type socket is easy to connect and also does not require much time for correction. Here again more care is needed while preparing the connection. As mentioned above, proper seizing is required to prevent the loss of lay. The rope passing around the wedge should not cause any deformity in its construction. Never hammer the loop (rope around the wedge), which will cause damage and lose the original lay or twist.

Most of the wedge-type sockets have an anti-wedge jump arrangement to prevent dislodging or disengagements of wedges from the socket. This dislodging happens when the rope gets loosened because the lift was buffered or retarded during safety action, or for other reasons. There are few sockets without this arrangement. In this case, the bulldog grip, or other forms of clip that hold the live and dead ends of the rope, should be fixed close to the mouth of the socket to stop the wedge from slipping down. In case of a pin-and-eye-bolt type, the pin end should be kept close to the wedge bottom and locked, if there is no split pin provided on the narrow side of the wedge.

Eye Bolt Connection with Bull Dog Grips

Today very few suppliers use this arrangement. Though this connection is very simple compared to other modes of connection, the efficiency of the clips reduces when the diameter of the rope decreases due to constructional stretch, elasticity and long usage. This requires periodic checking and tightening of the clips to maintain their efficiency. However, the efficiency of the clips also depends on the material used for its construction.

Equalization and Tensioning

Rope equalization and equal tensioning are different activities. Cutting and connecting all the rope in equal length without applying load on rope is the first task. Logically, after equalization, there should not be much difference in tension after loading the car and counterweight on the rope. But there will be a marginal difference

compared to the ropes which are not equalized, need more adjustment in thimble rod and sometimes cannot be even adjusted, which requires redoing.

Equalizing Ropes 2:1

After the ropes are connected at both the ends, the car support must remain intact (when the car is assembled at bottom). Crank the drive sheave slightly to lift the counterweight frame up and secure it. Do not put any fillers in the counterweight. Check and ensure the counterweight side ropes up to the main sheave have equal tension. After raising the counterweight frame, the ropes at the car side around the car sheave will become loose. Check the rope's loop for equal length. If the loops are the same for all the ropes, assume the rope lengths are correct. If any rope has gained slack, shorten it. If any rope loop is found tight, this also needs appropriate correction. Remember that whatever correction is needed, it must be done prior to loading the car and counterweights. Never allow a loaded wedge loop of rope (bend portion), when redone, to come in the live side during a lengthening process or correction.

Equalizing Ropes 1:1

The car is at bottom, the counterweight frame without fillers at the top and the rope hitched at counterweight side. The other end is connected to the car hitch. Tighten the thimble rod nut and leave it for some time. There will be an uneven gap developed in between the nut and the hitch plate (due to the partial constructional stretch, elastic stretch and rope's own weight). If the gap is the same for all the ropes, consider the ropes equal in length; if not, correct them. Next, the car and counterweight can be loaded and the rope tension can be checked after the elevator makes couple of trips.

It is proven that the incorrect tension will cause the rope to creep and slip and have grinding effect on rope and sheave, which shortens the life of rope as well as sheave. The distribution of non-uniform load on all the ropes also reduces the factor of safety.

To tension the rope, few conventional methods prevail in the industry. One of them is to press the individual rope with a finger and feel the tension. Another is to pull and leave the rope, which causes the rope to oscillate. Touch with finger to feel and count the oscillation with respect to time (vibration travel time). If the number of oscillations counted is less than other ropes, more load is on the rope. More time of oscillation indicates less tension. However, this method gives only an approximate value of tension. Tension the ropes using a rope tensioning gauge, which will give an accurate load on each rope.

These methods and other procedures are merely empirical and quoted from the field and hands-on experience, but have proven helpful. 