Mechatronics for elevator installers and drive technicians, part 10

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1 Deflection pulley and drive sheaves as the causes for poor travel characteristics

Elevator systems sometimes provide unpleasant surprises in practice in the form of very poor travel properties. Even though newer installations which are comparable in design may incorporate the latest in drive technology, many older elevators offer distinctly more comfort. The reasons for this many and varied and in most cases will be found in an unfortunate combination of several factors. Nowadays we first check the system`s electrical and/or electronic components whenever elevator travel proves to be unsatisfactory. Consequently, a later article will discuss in detail programming and parameterization for the electric drive. We will assume for the purposes of the present article that the drive system (in this case the motor and frequency inverter) has been adjusted correctly and that the interface to the external elevator controls is working perfectly. And in spite of this we find that the customer complains of oscillations and rumbling in the car, for example. There is no obvious explanation for this phenomenon. Measurements carried out with structural noise detection instruments reveal frequencies which are a function of travel speed. Often these are very low frequencies of 5 Hz and less. If we look more closely at the mechanics of the elevator, then we quickly discover the reason: The deflection pulleys are the most frequent cause of „hopping" cars and undefined vibrations. In most cases deflection pulleys are cast parts (e.g. a gray casting or plastic material). CNC machines (turning, milling, grinding, etc.) are used to impart the final dimensions and finish. In the interest of cost reduction the tool feed speeds are set quite high at these fully automatic units so that as much material as possible is removed within a short period of time. These high advancing speeds require, in turn, excessive chucking pressure. The forces exerted by the chuck and when advancing the tool tend to deform the work piece. A pulley manufactured in this way is no longer perfectly round and will inevitably induce vibrations (several periods per revolution). The vibrations are transmitted to the car through the ropes and generate a characteristic rumbling in the car (Figure 31).

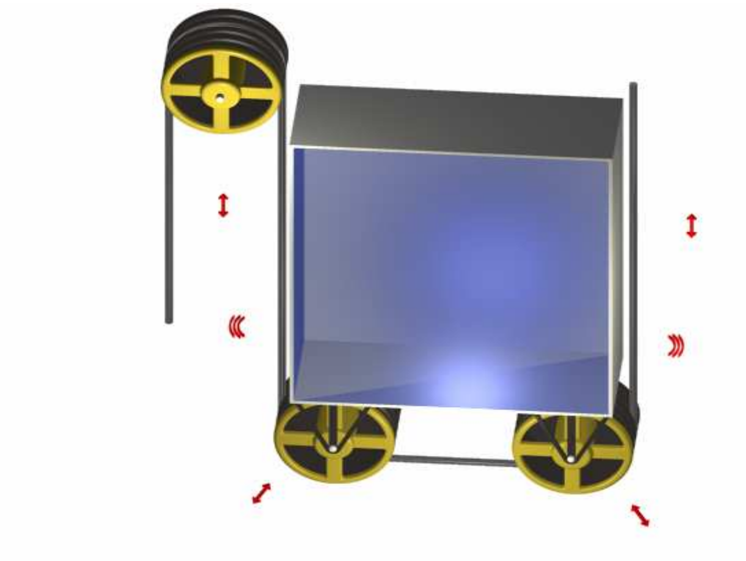

Figure 31

Equally unpleasant are those oscillations and vibrations occurring in a range of, for example, just 1 to 2 Hz. If here, once again, oscillation frequency rises proportionally to the elevator´s travel speed, then the cause may be radial run-out at the deflection pulley (Figure 32).

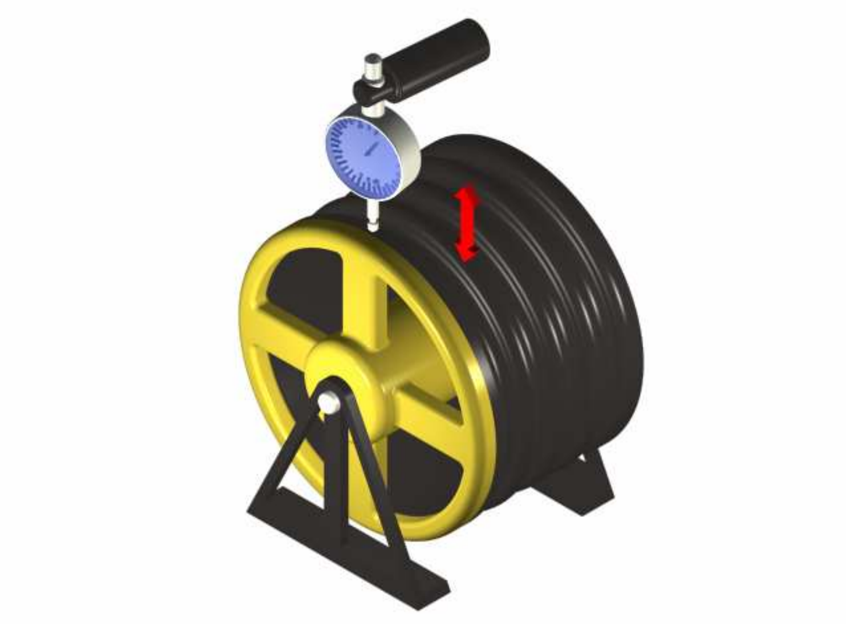

Figure 32
In some cases this is further aggravated by axial run-out and oscillations of the type just described are then joined by noise, since the ropes may very well vibrate the strings on a musical instrument (Figure 33).

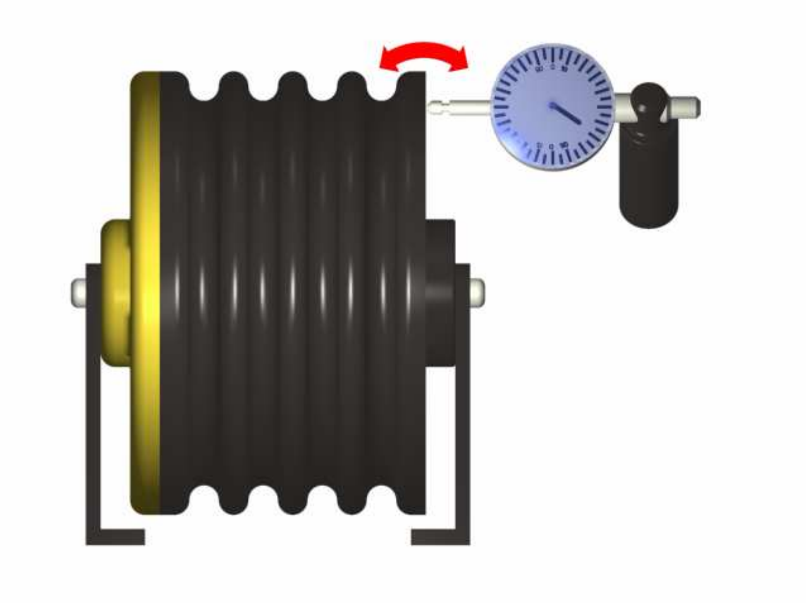

Figure 33
The reason for such phenomena at the pulley is improper machining (and most assuredly working the material too fast) on the one hand and failure to observe the resting periods prescribed for the raw material. (Before being machined, castings have to rest for a certain period of time during which internal stresses and strains can dissipate.) Quality control inspectors will not recognize at first glance that poor quality materials or poor machining techniques have been used. Here is a helpful hint: mount the pulley so that it can rotate freely on a shaft. Measure the radial and axial run-out; good pulleys and sheaves exhibit accuracy of +/- 0.01 mm (measured at the flanks of the groove). Values exceeding +/- 0.03 mm need not be accepted. Return such goods to the manufacturer; your elevator owner will be grateful.

2 Ropes, weight detection devices and compensation springs as causes for poor travel characteristics

Once you have examined the pulleys and drive sheave (and replaced them, if indicated), the lift should run perfectly without any vibration or rumbling. If in spite of all this discernible vibration continues to be present in the car and, in addition, this vibration does not seem to be directly related to travel speed, then we are dealing with resonance at a sprung mass. As a rule this will be an actual physical spring which is used either to equalize the loads on individual ropes or to implement mechanical load measurement (Figure 34). In the worst case this may induce resonance in the elevator system, which then results in unpleasant oscillations.

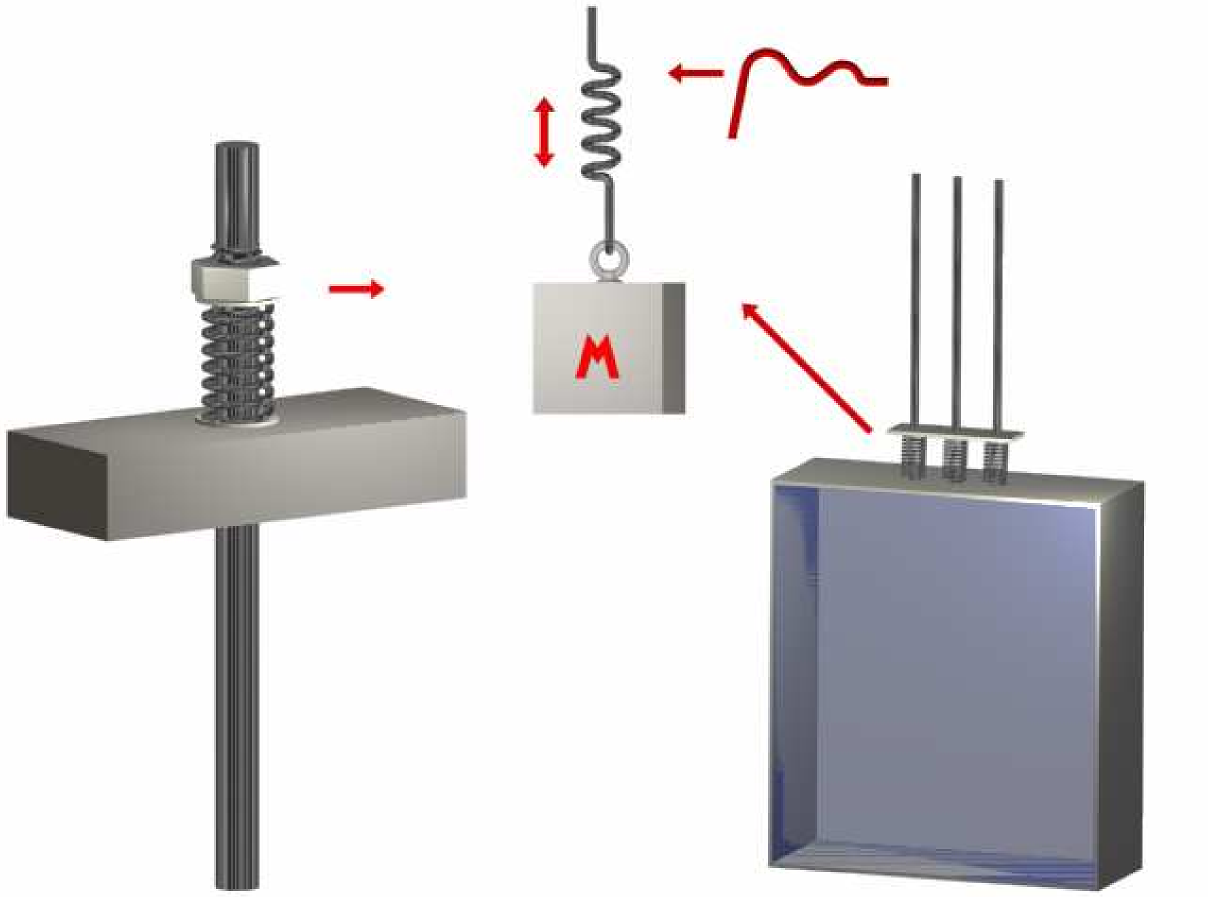

Figure 34

It is usually possible to suppress oscillations in such cases by changing out the spring (e.g. replacing it with one exhibiting „harder" response properties) and thus shifting the resonance point. Load measurement systems based on detecting linear displacement in a sprung system should no longer be used at all. Good electronic systems employ strain gauges which are, for example, integrated into the cable clamps, thus doing away with sprung systems entirely.

The final potential culprit in a lift which tends to oscillate during travel is great ascent height in conjunction with unsuitable ropes.

In this case the ropes themselves represent the spring in the system. The elevator rope´s natural elasticity can exhibit a time constant which is so unfavourable that once again a configuration capable of oscillation is created. The ropes cause the car itself – and the counterweight, as well – to oscillate. Suppressing this phenomenon is relatively difficult although using the „hardest" ropes possible will tend to counteract this effect. Putting compensating ropes under tension also effectively damps oscillations but this remedy is costly.

Where vacant grooves are available at the sheave improvements may in some cases be achieved by installing additional ropes. The best approach, however, is to try out a different rope design. Something which was standard practice in the past which is seldom seen today is installing ropes with alternating directions of twist. This will neutralize any tendency to a preferred direction of torsion and rotation, making more uniform the loading on the rope drives.
Very long ropes act like rubber bands (Figure 35). Further aggravating the situation is the fact that wide temperature fluctuations will also have a major effect on rope resonance. In addition, the importance of selecting the car´s weight and the rope design correctly should not be underestimated.

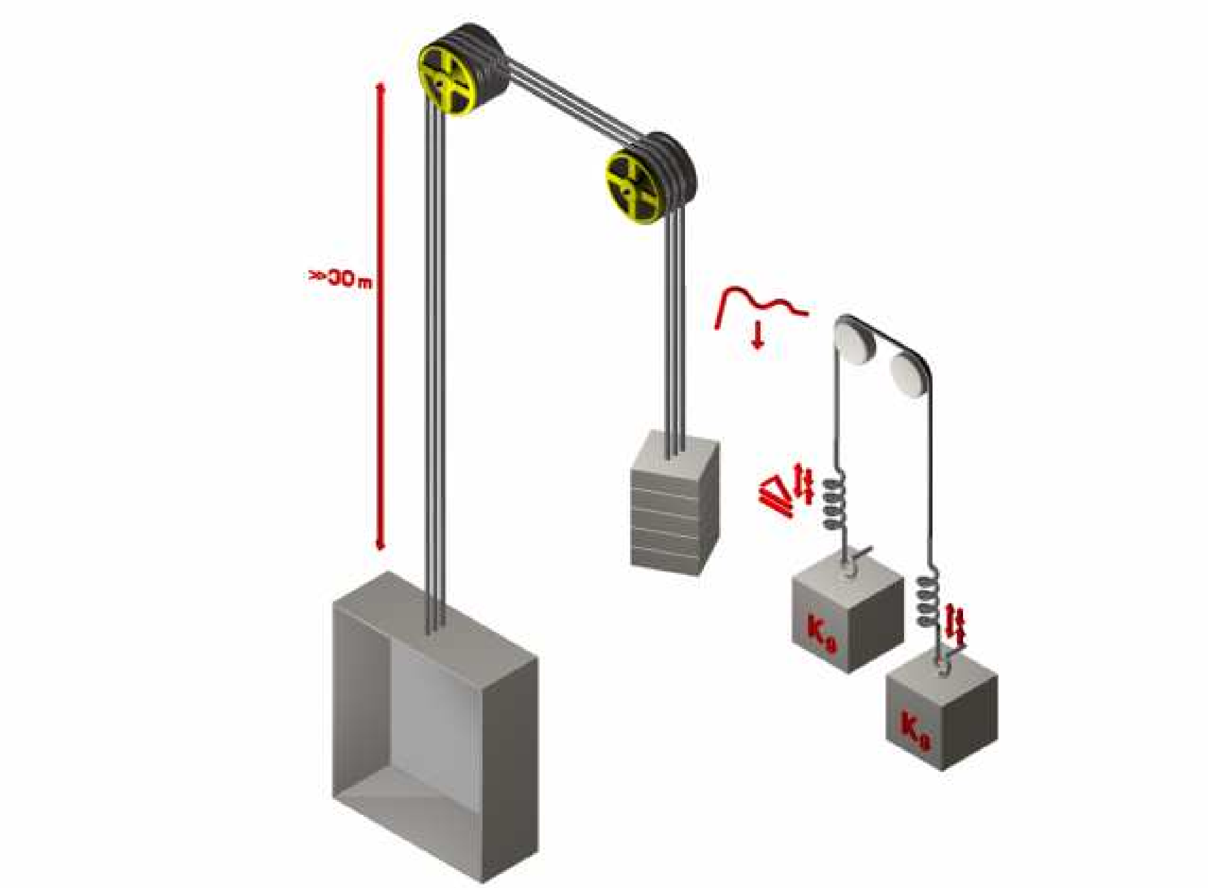

Figure 35