Vibration

Vibration, or rope chatter, is a leading cause of early rope wear and deterioration. Most complaints regarding "noisy ropes" occur very quickly after the ropes have been installed, and can be found in all types of equipment, reeving and groove configurations. Rope chatter may intensify at various speeds, and will be emitted throughout the elevator system. There may not be any complaints from riders, but complaints can be expected from the building manager.

Sheave-related Causes

Rope-to-Groove Mismatch

The most common reason for vibration is a size differential between rope and groove. New ropes are manufactured to a defined oversize diameter tolerance. For example, Bethlehem Wire Rope® on-tension diameter readings for new rope range between 0% and 3% oversize. Unfortunately, the grooves in which new ropes operate may not have been checked and regrooved prior to rope installation. If the previous set of rope was retired for minimum diameter readings, the grooves, now worn to the rope's diameter, can be up to 8% below nominal. This creates a substantial mismatch in rope-to-groove size. As the drive rotates, operating pressures force the rope into the groove, causing the snapping or chattering sound. Not only does this prematurely wear the rope, it also "reworks" the groove. The result, along with noise, is shorter rope and sheave life, and the telltale metallic dust buildup on the ropes, grooves and machine room floor.

To inspect for this problem, use a groove gauge to measure all the grooves, including the secondary if applicable. Based on the actual rope diameters, it may be necessary to rework or possibly replace the sheaves. Where chatter is present but not excessive, a light application of field dressing may allow the rope to "fit" more quickly into the groove. This is not to say, however, that new ropes need an application of field dressing. In this example, field dressing is lightly applied only to quiet the rope in question. Contact the wire rope manufacturer before applying any lubricant on newly installed ropes. It should be noted that an 8x19 construction rope is less likely than a 6x25 rope to chatter because it has more of a tendency (due to less metallic area) to squeeze into the worn groove.

Differential Groove Depths

Another cause of vibration can be attributed to differential groove depths. When a groove is worn, the rope in that particular groove travels over a slightly smaller radius than it would if the groove were closer to nominal. Naturally, the greater the groove wear, the smaller the radius as the rope wears closer to the center of the sheave. This becomes an issue when ropes, fixed at both ends, are used in a set. When one rope in a set operates over a slightly smaller radius in a worn groove, the other ropes must travel a greater distance to "catch-up" to the first rope. The "catch-up" is what causes snapping, popping, chattering and/or vibration. Even a small difference in groove depths will create this condition. Consider this one groove is worn only 1/16" below the other grooves. A deviation of 1/16" on a 24" diameter sheave calculates to a difference in rope travel of 3/16" for each rotation, or 0.26% between ropes. If the length of the ropes is 500 feet, the variation in travel between ropes is 15.6 inches. Imagine the chaos if all of the grooves are machined to varying depths. The ropes may eventually balance out, however, where and how they balance out may be reflected in unusual rope movement at the end of the hoist cycle, and certainly seen in shortened service life.

The best way to check for differential groove depths is with a straight-edge placed on top of the rope surfaces at the drive sheave. If the straight-edge does not contact all of the ropes, unequal groove depth is indicated. Where ropes are seated into the grooves so that using a straight-edge is impractical, a depth gauge or some other similar device can be used. The intent is to determine not only if differential groove depths exist, but to what degree.

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Vibration

Most of the elevator OEM's dictate the amount of groove depth allowed per type of groove and system. In addition, ASME A17.1-2004 Paragraph 2.25.1.1(c) states "Prior to regrooving any sheave or drum, check that the minimum groove button diameter will be maintained for structural integrity. For elevators installed under A17.1d-1986 and later editions, the sheave or drum must be marked to indicate the permissible groove bottom diameter." The concern with regrooving too often is the potential to machine away the hardened steel, exposing the softer steel beneath the surface. As the rope wears into the sheave, the remaining hardness of the groove may vary, causing accelerated wear and deterioration of both rope and sheave. Further information on this is addressed in Bethlehem Elevator Rope Technical Bulletin 7, *Traction Sheave Hardness*.

Harmonics

In some cases, vibration is the result of the rope's natural harmonics as it operates between the drive sheave and the secondary. A change in distance between the sheaves, if possible, alters the frequency and amplitude and can quite possibly reduce or eliminate the vibration.

Other Causes

Rope Stretch

On high rise, high speed equipment, vibration can come from another source. As discussed in the Bethlehem Wire Rope® Elevator Catalog, wire rope is an elastic member and is subjected to various elements of stretch – constructional, elastic, and dynamic. Constructional and elastic stretch values are well documented. Stretch due to dynamic load changes, however, is not as readily defined or understood. When a high speed car accelerates and decelerates, the changes in the dynamic loading can be quite significant. The acceleration stress is influenced by the suspended weight, rope weight, car acceleration, maximum speed and period of acceleration. Not only will this phenomenon be seen in the rope stretch, but also exhibited by the snapping and chatter between ropes and grooves.

Mechanical Issues

There are also many installation and mechanical issues in the elevator system which can cause the ropes to vibrate. Several of these include sheave misalignment, unequal rope tensioning, and bad sheave bearings. There may be misalignment in the rail guides which causes a "bump" every time the rollers pass over this area. Electrical or motor issues may also be contributing to an inconsistent motion that will be transferred to the hoist ropes.

Conclusion

When vibration occurs, the culprit is always perceived to be the ropes. There have been many cases in which new ropes were replaced, only to discover the problem still existed. Vibration is rarely caused by wire rope; rope chatter is merely a symptom of a larger issue. The majority of vibration complaints occur as a result of some type of problem with the sheaves.

WW cannot stress enough the importance of checking the sheaves before reroping a car. An expression frequently used in business is "pay me now, or pay me later." But where sheaves are concerned, it is not an equal trade-off. If bad sheaves are present, an inordinate amount of time and money will be spent investigating the problem, handling complaints, replacing parts, and the like. And nothing gets the building tenants' attention faster than rope chatter! Service contracts cannot be profitable if sheaves are not properly maintained. A simple check of the sheaves before installation may make the difference!

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