Condition Monitoring for Elevators – An Overview

Tim Ebeling

Introduction

Condition monitoring for elevators, developed to support maintenance work, in the past was limited to reading out error memories at the elevator controls themselves – and occasionally at drive units. Here, every manufacturer pursues a separate concept.

Sensors intended to register wear in the system are currently used, if at all, only as portable systems. These can be employed during spot checks to determine the car's acceleration properties, noise emissions and rope tensions. These measured values are made available as raw data, without analysis or comments.

In the past, maintenance work was carried out at prescribed, fixed intervals. Systems such as those described above are being used in initial trials with the intention of making the transition to status-oriented or even proactive maintenance.

Initial situation

Current maintenance strategies for elevators

The maintenance concept used most frequently for elevators, all around the world, is a combination of reactive, preventive and – at least to a limited extent – status-oriented maintenance. Preventive maintenance for elevators is carried out at specified intervals. Service technicians will perform work to delay the exhaustion of wear reserves, either at fixed times or after a certain number of trips has been executed. They will top up gear lube, grease guide rails etc. At the same time, they will usually examine the wear at certain elevator components – the guide shoes or brake pads, for instance. The latter is in fact an initial, elementary approach to status-oriented maintenance. The available information (e. g. data on wear and tear) is used to determine when components are to be replaced in the future in order to prevent unintended system failure or a safety-critical situation.

Condition monitoring

In many industries today, condition monitoring is one of the cornerstones for efficient operation and maintenance of technical equipment. This concept is based on regular and continuous registration of the status of the machinery, done by measuring and analyzing pertinent physical magnitudes. The technological developments in sensor technology, tribology and microprocessor technology have resulted in information never before seen in terms of the amount and quality. That information can be used today for maintaining production machinery. Industrial operations without conditioning monitoring are virtually inconceivable and can be seen as the indispensable prerequisite for status-oriented or proactive maintenance.

The more comprehensive the maintenance strategy is and the greater the expectations for that strategy, the more pronounced will be the significance of condition monitoring.

In the pursuit of maximum possible system efficiency, conditioning monitoring can provide support in a number of different ways, namely

- by improving system stability and failure-resistance on the basis of effective prediction (and avoidance) of defects,
- by minimizing downtimes on the basis of integrated planning for repair work as indicated by condition monitoring,
- by maximizing the service lives of components by avoiding circumstances that would shorten those service lives, and
- by virtually complete utilization of the components' wear reserves, thus cutting costs.

Condition monitoring is composed of three sub-steps, namely

1. acquiring the status, i.e. the measurement and documentation of relevant machine parameters which reflect the current status of the machine,
2. comparing states, which involves a comparison of the current state with a prescribed reference value (this usually being determined empirically as the complexity of the system increases) and
3. diagnosis, which uses the status comparison to identify, as early as possible, any faults which may be present and to ascertain their causes.

Condition monitoring for elevators

Even for the first sub-step in condition monitoring, i.e. status acquisition, there are hardly any measurement systems being marketed for elevators today. Some ride quality measurement systems as per ISO 18738 – such as the EVA System[1] or the LiftPC-System[2] – are available, but these are only for intermittent surveillance of vibration and noise. Thus it is possible, for example, to acquire information on the status of the elevator on the inspection dates. Comparing data at subsequent inspections could suggest certain long-term developments. Brief or transient events would not be detected, however, and correlation with other data – such as loading situation, temperature etc. – is difficult to achieve.

Continuous monitoring that constantly records physical parameters in the lift, in real time, would document both long-term trends and erratic or transient changes in status. Subsequent status comparisons using diagnosis algorithms could then draw upon an extensive data warehouse and generate recommendations for maintenance work.

Pilot project for condition monitoring at elevators

It was as early as 2004 that the Henning Company installed prototypes of an elevator condition monitoring system on eleven lifts at a chemical company. Used there, in addition to accelerometers and vibration sensors, were detectors to monitor drive sheave rotation speed, to record the current ascent height, to ascertain the overall car loading level, and to determine tensions in the individual suspension ropes. The measurement data were evaluated using an industrial PC located right at the elevator. The evaluation results were sent via remote data transmission to a central location. The main component of the condition monitoring systems – a sensor for vibration and acceleration – was mounted directly on the car roof. In this location it could record both the car's travel direction and information on the car guides, door motions and indirectly, through the suspension ropes, the behavior of the drive, as well.

The data acquired by all the sensors are converted into specific characteristic values for each trip and examined for violations of limit values. Then the characteristic values for all the trips on a given day are summarized to form a statistical mean value. This mean value, derived in each case from several hundred trips per day, is used for trend surveillance purposes. Thus the two examples that follow chart the trend over several days. These might be based on thousands of trips.

At the begin of the recording period, depicted in Figure 1, the sliding guides on the car were already worn. These were replaced on March 11, 2004. It is easy to see that vibration along the X axis (perpendicular to the distance between the two guide rails) drops immediately. Vibration parallel to that plane increases, by contrast, before it drops back to the original value, after about twenty-five days. The behavior of the vibration in the Y axis can be explained by the fact that the distance

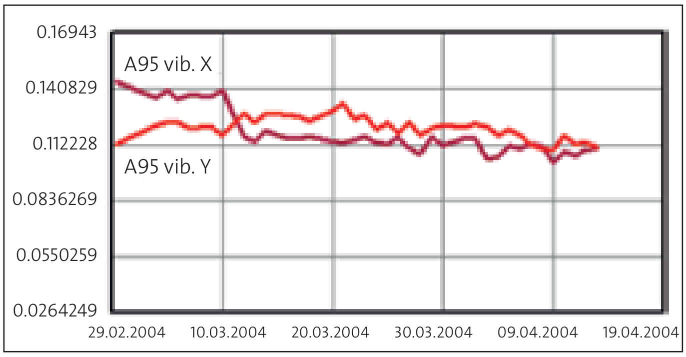

Fig. 1: Elevator car vibration along both horizontal axes. The replacement of the car's guides on March 11 can clearly be seen.

between the rails is not absolutely uniform along the full height of the elevator. The new guides first have to be "run in" along this axis. It is easy to use the graph shown to determine a limit value for vibration along the X axis. The elevator may not violate this value and, if this does happen, then a maintenance recommendation for the guide shoes will be triggered.

The second example (Fig. 2) shows four characteristic vibration values for door motions. Quite striking here is the period

1) www.pmtvib.com
2) www.henning-gmbh.de