EXPERIENCE WITH ROPE BRAKES

R.Deimann
Bode, Fichenstr 66, D-4000 Duesseldorf, Germany

INTRODUCTION

I am pleased that I have been given the opportunity to hold a modest paper today on practical experience with a safety device for elevators whose major components deviate from the long-established facilities: the so-called rope brake which was invented here in The Netherlands over 40 years ago.

At the time of Elisha Otis, who presented the first safety gear for elevators in the Crystal Palace in New York in 1853, consideration was only given to the fact that an elevator car could drop, that is to say fall downwards. As a rule the suspension ropes at that time were wound and unwound on drums and made of sisal hemp. It frequently happened that owing to their vegetable origin these ropes exerted an irresistible attraction to rats and mice and were eaten by them;

the elevator car fell down the shaft after the ropes had broken.

The introduction of the traction sheave and steel wire ropes created completely new conditions. Owing to the considerably heavier counterweight - as a rule elevator car weight plus half the useful load - the car was drawn upwards by the counterweight with the intact ropes in the event of breakage of the drive mechanism. The quality of the steel wire ropes continued to improve and nowadays there is absolutely no doubt that under certain conditions it can be assumed that the suspension ropes will no longer break, which means that rope breakage can no longer be the cause of a fall.

Naturally, the old safety gear of Elisha Otis also changed, it was in fact merely a slack-rope facility. In emergencies the elevator car was brought to a standstill with wedges, rollers, eccentrics, catching grips or similar devices owing to their clamping action on the rails.

There was still always the fear that the suspension ropes could indeed break and that the car would fall.

However, at the same time it had to be expected that the travel speed would exceed the admissible limits when other faults, such as gear reducer damage, breakage of the drive shaft or some other reason, were the cause of this.

Now we all know that the conventional safety gear attached to the elevator car is merely intended to brake a fall but not when the car "falls upwards".

In order to monitor both conditions, a second safety gear can, of course, be installed with a second speed limiter etc. on the counterweight.

Some years ago here in Holland thorough experiments were conducted on safety gears at the Lift Institute. In view of the extremely poor results - out of 20 safety gears only one functioned satisfactorily - the question was raised at the Duyvis machine factory, which at the time was also involved in the manufacture of elevators, as to what could be done to create real improvements.

Mr. Nederbragt, the former technical director of this company, hit on the idea of braking the car directly on the suspension ropes when it fell either down or up.

The idea of the rope brake was born!

THE ROPE BRAKE

In the early days attempts were still made to apply the brake with spring action and thus clamp the suspension ropes between two brake linings. This could be achieved but the spiral springs required for this took on oversized dimensions and were difficult to open again. Disc springs were automatically out of the question because they were difficult to adjust and after every emergency braking would have had to have been reset.

The idea to use compressed air to apply the brake was obvious as this force is always available, can be calculated and had been used on the Duyvis elevators for some time to open and close the doors.

So Mr. Nederbragt began to design the first rope brake.

It involved a fixed plate and a movable plate which were provided with special linings and the suspension ropes of the elevator ran between them. The ropes could be clamped by means of an eccentric device which was activated by a compressed air cylinder arranged vertically beneath it.

Later on they went over to dispensing with the eccentric and used a pressure cylinder instead accommodating a sealed piston which in turn pressed a steel plate with a brake lining against the ropes, thus pressing them against a fixed brake plate.

There are now over 400 elevators in the Netherlands which have this kind of safety device without having one of the conventional safety gears.

For the question was raised as to what was the point in having a normal safety gear when rope breakage was no longer expected with a minimum safety factor of 14 and at least 4 ropes.

Mr. Nederbragt has now retired and his former company has discontinued production of elevators because they have concentrated on selling other high-precision machinery which enjoys a reputation of high quality all over the world.

What should become of the now long-established rope brake?

What Mr. Nederbragt needed to continue production of this device was a small independent company which was willing to work with him.

And so finally he found me through Mr. Kollmorgen, the owner of a reputable company producing elevator controls.

My company was founded by my grandfather in 1919, which means that we are now in the third generation and involved in the manufacture and distribution of safety gears for elevators, for the most part speed limiters.

Our cooperation began on 22nd September 1987.

IMPLEMENTATION

Although the working principle was retained, there was a lot to change. The brake linings had to be free of asbestos and an electronic control was intended to offer the rope brake more possibilities than before. In addition to overspeed downwards and upwards, the brake now also monitors uncontrolled slow motions when the doors are open. Should the elevator car start to move without a travel command being given or slowly slip away when the doors are open, the rope brake closes after a short distance of about 10 cm and stops the elevator car.

In the case of goods elevators which are loaded with fork-lift trucks, the car can, on request, be held at each stop by a rope brake in order to prevent it from falling as a result of the additional weight of the fork-lift truck.

When the doors close, the brake is released again. However, this set-up is only required in exceptional cases.

It so happened that a Dutch chemicals company demanded the rope brake instead of the conventional safety gear because the rope brake did not produce any sparks in an emergency, that is to say during deceleration from overspeed upwards or downwards, as the elevator was to be installed entirely in explosion-proof design. It was feared that in spite of the many explosion-proof switches in the shaft and machine room sparks could still be produced by the standard safety gear on the rails.

A steel company of international repute insisted on installing the rope brake and dispensing with the safety gear on certain elevator installations where severe contamination of the rails was unavoidable. It had been shown that this dirt and grease on the rails frequently triggered the safety gear unintentionally at normal travel speed.

The day of the very first meeting between Mr. Nederbragt and my company resulted in very close cooperation.

TESTING

Many tests have been conducted and expert reports compiled, for example by the TNO at the University of Technology in Delft, the German Technical Supervisory Association (TÜV) which was present in Delft, the Department of Labor and Industry and the Department of Environmental Resources in the USA etc.

I will never forget the first test which Mr. Nederbragt and I had conducted at the well-known Dover company in Toronto. The brake was installed on a variable-speed elevator in Dover's test tower. The first braking operation produced a lot of dust from the brake linings which, of course, had no preformed grooves as we, the manufacturers, did not know exactly in advance where the ropes would run. That is why the ropes form their own grooves during the first 10 braking operations. We were able to calm the observers for the brake dust no longer contains any asbestos. After further tests the grooves in the linings had reached a certain depth and from then on did not increase. For as they become wider, the surface pressure falls.

Then the inevitable question arose: What happens to the ropes?

In fact the ropes of the elevator in Toronto exhibited small flat areas. However, we were able to very quickly prove that these markings did not originate from the rope brake but from the traction sheave itself.

Probably the most extreme tests were conducted on a mine elevator in Pittsburg in the USA.

There had been difficulties with the elevator there and it was going to be shut down by the department responsible. My partner today in the USA, Mr. Raymond Gielarowski, came immediately to Düsseldorf to obtain information about our BODE brake.

14 days later he had installed the first large rope brake, the so-called 580, sufficient for a capacity of 5,000 kg.

From then on, at the demand of the American authorities, the test had to be performed every 4 hours round the clock every day for one month. In addition, tests with overspeed downwards and 25% overload were conducted.
The empty elevator car was sent up a 100 m shaft from the bottom with the machine brake open. The operating speed was 3.0 m/sec. When it reached the overspeed preset in the control electronics of the brake, the rope brake closed and the car came to a standstill.

The compressor was switched off and the pressure in the air storage tank reduced to a minimum. The braking distance was then greater but the speed fell significantly.

Then they wanted to know what would happen with a leak in the brake. Air was fed into the cylinder which could no longer escape owing to a non-return valve which had been added. Then the air line was disconnected. After one hour no major loss of air was detected.

Altogether more than 153,000 tests were conducted in the USA with this one brake! Subsequently, we obtained our approval from the departments responsible.

That was in 1989. Today we can say that the new version of the rope brake, the so-called BODE brake, Nederbragt system, is fully refined. In recent years we have improved the electronic control. It no longer needs to be set by us at the works according to the customer's specifications but this can be performed on site by a mechanic. For this purpose the empty car is sent to the top and on reaching the operating speed you merely press 2 buttons inside the control box simultaneously. With this "teach-in" facility the speed sets itself automatically to 7% above the actual travel speed. So the customer does not even need to specify the operating speed when he orders a brake from us. All we need to know is the useful load as well as the equilibrium of the elevator car and counterweight as well as a few other details, such as rope spacing, number and diameter of the suspension ropes etc.

It goes without saying that every BODE rope brake is subjected to a pressure test before dispatch.
We believe that the introduction of this new safety system, although it is well-known and time-tested in the Netherlands, makes an important contribution towards preventing accidents in elevator installations especially as different criteria than before now apply following the introduction of product liability obligations in Europe.