National Association of Lift Makers

NALM

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Director D M Fazakerley

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To: All Members

cc: The Quality and Technical Committee (1477)

16 March 1992

Dear Sir,

Sheave Shaft Cracks due to Fatigue

I enclose a letter dated 13th March from Schindler Ltd and a translation of an article from the German journal 'Lift Report'.

Would members please take due note of the content which I trust will prove self-explanatory.

Yours faithfully,

D M Fazakerley
Director

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Date

13th March 1992

Our Ref

KAL/SC553

Mr D Fazakerley
NALM
33/34 Devonshire Street
London W1N 1RF

Dear Sir

Re: SHEAVE SHAFT CRACKS DUE TO FATIGUE

Because of the considerable risks involved we believe we should draw the attention of members to an article which was published recently in the German "Lift Report" magazine (translation enclosed).

The article points out the dangers which can result from cracks or breakage of elevator sheave shafts due to fatigue, particularly if the sheave shaft has an outer bearing.

The article also points out that the state of the art ultrasonic measurement is the most reliable method for detecting a crack in a sheave shaft before breakage occurs.

We have successfully applied the method over a considerable time to all lifts maintained by us, independent of the manufacturing origin as part of our Quality Programme and can recommend to members the usefulness of the tests.

We therefore advise them to consult a qualified institution for "non destructive testing of material" should they wish. We shall also be glad to share our experience of this method with any member contemplating similar tests.

Yours faithfully

K A Lindus
Managing Director

Enc

NALM

STA/0371

Translation
From the German Magazine "Lift-Report" No. 4/1990

ULTRASONIC TEST ON SHAFTS AND AXLES

Summary

Many factors stemming from various areas such as design, assembly, maintenance, use, and so on, can lead to overstress of the sheave shaft - especially if several factors are combined and particularly on the older roped lifts. Cracks may occur as a consequence of "continuous fatigue", and with continued development of the process - a break of the sheave shaft. According to present knowledge, in certain borderline cases, the dangers of such a break cannot be avoided by any of the usually existing safety devices - even with the very best maintenance. In individual cases, therefore, the possibility of an accident is not to be excluded. A preventive symptom test appears to be called for, in view of the potential consequences of such a fatigue break. Through systematic checking of the sheave shafts by means of ultrasonic tests, any cracks can nevertheless be discovered long before a shaft breaks - for whatever the reason. Elimination of the causes can afterwards be carried out specifically.

Ultrasonically tested material

Ultrasonic tests are undertaken nowadays on very many objects to ensure quality and safety, i.e. to avoid injury to persons and damage to material. Raw materials and semi-finished products (such as mouldings, wrought iron pieces and welding seams, etc.) are examined before or after production for their quality. Periodic ultrasonic testing is carried out on finished objects to ensure safety in operation (e.g. pressure chambers and compressed-air piping, railway axles, aircraft components, etc.).

Symptoms of fatigue in lift components

Lifts are the safest means of transport. However, in spite of systematic, regular maintenance, during the lifts' long "lifespan" (20 years or more, with millions of ascents and descents) invisible fatigue symptoms may occur, e.g. a wire breakage in the internal lift rope or cracks in the welding seams of the car's suspension elements. In the event of such an element breaking, the "safeties" would still prevent the car from crashing and thereby no injury would be caused to persons or material.

Material breaks with safety risk

Far more critical is a fatigue break of the lift's sheave shaft, and particularly when the shaft side-fin (detached by the break), inclusive of the traction sheave, can continue to rotate freely. The illustration shows one example of such break possibilities. The mechanical brake on the drive can only firmly brake the motor and the "left" side-fin of the shaft, while the "right" side-fin - inclusive of the traction sheave -can virtually rotate quite freely. However, depending on the location of the break, it will be supported by one or two bearings. Depending on the load ratio of the counterweight and the car, the car may then speed up or down, uncontrolled.

Danger occurrence of a sheave shaft break

The following accidents are conceivable in uncontrolled motion of the lift car: If the fatigue break of the sheave shaft happens during a regular car motion, a heavily laden car - even if previously ascending - would descend with accelerating speed until the "safeties" would brake it because of excessive speed. In this case there is no danger. In a lightly laden car, the car would move with accelerating speed upwards - even if previously descending - and it would strike the liftshaft ceiling at excessive speed. This could gravely injure the passengers. This case has been fully documented (1). According to the regulations, the conventional safeties does not and may not work in the ascents! Therefore, only a second safety device on the counterweight would prevent such an impact.

If the fatigue break of the sheave shaft occurs either when the car is stationary or when the car and hoistway doors are open during passengers' entry or departure, as the car moves off, the passengers might well be clamped in and injured.

Possible causes for overstressing of the sheave shaft

The continual oscillating stability of a sheave shaft is diminished, or may be reduced to such an extent that it could lead to a fatigue break. In the manufacture of the sheave shaft, for example, inadequate dimensioning, unsuitable or faulty material, as well as in the forming (sharp edged small radius diameter chamges, sharp grooves in the wedge rails) could be sources of the fault. During transport or on the building site the shaft may have become bent or notched. Furthermore, the "third bearing", due to assembly faults (e.g. unfirm foundations, construction shrinkage) may not be aligned with the main bearings (see illustration). Apart from these factors, the lift may simply be overloaded. The car platform is so large in the older type of lifts that more people than are actually allowed have room. Or it could be that later additions have been mounted to the lift, such as car doors, wall coverings, mirrors or marble floors, etc. From the quoted literature it can be seen that the problem of shaft break is not specific to certain companies.

Prevention through ultrasonic checks

Naturally, the above mentioned dangers or even accidents do not happen very frequently. Even so, in Germany alone there are up to ten cases of "uncontrolled ascending movement of the lift car" registered every year (2). Through systematic control of the sheave shafts by ultrasonic means, in particular for older lifts with external bearings (see illustration), these cases too could be prevented with relatively low expenditure. The ultrasonic examination applied from both ends of the sheave shaft, for example, shows up even small cracks from about 2 mm in depth, so that in conventional sheave shafts (more than 50 mm thick) action can be taken long before there is a fatigue break. In our experience, the actual examination time for a lift unit, without travelling time, is about 30 minutes.

We believe it is important that a ultrasonic device is used that records in writing the test results in the simplest manner, giving date and time. For this, the USD 10 microprocessor-controlled ultrasonic dialogue device has proved its value. Digitalized examination results are available via normal interfaces for data processing or for direct documentation.

Procedures when cracks or other irregularities are established

If a crack, a cavity or an occlusion is established in the sheave shaft, the lift must be put out of operation immediately for safety reasons, and the cause of the defect clarified. A recalculation of the "continual oscillating stability of the sheave shaft", with the possible fitting of a reinforced shaft is also to be considered. The lift should naturally only be put back into operation after all the weak points have been eliminated after another inspection by TüV.

Literature References:

(1) J.A. Nederbragt: Uncontrolled speed up and down -is it necessary to consider free-fall?" ("Elevator World", December 1985)

(2) V.d. TÜV (German Technical Supervision Association): Lift accidents from 1982 to 1986 ("Lift Report", Issue No.4, 1988)

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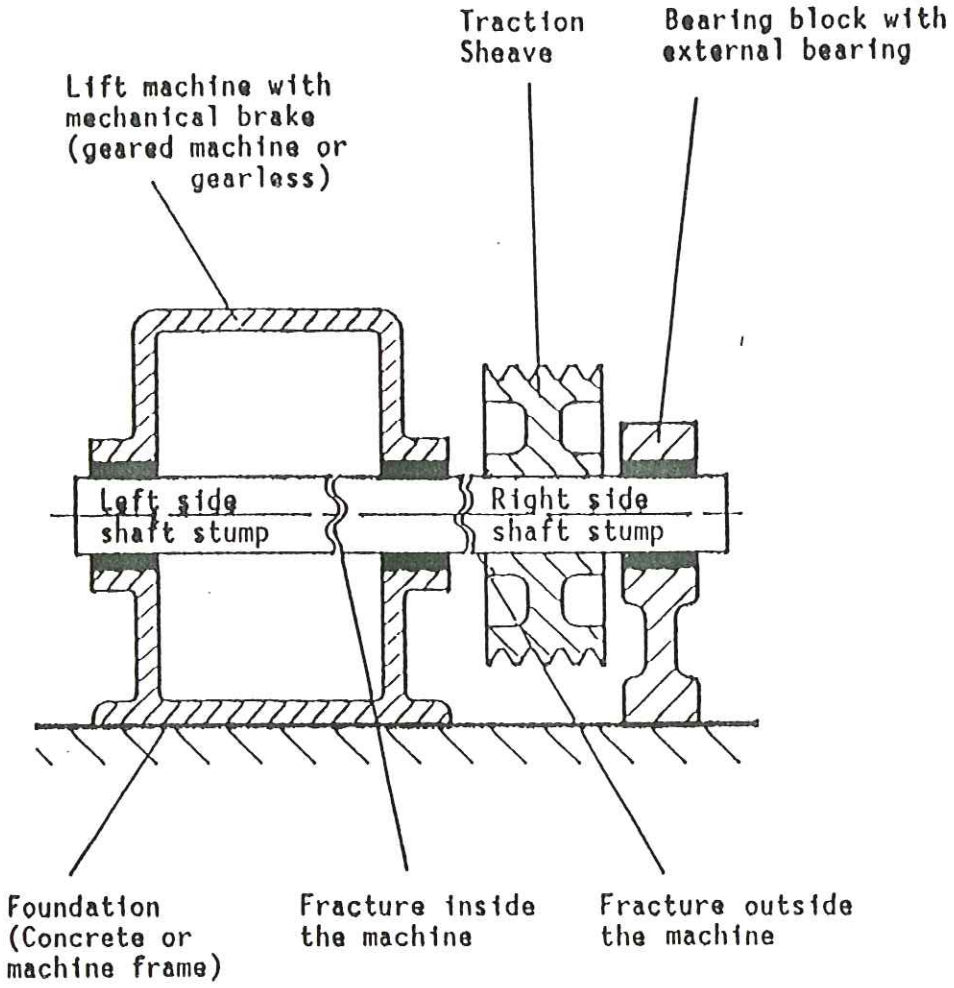
Traction
Sheave
Bearing block with
external bearing
Lift machine with
mechanical brake
(geared machine or
gearless)
Left side
shaft stump
Right side
shaft stump
Foundation
(Concrete or
machine frame)
Fracture inside
the machine
Fracture outside
the machine