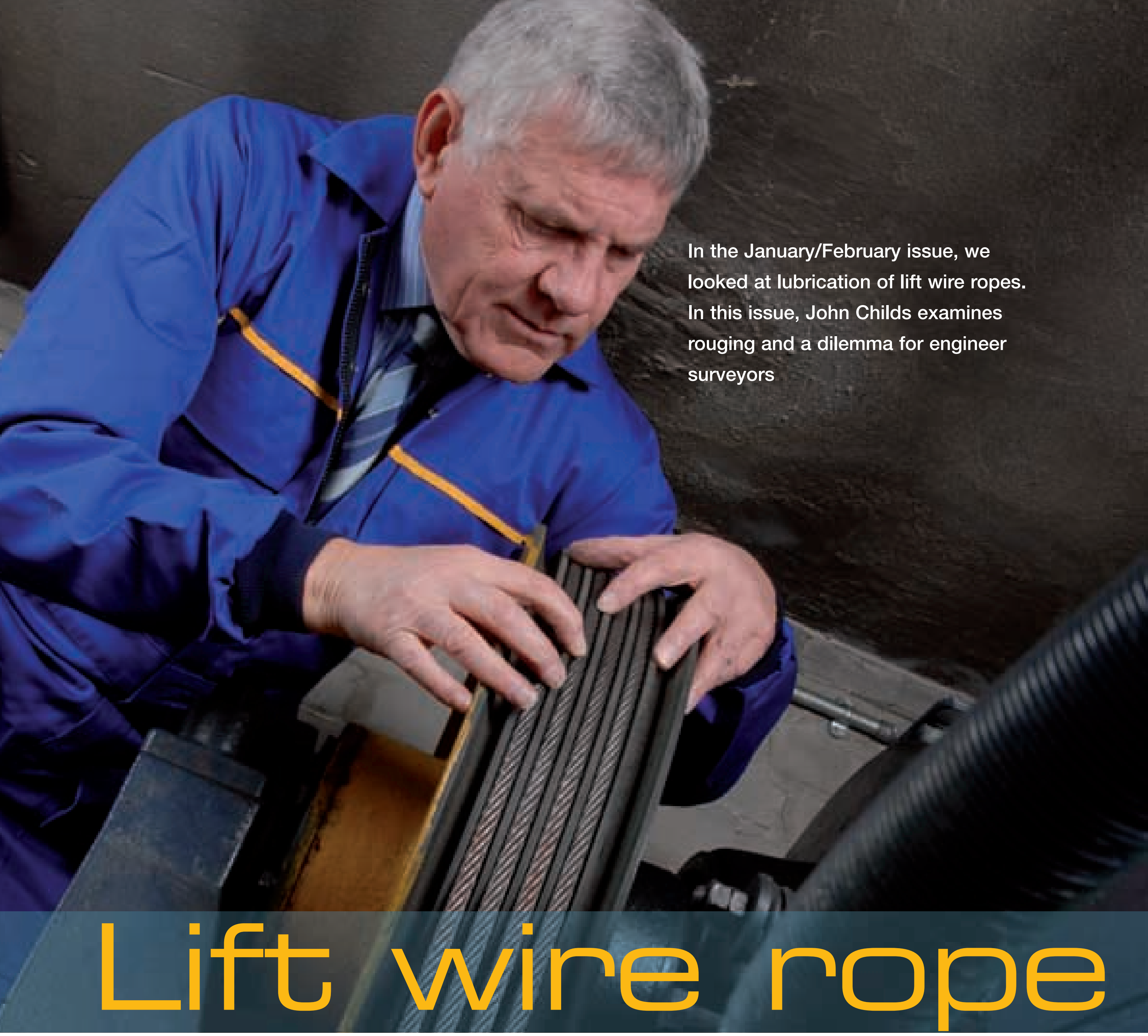

Lift wire rope

In the January/February issue, we looked at lubrication of lift wire ropes. In this issue, John Childs examines rouging and a dilemma for engineer surveyors

Under instruction, and on making almost my first thorough examinations of lifts, I recall how my instructors stressed the importance of looking for 'rouging' between the strands of the wire ropes. Research soon showed that rouging was the lift industry term for the debris that exudes from within a working wire rope – in fact, corrosion fretting caused by two or more wires rubbing against each other, under varying loads.

Since the effect of internal corrosion is hard to quantify, we were regularly reminded to be vigilant in looking for corrosion fretting. The rule was clear: call for immediate replacement, if tell-tale rouge signs were seen, even if this was the only visible defect.

No doubt, several sets of wire ropes were removed from lifts on this basis – and there were occasional complaints from lift owners (or maintainers, if they were responsible for the bill) that, once removed, little or no evidence of deterioration could be seen. Many engineer surveyors will recall the experience of having to explain the issue when faced with a few hundred metres of 'failed' lift ropes snaking across an office car park and an irate owner demanding: 'where's the problem?'.

For most, it was only short sections that resulted in the decision, but owners expected to see broken wire ends like a hedgehog's back, kinks as full as reverse bends or rope diameters reduced by 50%. Many wanted to see rust in handfuls before parting with money. And, whatever the condition, owners invariably referenced wire rope life expectancy cited in standards or by the manufacturer. A trace of rouge affecting short lengths of otherwise faithful wire ropes seldom satisfied them.

As always, the engineer surveyor needs to understand the engineering reasons for reaching a rejection decision, rather than blindly following instructions or the recommendations of standards or literature. This doesn't mean disregarding instructions or guidance; it means reaching

corrosion

conclusions based on technical knowledge.

Textbooks do cover corrosion fretting and its causes, but few are specific to wire ropes, and that's important – because our understanding of the internal mechanisms matters. Far from being simple inert items, wire ropes are as complex as many machines, given the incalculable abrading interfaces between the multiple wires and strands.

Corrosion fretting involves 'dry' corrosion, producing ferrous oxides at the rubbing points within a wire rope that then exude as rouge, which is itself corrosive, making rouging self-sustaining.

Dry or wet corrosion

At the microscopic level, temporary localised pressure welding probably occurs at the rubbing points, resulting from heat generated at peak vibrations. These spots subsequently break and the sites become initiation sources for fatigue cracking. Inquests involving the unravelling of lays of rouged wire ropes often show that, in addition to corrosion, internal wires have disintegrated and wire diameter has reduced. So at least three wire rope enemies are present: wear, wire breaks and corrosion.

Conversely, where a wire rope is saturated with lubricant and/or is operating in a damp atmosphere, a wet corrosive mechanism is likely. This will produce external electrolytic corrosion, which might be compounded by internal rouging. Indeed, the 'eternal triangle' for any form of wet corrosion is easily attained in lift wire rope installations: cathode, anode and electrolyte in the form of atmosphere.

Note also that the atmosphere in a lift well can vary seasonally and be affected by volumes of moving air. Where lift well or lift motor room venting is a feature, temperature gradients are also likely at the exit grilles, which are often close to wire rope runs. Forced air circulation in heated motor rooms might also accelerate wire rope corrosion problems.

So how exactly can we assess the internal condition of wire ropes fitted to lifts? Not easily. Invasive techniques are always unacceptable: opening of the lay by spiking is out of the question. Hand flexing – as usual with a wire rope sling – is impossible, given the constant tension. And even if it were possible, it would be inadvisable, given that the rope will have settled to match its internal parts and the traction groove profile.

What about rust expansion – a phenomenon known throughout engineering? What comes off is bigger than what goes in: hence the ruling sections of electrolytically corroded structural steel members tend to swell prior to detachment of corrosion debris. But for a rouged rope (mechanically, as opposed to electrolytically, corroded) any swelling will be nil or negligible. The individual interfaces between wires produce only small volumes of debris, most of which is not retained, but appears between the strands at the outer diameter.

Meanwhile, engineer surveyors need to remember another point: the effect of a rouged wire rope on the sheaving, especially the traction sheave. Rouging debris is likely to be as detrimental to sheave profiles as it is to the wire ropes, so we need to be aware of remaining tractive effort and consider sheave replacement, if new wire ropes (always replaced in sets) are demanded.

That said, in the absence of new rejection criteria for rouged lift wire ropes, it remains usual to call for immediate replacement – except that we should give serious thought to the term 'immediate'. Using this word, consequent upon an examination, implies that the lift must be withdrawn from service at that instant, resulting in considerable disruption.

Fitting new wire ropes instantaneously is virtually impossible. The lift was working satisfactorily prior to examination, so how sound is an 'immediate' judgement, particularly with inconclusive external evidence? All that is certain is that rouging has occurred. So, given the very large factors of safety in wire ropes serving lift installations, partly for efficient traction, is it probable that rouged wire ropes will fail with one more lift service cycle? Would a further one week's service be irresponsible?

To get a surer appreciation of quantified risk, we need research into the effects of rouging – testing wire ropes with a series of stress cycles to assess attrition at various stages of corrosion. Tensile strength and fatigue strength might then be extrapolated into a useable format, making wire rope life prediction a science. But, in the absence of such a study, the dilemma for engineer surveyors remains, and we must use our technical knowledge and experience, not rulebooks alone.

Wisely, regulations regarding wire ropes for lifts shy away from demanding immediate action where defects are noted, merely obliging the competent person to exercise that competence. Standards (and directives) are similarly non-committal, except where incontrovertible visual evidence exists. The competent person rules; his technical knowledge is the final arbiter by which he must stand.

Pointers

- Rouging, corrosion fretting caused by wires rubbing against each other, is dry corrosion and is usually indicative of wire breaks and wear as well
- Wet, or electrolytic, corrosion can also occur, assisted by lift shaft air conditions and air movement
- Sheaving, especially the traction sheave, may also be affected by rouging
- In the absence of further research on the impact of rouging, engineer surveyors must use their technical knowledge and experience

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