Escalator Runaways

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Abstract. There have been a number of high-profile escalator runaways in recent years resulting in passenger injury and deaths. This paper will look at the standards for escalators over the years, how they have developed with respect to the prevention of this type of accident and will also challenge the current standards as to whether they are sufficient. The paper will also look at the appropriateness of EN115 and how it allows variables dependent upon rise and angle of inclination and whether this can be improved. The paper will be supported by video evidence.

1 EXAMPLES

There have been a number of examples of escalators rolling backwards and they can be compared with lifts rolling away, due to the counterweight or car taking over and causing an overhauling situation on a lift where a gearbox or brake failure have occurred.

Recent escalator runaways include:

- 26th March 2017 Mong Kok Shopping Mall, Hong Kong (17 injuries)
- 23rd October 2018 Piazza Della Republica, Rome (20 injuries)

In reality, runaways have been occurring ever since escalators were invented, with some attracting more media attention than others.

One of the worst cases occurred in 1994, which became known as The Camden Yards incident in the USA and saw an injury toll of 43 people.

2 WHAT HAPPENS?

A runaway situation can occur in both the upward and downward modes but the ultimate event results in the escalator rolling backwards (down mode) in an uncontrolled manner.

Where the escalator was initially travelling in the up direction and a runaway occurs, it may be referred to as a runback or unintended reversal.

Where the escalator was running in the down mode, the escalator will simply be in an uncontrolled descent.

In either case the situation may or may not include acceleration of the step band.

In such situations, and especially when there has been an acceleration component involved, passengers are often deposited in a pile at the bottom end of the escalator due to the inability of passengers to egress the escalator because of its high speed.

When these events occur, passengers are often seen clambering over the handrail to avoid the collision with other passengers at the bottom of the escalator.

An accumulation of passengers can be seen building up in the below photograph, with passengers behind them unable to avoid the passengers at the bottom, as there is no way of escape due to the escalator being installed with a void to the side.

Photograph 1: Passengers at base of escalator in the Mong Kok Mall incident in Hong Kong

3 HOW CAN IT HAPPEN?

Investigation into such incidents reveals a number of ways a runaway can occur including:

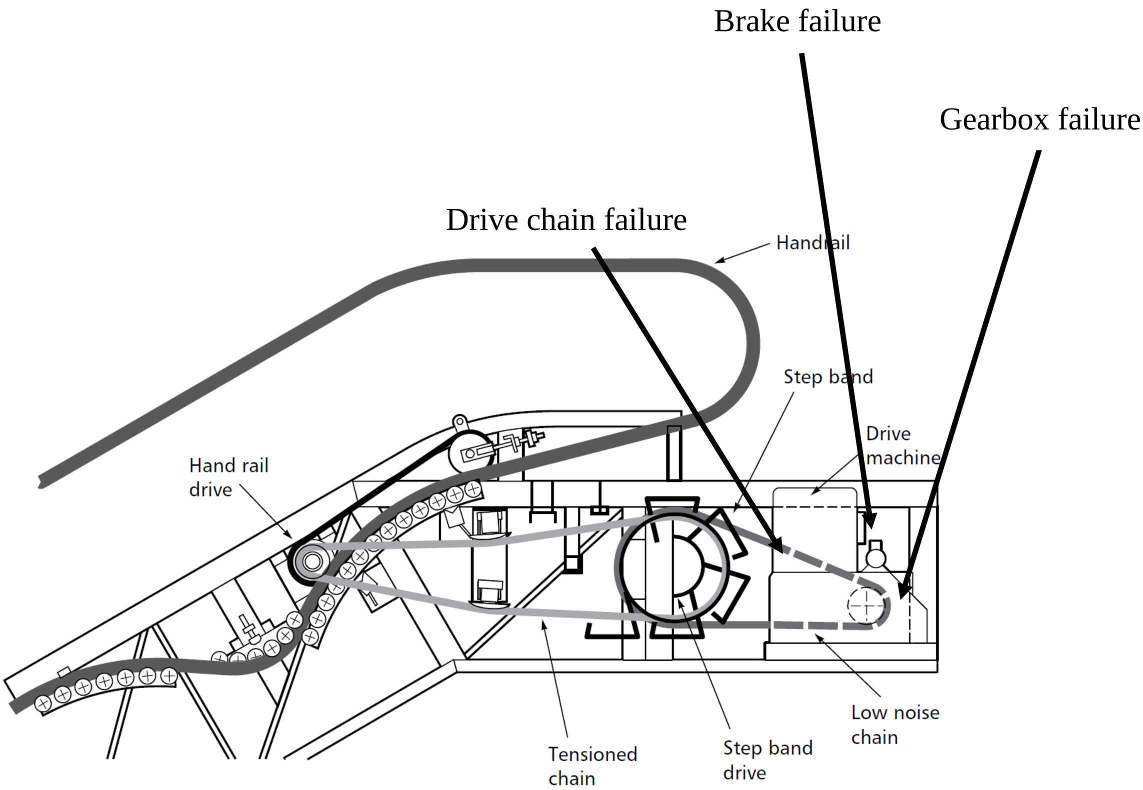

Figure 1: Principal Components of an escalator drive system (source CIBSE Guide D [1])

There have been incidents where a second component failure has also contributed to a runaway condition, primarily when an auxiliary brake is installed but has failed to bring the step band to rest.

There are other reasons why an escalator can runaway but the above are the primary reasons found in researching the subject.

One example of another reason found is a drive unit fixing failure leading to the drive chain, brake and gearbox being ineffective.

Al-Sharif has previously derived a Venn Diagram (Fig.2) showing seven possible ways accidents with escalators and escalator runaways occur, falling into the categories identified including design, maintenance and passenger behaviour.

When it comes to passenger behaviour, they have not been found to be associated with primary causation of a runaway, but minor contribution such as pressing an emergency stop button, leading to the primary reason for it becoming apparent (e.g. operational brake doesn't hold when required to do so). In addition, it has been found that in the initial stages of an accelerating runaway, passengers continue to board the escalator if it is a down running machine, unaware that it is in trouble.

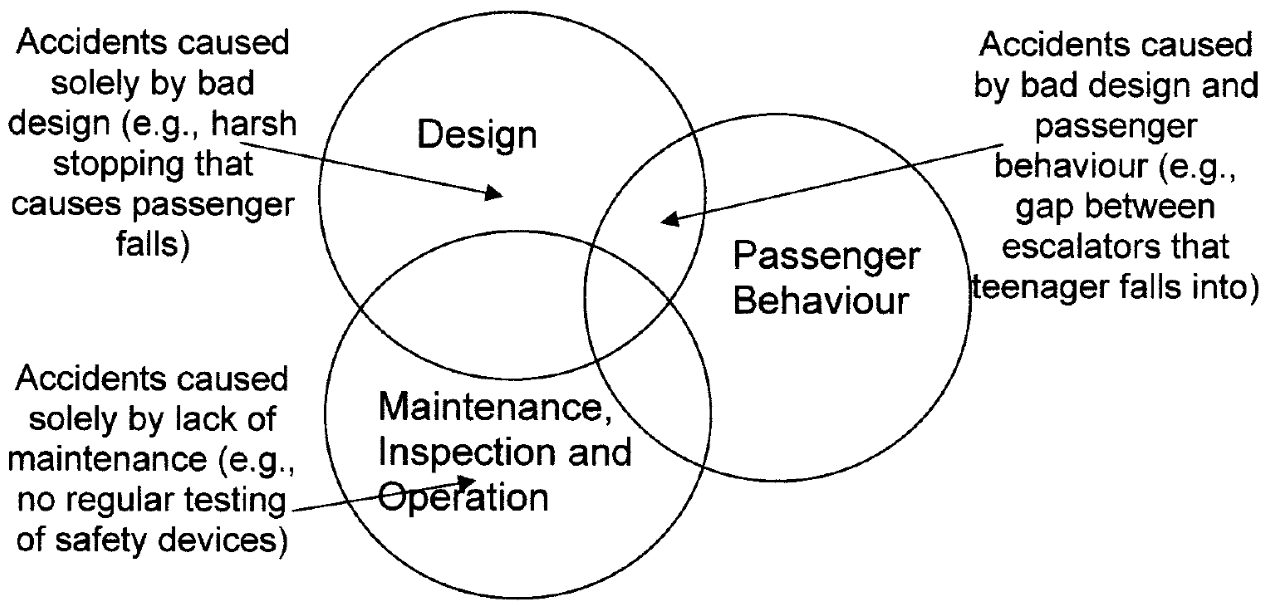

Figure 2: Al-Sharif's Venn Diagram of escalator accident causation [2]

This leads to the other two components namely design and maintenance.

When it comes to design, the inclusion of an auxiliary brake is a consideration. Not all escalators require an auxiliary brake and this is discussed in the section about whether standards are sufficient.

Consideration should also be given to the location of the operational brake, as if it is onboard the gearbox, it will provide no protection in the event of a gearbox internal failure. This is the same for lifts where the brake on geared machines is mostly found between the hoist motor and gearbox.

Maintenance is normally a key contender in escalator runaway situations, especially with respect to brake failures where issues such as lubrication getting onto braking surfaces, poor adjustment or worn pads can be a contributory factor. It should also remember that the brake is often used as a means to stop an escalator at the end of a working day and therefore, even if a VF drive, the pads are subject to wear on a regular basis.

In the incident in Rome, the CCTV footage can be seen showing the escalator slowing down and then increasing in speed.

It appears what has happened, is that someone has operated an emergency stop button and the operational brake has been asked to bring the escalator to a safe stop and hold the step band in position but failed to do so.

It appears the step band starts to accelerate in the down direction causing a passenger crowding situation.

In the environment where the escalator was installed, it would be expected that an auxiliary brake would have been installed, and on the assumption that it has, then it has clearly failed to arrest the reversal of the step band.

Photograph 2: Passengers, during the initial phase of a runaway, starting to hold the passenger in front.

4 ARE STANDARDS SUFFICIENT?

The 2017 EN115 standard (5.4.2.2) more or less mirrors the previous 2008 and 1995 standard with respect to the requirement for an auxiliary brake and states:

5.4.2.2 Auxiliary Brake

5.4.2.2.1 Escalators & inclined moving walkways shall be equipped with auxiliary brake(s) if:

a) The connection between the operational brake and the driving sprockets of the steps/pallets or the drum of the belt is not accomplished by shafts, gear wheels, multiplex chains, or more than one single chain, or
b) The operational brake has not an electrical-mechanical brake according to 5.4.2.1.2, or
c) The rise exceeds 6 m

The problem with this situation is that an escalator or inclined walk with a rise of less than 6 m, with a conformant drive chain, can still fail and runaway due to brake failure, gearbox failure or drive chain failure.

CIBSE Guide D defines an auxiliary brake as, “a fail safe brake, which is used to stop an escalator under all normal conditions or under certain fault conditions only. It is typically situated on one side of the main drive shaft.”

It should be noted that this was derived from a London Underground Glossary of terms – one of the major UK operators of escalators.

The 2017 EN115 standard (Clause 5.12.2.7.3) also calls for detection of unintentional reversal of the direction of travel and states, “a device shall be provided for escalators and inclined ($\alpha = \geq 6°$) moving walks to detect the unintentional reversal of direction of travel”. The problem with this is that it could use the operational or auxiliary brake (if fitted) to prevent the reversal and these components are known to have failed in the past.

5.12.2.7.2 also calls for the detection of excessive speed before the speed exceeds a value of 1.2 times the nominal speed.

It can be argued that the standards provide sufficient protection, however it is the authors contention that an auxiliary brake should be provided on all escalators and inclined walks in situations where the failure of the operational brake, gearbox and/or drive chain can occur. In reality, this would mean that all escalators and inclined moving walks would require an auxiliary brake.

5 CONCLUSION

Runaway escalators are still occurring despite the EN115 standard recognising that unintended reversal or an overspeed condition is a foreseeable event.

It is accepted that rather like a lift, if where the overspeed governor or safety gear fails to work, there are scenarios where an auxiliary brake does not provide full protection.

It is, however, concluded that all escalators and moving walks should be provided with an auxiliary brake to support the operational brake.

REFERENCES

[1] Chartered Institution of Building Services Engineers (2015); Transportation Systems in Buildings.

[2] Al Sharif (DnK), Escalator Human Factors: Passenger Behaviour, accidents & design

[3] British Standards Institution (2017); EN115-1 Safety rules for the construction & installation of escalators & moving walks

BIOGRAPHY

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David Cooper is the Managing Director of UK based lift consultants LECS (UK) Ltd. He has been in the lift & escalator industry since 1980 and is a well-known author and speaker. He holds a Master of Philosophy Degree following a 5-year research project into accidents on escalators, a Master of Science Degree in Lift Engineering as well as a Bachelor of Science Honours degree, Higher National Certificate and a Continuing Education Certificate in lift and escalator engineering. He is a co-author of "*The Elevator & Escalator Micropedia*" (1997) and "*Elevator & Escalator Accident Investigation & Litigation"*. (2002 & 2005) as well as being a contributor to a number of other books including CIBSE Guide D.

He is a regular columnist in trade journals worldwide including Elevation, Elevator World and Elevatori. He has presented at a number of industry seminars worldwide including 2008 Elevcon (Thessaloniki), 2008 NAVTP (San Francisco),1999 LESA (Melbourne), 1999 CIBSE (Hong Kong), 1999 IAEE (London), 1998 (Zurich), 1997 CIBSE (Hong Kong), 1996 (Barcelona) and 1993 (Vienna) as well as numerous presentations within the UK. He is also a Founding Trustee of the UK's Lift Industry Charity which assists industry members and/or their families after an accident at work. In 2012 David was awarded the silver medal by CIBSE for services to the Institution. David Chairs the Charity that runs the Lift Symposium and is an Honorary Visiting Fellow at The University of Northampton.