Optic Technology for the Entrapment Issues of Side of Step, Comb Plate and Lift Doors

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Abstract. This paper describes the prevalent issues that are apparent with side of step, comb plate and lift doors and how a better solution can be introduced. There have for many years been designs which have partly solved the problem, but are generally mechanically biased and in some cases are not used at all by the manufactures, as is the case of skirt panel detection and lift doors. Due to the increased number of reported incidents and the recent fatalities of strangulation, some consumers have developed an unbiased opinion that escalators and lift doors are dangerous. It has become more apparent that safety at the main entrapment points of skirt panel, comb plates and lift doors can be increased to be more reliable and functional with optic technology.

Step to skirting panel entrapment has been for many years a major incident issue, and only recently a small boy in the UK had an incident on an escalator and got his hand caught at this such point.

With reference to the comb bearer, incidents of entrapment have resulted in fatalities in Canada and Belgium. Issues of entrapment are caused by the type of footwear i.e. crocks and clothing.

A scenic lift door is a viewing area especially for small children, resting their hands on the glass. As the car arrives the doors open, the fingers have the potential to become trapped at the door frame.

These three main trapping points would undergo their regular maintenance schedule and the relevant safety checks would be carried out, with the equipment within its recommended tolerances. But with all moving parts the potential for entrapment is possible.

An optic cable installed into a module unit, sending a light signal out and monitored on its return for any distortion, has the function ability to assist with eliminating these potential trapping points. A light signal is monitored going out to its return on a multitude of parameters within the module box. When a pre-set distortion point has been reached, “which can be as sensitive as 0.01mm of movement”, a signal will be sent immediately to stop the unit at its safety function. The sensitivity of this function is due to the self-calibrating function in the system.

1 INTRODUCTION

The optic technology was originally developed for the automotive industry. It has been widely used on buses, designed to indicate to the driver when the entrance step was sufficiently acceptable to the pavement, so passengers could enter without an uneven step.

Johan Sevenants took the optical system in 2009 and came to the conclusion that it could be developed initially for the escalator industry, to help solve the potential issues that arise from side of step entrapment. It was enhanced further to help identify step to step entrapments at the two transition areas.

The system was then introduced to work alongside the existing comb plate safety switches to help identify foreign object entrapments such as screws which cause a considerable amount of damage to the step band.

The next and most recent move forward for the optical technology was to help with lift door entrapment at the door frame caused for example by children who rest their hands on the glass.

2 HOW IT FUNCTIONS

Principle operation optical detection:

Micro-spectrometry is the measurement of change in the light spectrum, and this is the basis of this innovative detection system. Light is a clear signal that can be measured very accurately and reliably with advanced electronics.

The closed system is made up of a plastic optical cable and an advanced electronic module. Use is made of a patented system involving the entire spectrum of light that is coupled into the optical cable. Through the software, various colours "put apart", to which the base values are assigned. These base values, as well as the desired bandwidth, are stored in the core of the system and form the limits of detection. When pressure is put upon the cable provided with mechanical break points for distortions in the cable, these distortions result in a change of the spectral distribution of the light in which the changing values belong. Including these new values beyond the set limits of detection, a signal will be given.

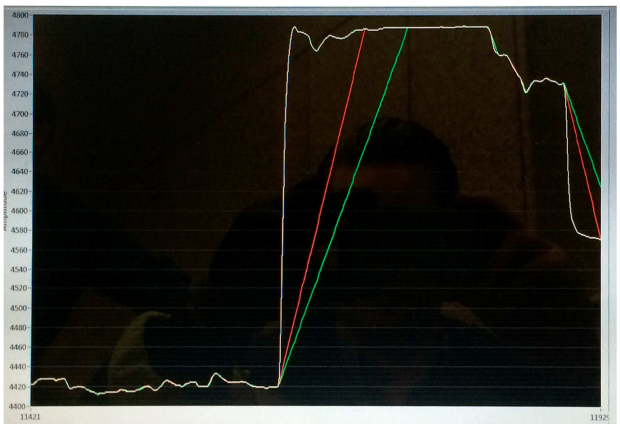
Only the kink points caused by the mechanical light changes, at the application of pressure using the pre-determined sensor points, finally provide for the detection. Changes in composition of the light as a result of factors such as dirt, wind, rain, hail, fog, snow, moisture and temperature cannot therefore exert any influence on the operation of the system.

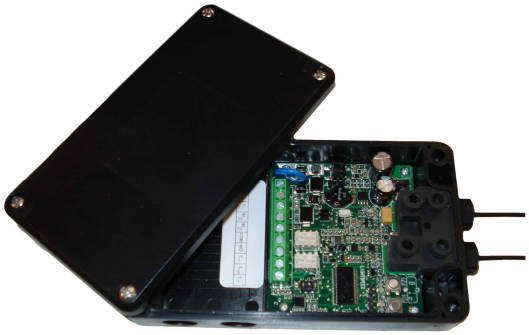
The various parameters of the system to adapt by application are tailor-made, making unique multiple detection combinations possible, making the system intelligent so that it can then have the function to carry out auto calibration. The system for auto calibration functions such that if an object has become trapped and activated the system and has not been removed after for example 10 seconds, the system will auto calibrate to this new position. Safety has been re-instated to the machine.

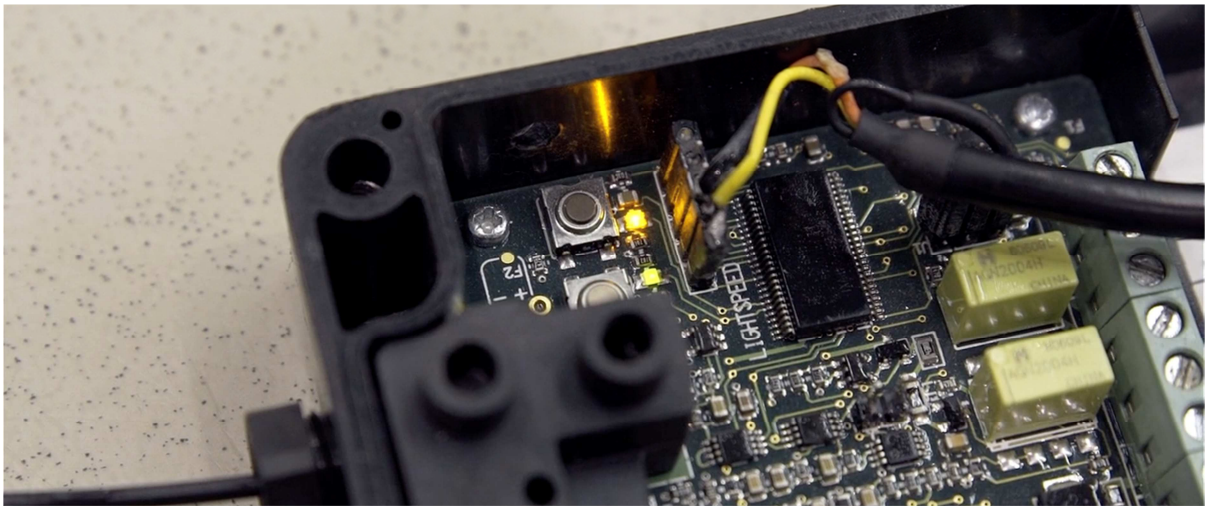
When the pre-set distortion point has been reached “which can be as sensitive as 0.01mm of movement” a signal will be sent from the module unit to immediately stop the unit at its safety function.

i. 0,01mm of movement is enough for activation

ii. Accurate in wide range i.e. less than 0,1N to over 10 tons





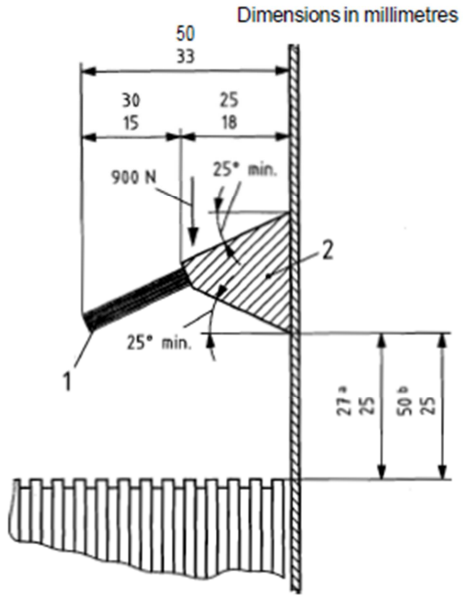


3 SKIRT PANEL | SIDE OF STEP

Side of step (=Step to skirting panel) entrapment has been for many years a major incident issue, involving clothing, shoes and especially children sitting on the steps. Only recently a small boy in the UK had an incident on an escalator and got his hand caught at this such point. We also know that units that have skirting brush are often used to clean shoes, and this can cause the shoe to become trapped in between the skirt panel and step.

The system is pressure sensitive to “force overtime” - the system measures 240 times a second and it is not susceptible to impact blows to trigger the distortion. As is often the case there can be issues of passengers kicking the skirt panels, but the system understands that no pressure is being engaged so will not activate.

The Skirt Panel detection is mounted at strategic points behind the skirt panels. The sensor points are installed at the centre point of the panel where the most distortion can take place.



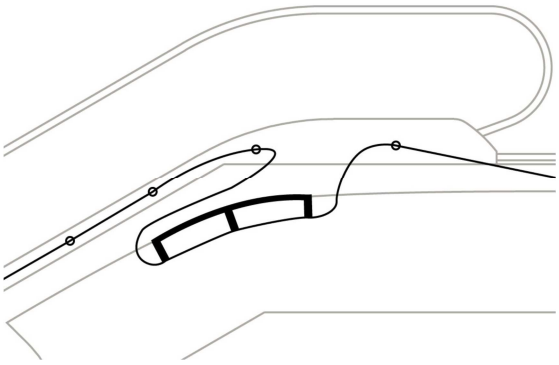
NEN-EN115-1:2008+A1:2010 (Article 5.5.3.3)

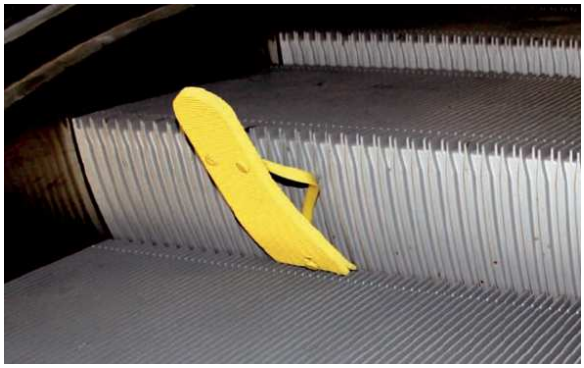
The skirting shall yield not more than 4mm under a single force of 1 500N acting at the most unfavourable point at right angles to the surface over an area 2 500mm² using a square or round area. No permanent deformation shall result from this.

4 STEP TO STEP

The step to step transition point at the bottom and top curves of the escalator are known to cause entrapment of shoes especially soft soled flip-flops. The passenger may have their foot too close to the leading edge and as the soft sole is depressed into the step tread, the step passes through this transition point and has the potential to grab the shoe. There was an incident in the UK on an old 1967 escalator that had a smooth stainless steel riser. This riser had somehow become removed from its position and as such there was a void into the step. The passenger had placed their foot on the steps with their toe edge into the void. The unit was running in the up direction and so as the steps reached the upper transition curve the foot became trapped.

With the step to step optic system mounted at the step roller guides, if an object is getting trapped between two steps, the upper step will be lifted. The optical system will be activated by touching the counter guide of the step rollers.





i. Mechanical setup
   a) Both sides of step
   b) Step to step
ii. Outputs
   a) Alarm
      1. 1 potential free contact
      2. NC at power
iii. Pressure sensitive
iv. Auto calibration

5 COMB PLATE

The Comb Plate detection is mounted just in front of the comb plates, on the comb bearer behind the skirt panels. It is mounted in this manner so as not to interfere with the existing safety switches. It can be retro fitted to any manufacture and model of escalator and has the added function of being able to detect vertically and horizontally. As we know for most manufacturers the comb bearer will only function in one movement.

The system is pressure sensitive, but it is not susceptible to impact blows to trigger the distortion. As is often the case there can be issues of passengers jumping from the transition point to the comb bearer, “especially on down running units”, but the system understands that no pressure is being engaged and so will not activate. The added function of being pressure sensitive is that if a foreign object becomes trapped in the comb plate, i.e. a screw, as the screw enters the gap between the teeth of the comb platethe pressure point will be reached and the unit will shut down. This helps eliminate further damage to the comb and the step flute. So instead of having the whole step band scored, there may only be a certain number of steps scored.

The comb bearer incidents of entrapment which resulted in fatalities in Canada and Belgium in the past years may have been avoided as these deaths were of strangulation. The items that were the cause of death may have been detected using the optic system. The issues of entrapment are generally caused by loose clothing, long dresses, scarves, coats, etc. Most common of all is footwear in particular crocks, flip-flops and wellington boots. These have a soft soled base to them that causes the sole to become squashed on the step tread, which has been known to then become a trapping point at the comb plates if the passenger does not lift their foot before exiting the escalator.

NEN-EN115-1:2008+A1:2010 (Article 5.7.3.2.5/6)

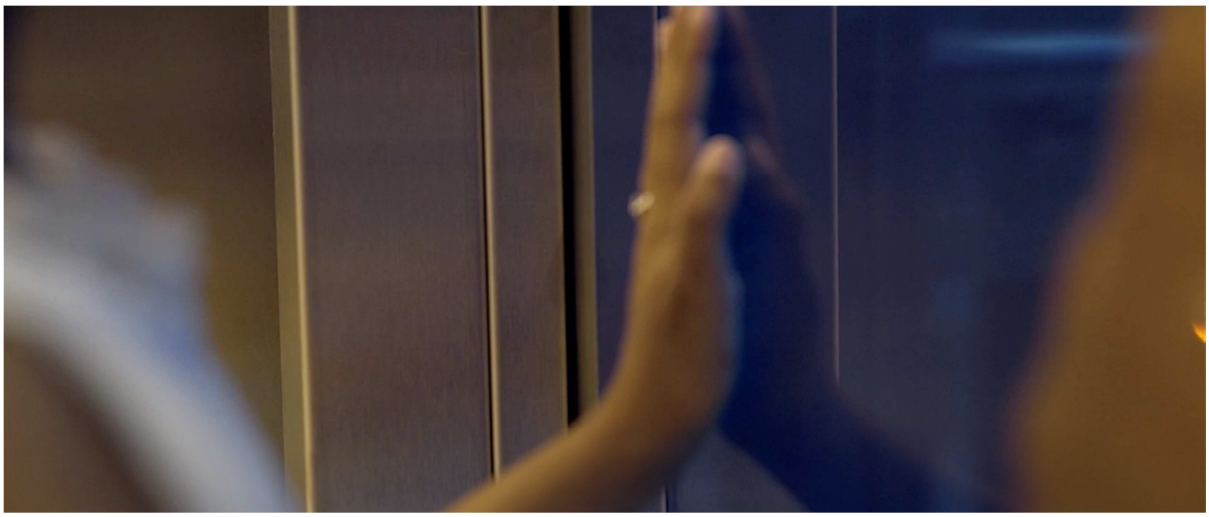
5.7.3.2.5 – The combs shall have such a design that upon trapping of foreign bodies either their teeth deflect and remain in mesh with the grooves of the steps, pallets or belt, or they break.

5.7.3.2.6 – In the case of objects being trapped which are not dealt with by the means described in 5.7.3.2.5 and in the case of comb/step/pallet impact the escalator or moving walk shall be stopped automatically.

i. Mechanical setup
   a) Horizontal & vertical detection
ii. Alarm
   a) 1 potential free contact
iii. Pressure sensitive
iv. Auto calibration

6 CENTRE OPENING LIFT DOORS

A scenic lift door is a viewing area especially for small children, who often rest their hands on the glass doors. As the car arrives the doors open, the fingers have the potential to become trapped at the door frame.



NEN-EN81-1:1998+A3:2009 (E) (Article 8.6.7.5)

“To avoid dragging of children hands, automatic power operated horizontally sliding doors made of glass of dimensions greater than stated in 7.6.2. Shall be provided with means to minimise the risk, such as:”

1. Reducing the coefficient of friction between hands and glass
2. Making the glass opaque up to a height of 1,10m
3. Sensing the presence of fingers, or
4. Other equivalent methods

i. Mechanical setup

a) Both the lift car and landing doors
b) System is auto-calibrating
c) Suitable for metal and glass doors
d) Plug and Play installation
e) Available for multiple door heights

ii. Outputs
    a) Preventive system
        1. Alarm
            - NC or NO at power
    b) Corrective system
        1. Alarm
            - 1 potential free contact
    c) Pressure sensitive
    d) Auto calibration

7 CONCLUSION

These three main trapping points would undergo their regular maintenance schedule and the relevant safety checks would be carried out, with the equipment within its recommended tolerances. But, due to the nature of moving parts, the potential for entrapment is possible. The main concern is always to the passenger, but when an incident occurs, there may well be damage to the unit, which results in expensive litigation and repair costs.

REFERENCES

i. NEN-EN115-1:2008+A1:2010 (Article 5.5.4 / 5.5.4.1 / 5.5.4.2)
ii. NEN-EN115-1:2008+A1:2010 (Article 5.5.3.3)
iii. NEN-EN115-1:2008+A1:2010 (Article 5.7.3.2.5/6)
iv. NEN-EN81-1:1998+A3:2009 (E) (Article 8.6.7.5)

BIOGRAPHICAL DETAILS

Stephen Williams has been in the escalator industry for over 16 years. Starting as a service engineer completing NVQ level 3 escalator service, repair. Through the years developing all the field skills involved with escalators from handrail vulcanisation and all major escalator related repairs to eventually completing NVQ level 4 Escalator field tester. He has field experience with installation projects in the UK, Ireland and Middle East from the installation of single piece units to large multiple jointed units. Leading to coordinating the survey and building associated works that can transpire around the project. He also helps Johan Sevenants with the development of various innovative products within the lift and escalator industry.

Johan Sevenants has been in the lift and escalator industry for more than 25 years and holds a degree in Mechanical Engineering. His knowledge as project manager in the installation of more than 1000 escalators have helped to understand simple solutions to complicated projects. The majority of his time is taken up with the research and development for innovative products and services within the lift and escalator field, all over the world. He is co-owner of several companies who develops and promotes these products and services.