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THE Green ISSUE

Specifying Escalators for Transit Projects

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Cover Story

Technology in Motion

Escalator design in transit applications

By David Evans

All images courtesy Schindler Elevator Corporation

Increasingly, municipal planners are recognizing the importance of connected and accessible mass transportation solutions. By removing personal vehicles from the roads, public transit becomes an economical, environmentally responsible action to reduce the smog and greenhouse gases (GHGs) generated by combustion engine emissions.

An integral component to any mass transit design is 'people-moving'—getting users in and out of the stations, platforms, and other loading areas using escalators and elevators. Much like other building decisions, specifying escalators and elevators in transit applications is a balancing act between safety and reliability requirements, budget, and, more frequently, the need for green design considerations. With proper planning, selecting an escalator can meet all three constraints without compromise.

Meeting the basic requirements

The escalators specified for transportation projects—airports, train stations, and the like—are often more complex than those chosen for shopping centres. These conveying systems must frequently be larger, deal with heavier and more constant traffic, operate for longer periods, and, in some cases, endure outside weather conditions.

While escalators are always expected to offer safe, reliable performance, this becomes especially important in mass transit applications with high traffic loads. The American Public Transport Association (APTA)—which, despite the name, includes Canadian membership—has recognized the specific requirements for transit applications in RT-RP-FS-007-02, *Heavy Duty Transportation System Escalator Design Guidelines Volume 5: Fixed Structures.*[1]

This document provides recommended guidelines for transit systems when specifying heavy-duty escalators for a North American transit environment. However, it is only a guideline—the design community still needs to review the requirements and adapt or adjust them according to the required performance parameters.

Everyone in escalator and elevator design—from manufacturers, designers, and installers to maintenance technicians—is committed to delivering a safe, reliable product. Fortunately, the governing standard, American Society of Mechanical Engineers (ASME) A 17.1/ Canadian Standards Association (CSA) B 44, *Safety Code for Elevators and Escalators,* defines many of the intrinsic safety features in an escalator. Beyond the minimum code requirements, many manufacturers now offer dozens of additional safety features.

To handle the extreme operating conditions experienced in a transit application, it is important to look for an escalator design that minimizes vibration, and the resulting wear and tear, by using a track-and-chain system with diverter sprockets. Further, larger transition-curve radii and longer horizontal step runs safeguard passenger comfort.

Depending on the local jurisdiction's adoption of code standards, the escalators may need to have their Step/Skirt Performance Index measured to minimize the possibility of entrapment between the edge of the step and the side skirting. This index is determined by the coefficient of friction of the skirt, and the maximum loaded gap between it and the step. Although escalators may be installed with initially tight tolerances between the tread and skirting, the space may increase over time.

Installing skirt deflectors (*i.e.* skirt brushes) in conjunction with a stair-tread-positioning system potentially limits liability. Some manufacturers provide a step-guiding system that allows service technicians to adjust each one separately. Therefore, if the gap between the skirting and the step increases due to wear, the guide can be adjusted to return the spacing to within acceptable tolerances. This feature, combined with skirt brushes, can help increase passenger safety (Figure 1).

Figure 1

Skirt brushes are mounted on the sides of the escalator, just above the moving steps. A continuous length of bristles projects out from the skirt, gently deflecting and guiding riders away from the step-to-skirt gap.

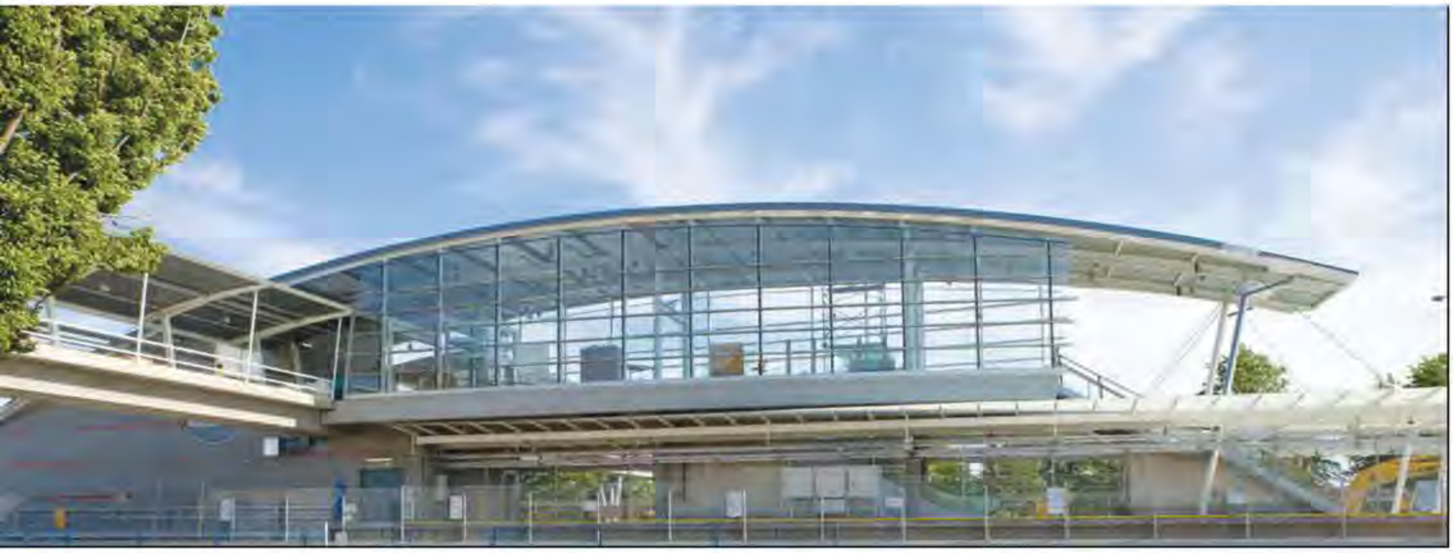
All escalators must meet or exceed the code requirements in ASME A 17.1/CSA B 44 for braking systems, including redundancy considerations. However, most of the equipment manufacturers offer different approaches that can improve both reliability and service life. For example, an escalator with a service band brake, although mechanically simple, can deliver up to 12,000 full-load braking operations, contributing to a long unit life. Similarly, escalators equipped with annular disk brakes provide even deceleration before engaging the full mechanical stop, minimizing an abrupt stop that may endanger riders.

Proper sizing of the escalator equipment is probably one of the most complicated, yet critical, design decisions. Variables such as passenger flow studies, expected loads, operating hours, maintenance requirements, and escalator layout must be considered.

Equipment layout can be an issue, especially with smaller building floor plans. Depending on space, the escalator drive should be positioned within or outside the truss (Figure 2). When the drive is placed inside, an optional second drive can be installed (if required) to accommodate larger spans and heights. Where this is not an option (*e.g.* the required motor is too large to be accommodated within the truss or maintenance access is an issue), the motor(s) can be installed in a cage under the main truss or installed in a separate machine room.

One advantage to a separate machine room is other support equipment—such as electrical panels and control equipment—can easily be inspected without having to block passenger access to the escalator. When the drive equipment is located in a 'pit' at the base of an escalator, any maintenance means the escalator cannot be used—even as a temporary stairway.

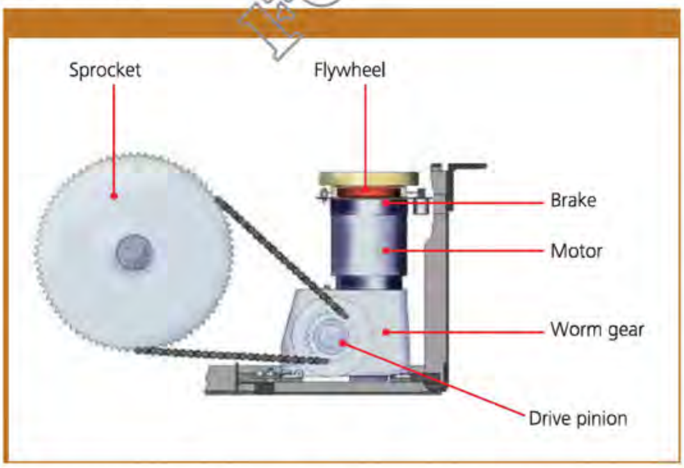
Expected passenger loads, usage, and operating hours directly affect the escalator drive sizing. This is perhaps one of



With stations throughout Vancouver, the Canada Line has improved mass transportation in the area. Such infrastructure also relies on escalators and elevators to move passengers in and out.

Specifying escalators for transit applications is a balancing act between safety and reliability, budget, and green requirements.

Figure 2



Typical transit applications utilize an internal drive assembly that fits within the escalator truss.

the most misunderstood design criteria with escalators. The challenge is to have the equipment adequately handle the expected load requirements without over-designing and compromising operating efficiencies.

Understanding passenger flow and loading is part science, part conjecture. APTA uses a design factor of 145 kg (320 lb) for each escalator step. This theoretical value may not reflect what some studies have shown. Even at peak passenger traffic, it is not uncommon to see empty steps on the escalators, reducing design capacity. The natural slight hesitancy to board an escalator often means there is an empty step separating passengers. For others, there is a desire to maintain a more comfortable human or personal space.[2] Industry experience points to a more realistic passenger loading of 40 to 50 per cent of the theoretical load.

Using the inflated design load directly affects equipment selection and may later cause maintenance issues. For example, APTA mandates a long life requirement and high-duty cycle for transit equipment. To meet this, the gearboxes must be sized to resist wear at these higher usage levels, even though they may be overstated by up to 50 per cent.

Sizing the gearboxes two to three times bigger than the associated drive means the equipment never runs to maximum efficiency. Therefore, although the drive efficiencies are quoted at more than 85 per cent, the actual efficiency may be closer to 60 per cent.Designers must understand these implications as lower efficiencies means higher operating costs and, possibly, increased maintenance.

With so many moving parts in an escalator, high passenger loads and 24-7 operations, a regular maintenance program should be considered to meet the stringent requirements. Something as simple as lubricating the step chain—an expensive and critical component—can result in extended life. Some escalator manufacturers offer various methods, including an option where the lubricants are encapsulated for maintenance-free operation.

Escalators are not the only means for people-moving, of course. Canada Line stations also feature elevators for accessibility.

Figure 3a

In transit applications, the step chain roller is typically outside the chain. This allows for larger rollers with a longer service life.

Figure 3b

By locating rollers outside the chain, the rollers absorb less pressure. The chain handles most of the stress load at the turnaround.

In heavy-duty transit installations, the step chain roller is typically placed outside the chain (Figure 3 ;). The rollers are positioned on every step connection link outside the step chain, which means they do not have to transmit the force from the step chain sprocket. These larger diameter rollers (as compared to in-line step rollers) have an extended life due to the lower loads and revolutions.

Additional protection is required for external escalator installations. Along with an overhanging canopy, the truss may require extra primer and finishing, including hot-dip galvanizing. Other measures include using stainless steel step axles and double-sealed bearings for both the chain and step wheels, or even stainless sheet steel motor and drive chain covers or galvanized sheet steel step chain covers.

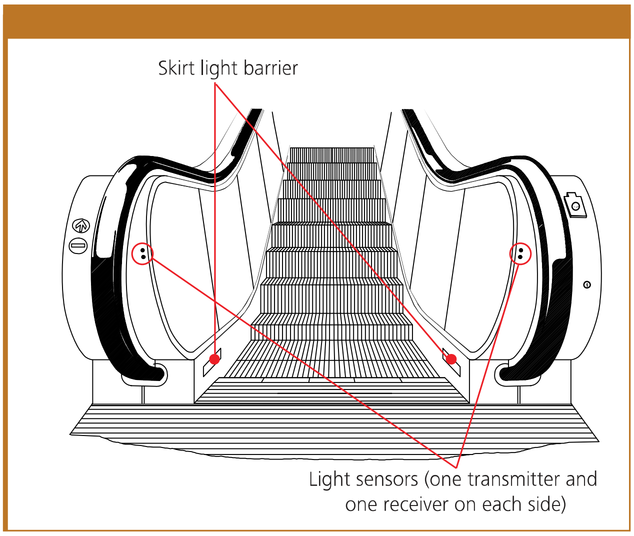
To prevent icing, heaters may be required in the step band, at the comb plate, and at the upper and lower equipment pits. In some cases, oil/water filtration systems are incorporated to manage any lubrication oils or water from station wash-downs.

Thinking sustainably

Green is more than a colour choice—it frequently becomes one of the dominant design philosophies. 'Green' refers to measures reducing the environmental footprint by considering the impact on using renewable resources. Escalators can meet this definition.

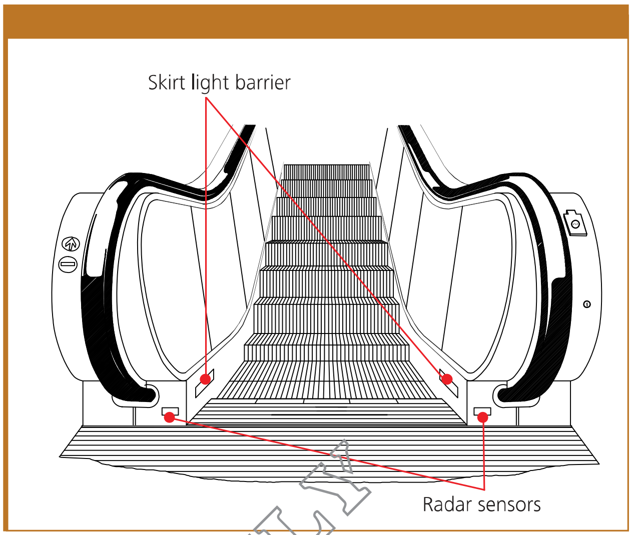
Technological improvements have meant energy use can be significantly reduced by using more energy-efficient motors, including the option of variable voltage/variable frequency (VVVF) drives. Managing the rotational speed of electric motors by controlling the frequency of the supply power can result in significant savings, as well as reduced wear on the components. One escalator manufacturer shows

Figure 4



Light sensors at both ends of the escalator detect persons passing them.

Figure 5



Radar sensors at both ends of the escalator detect those approaching.

energy savings greater than 20 per cent at rated speed versus the more traditional direct start motors.

Intermittent operation escalators—common in Europe and increasingly appearing in North American projects—are configured to react to passenger traffic. By installing a light sensor (Figure 4) or an entrance monitoring system (Figure 5), an escalator can be turned on automatically when a passenger activates the barrier. If the barrier is not activated during a pre-defined time, the escalator slowly stops, further reducing wear in comparison to conventional automatic operation. When activated, the escalator ramps up to the rated speed based on a configurable acceleration curve.

Another option is to have the empty escalator running at 'sleep' or 'crawl' speed with a VVVF drive (*i.e.* 10 to 30 per cent of the rated speed), saving up to 60 per cent in energy compared to conventional automatic operation. In both cases (stopped or sleep mode), when a passenger passes the barrier, the escalator ramps up to the rated speed.

Radar or sensors are positioned at both ends of the escalator. For safety reasons, if a passenger tries to walk the incorrect way onto the escalator, the escalator accelerates in the pre-determined direction. The distance between the light barrier or entrance monitoring system and the first step of the escalator ensures it is close to or at the rated speed by the time the passenger steps on the escalator. Proposed changes to ASME A 17.1/CSA B 44, expected later this year, are considering incorporating references to intermittent escalator operation. In the meantime, many local jurisdictions permit code variances.

When it comes to existing escalators in transit installations, retrofit upgrades can enable these older systems to cope with increasing passenger volumes. One option is to install an energy efficiency controller that provides precisely the right amount of power to meet the demands of the escalator passenger loads. For example, during lower passenger traffic conditions, the electronic sensors automatically phase back the supplied power to the motors without affecting the escalator speed. This reduces the wear and tear on the AC motor, as well as lowers energy consumption by up to 40 per cent (Figure 6).

In many jurisdictions, utility and government rebates may be available when incorporating energy efficiency controllers. Other upgrades that can help reduce energy costs include optimized drive systems, matched to the demands of the rise; nominal motor power drops of up to 27 per cent can be realized.

Partnering early for success

An early partnership between escalator specialists and the design community can deliver many benefits. Unfortunately, in some cases, the project team—including architects, transit authorities, contractors, engineers, and building owners—enlists the support of the escalator manufacturers only after the specification has been released for tender.

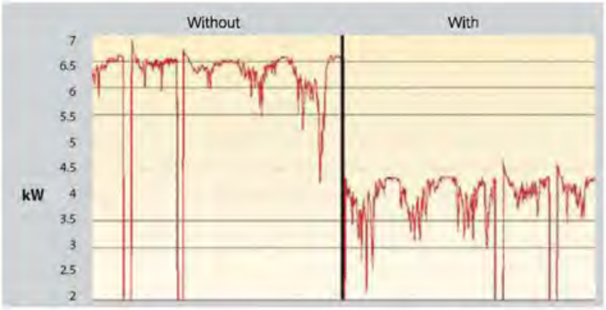
In fact, optimal results are usually achieved when these manufacturers are invited to participate in the earliest planning discussions. A partnership forged before a project is even defined often yields a better design solution throughout the entire life of the escalator.

For example, it is not uncommon to find escalators that cannot be easily accessed at their end of life or when major upgrades are needed because the building has been constructed around it.

Although each transit application is different, there is one constant: getting the most out of the equipment working within the available budget. Partnering and consulting early with an escalator manufacturer can help yield potential savings by optimizing the design.

Public infrastructure projects in mass transit applications are long-term investments. By working early with escalator

Figure 6



This chart shows a 2.3 kW or 37 per cent savings achieved on a 40-hp down escalator using proprietary energy efficiency controls. Savings over one year were 0.08 kWh or $1775. The study, prepared by Paragon Consulting Services, was conducted by Nevada Power at Caesars Palace in Las Vegas, Nev.

Savings through installation of energy efficiency controller.

manufacturers, practical and economical design solutions can be implemented without compromising safety and reliability while contributing to sustainable designs.

Notes

[1] Visit www.aptastandards.com.

[2] This information comes from a 1987 *Elevator World* publication, "Pedestrian Planning and Design," by J.J. Fruin.

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The Canada Line

Highlighted on page 8, the Canada Line is an automated rail-based rapid transit line connecting Vancouver with central Richmond and the Vancouver International Airport through an underground tunnel and elevated guideway. Open in August 2009 (three months ahead of schedule and well in advance of the XXI Olympic Winter Games), the Canada Line added 16 new stations and 19 km (11.8 mi) to the SkyTrain network. An example of a public-private partnership (P3), it was built by SNC-Lavalin, which will also operate it for 35 years for TransLink.

According to TransLink, approximately 35 per cent of greenhouse gas (GHG) emissions in Metro Vancouver come from transportation alone. The Canada Line adds much needed transit capacity (equivalent to 10 major road lanes), thereby reducing the cost and pressure of the automobile on the environment. Ridership on the $2-billion transit has been steadily growing; already the line is reaching near its capacity of 100,000 trips daily.

As with any transit project, having the trains run on time is only part of the equation—getting people on and off the train safely and reliably is equally important. Servicing 15 stations are 38 escalators and 34 elevators, designed for complete accessibility and unique to each station. For example, because each station would be monitored with cameras, extensive use of glass in the elevators was specified to meet security requirements. To ensure the equipment is kept in top operating condition, a suite of International Organization for Standardization- (ISO-) certified maintenance services was implemented, including an intelligent electronic remote monitoring system.

Many of the escalators and escalator installations are outdoors and were designed to out-perform in the weather and temperature extremes of Vancouver. Some of the required modifications included:

- durable canopies over the escalators;
- waterproof switches and controllers;
- automated lubrication of key components; and
- additional heating elements in the equipment pit, comb plate, and step band.