Escalator Handrails:
Principles & Practices

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Draka EHC

A Brand of Prysmian Group

Terminology & Anatomy

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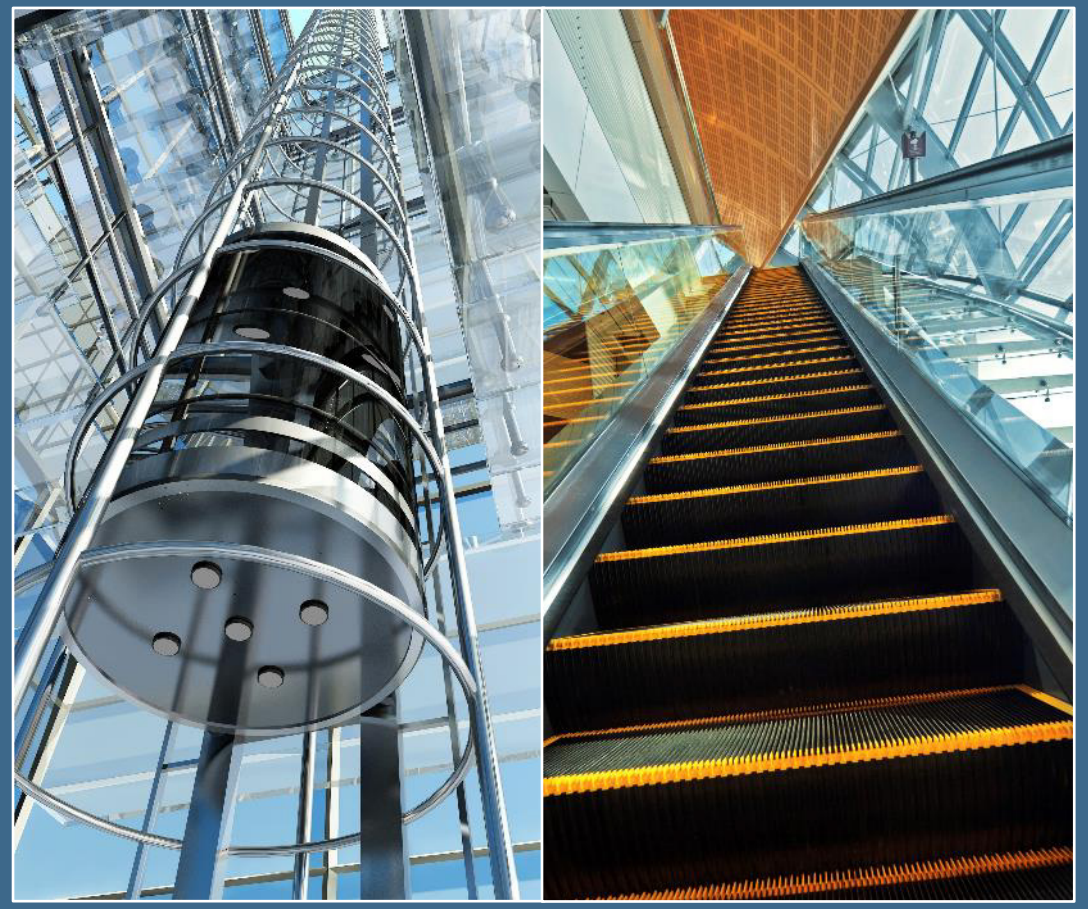
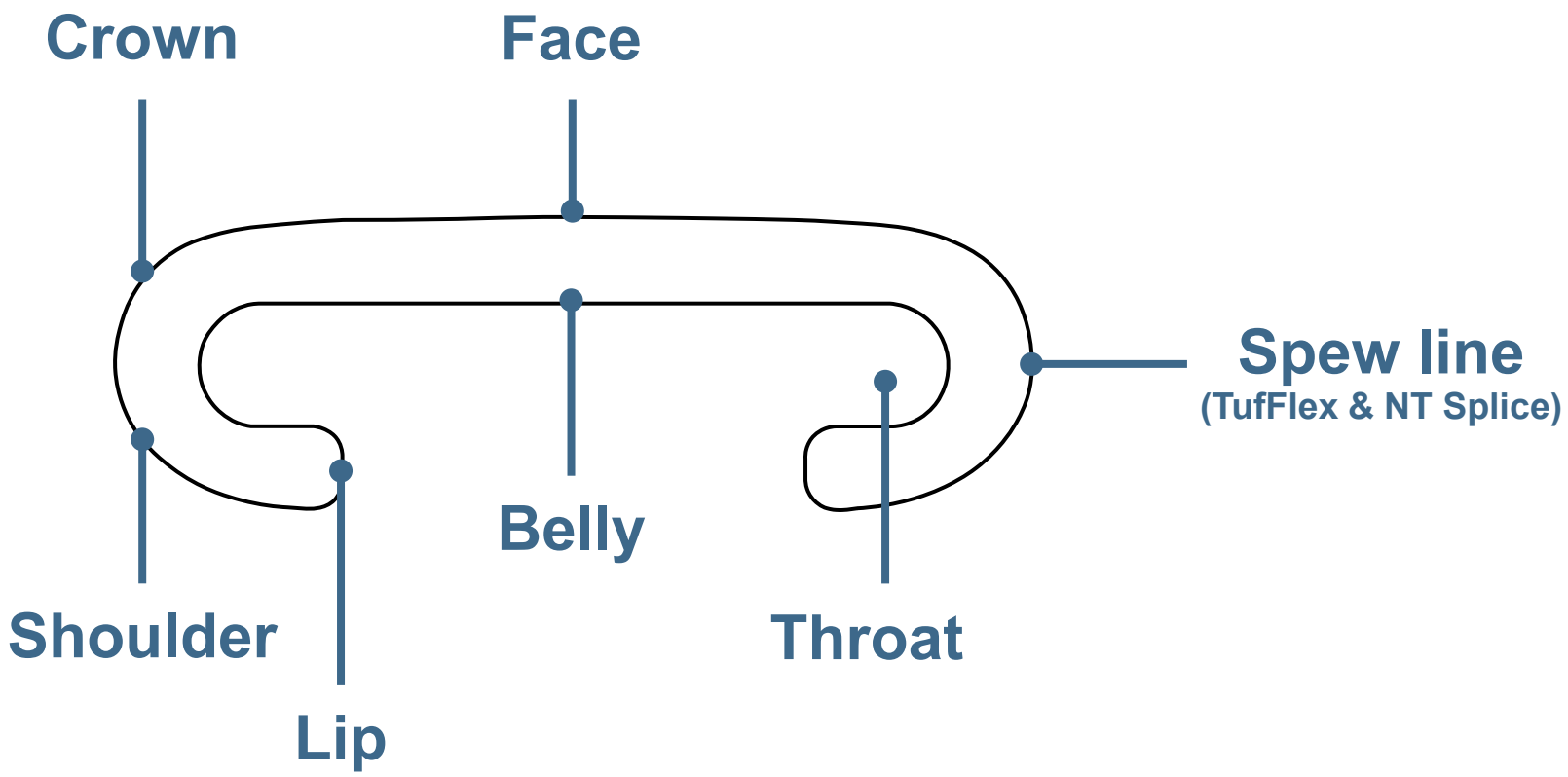


Terminology



Anatomy: TufFlex (Rubber)

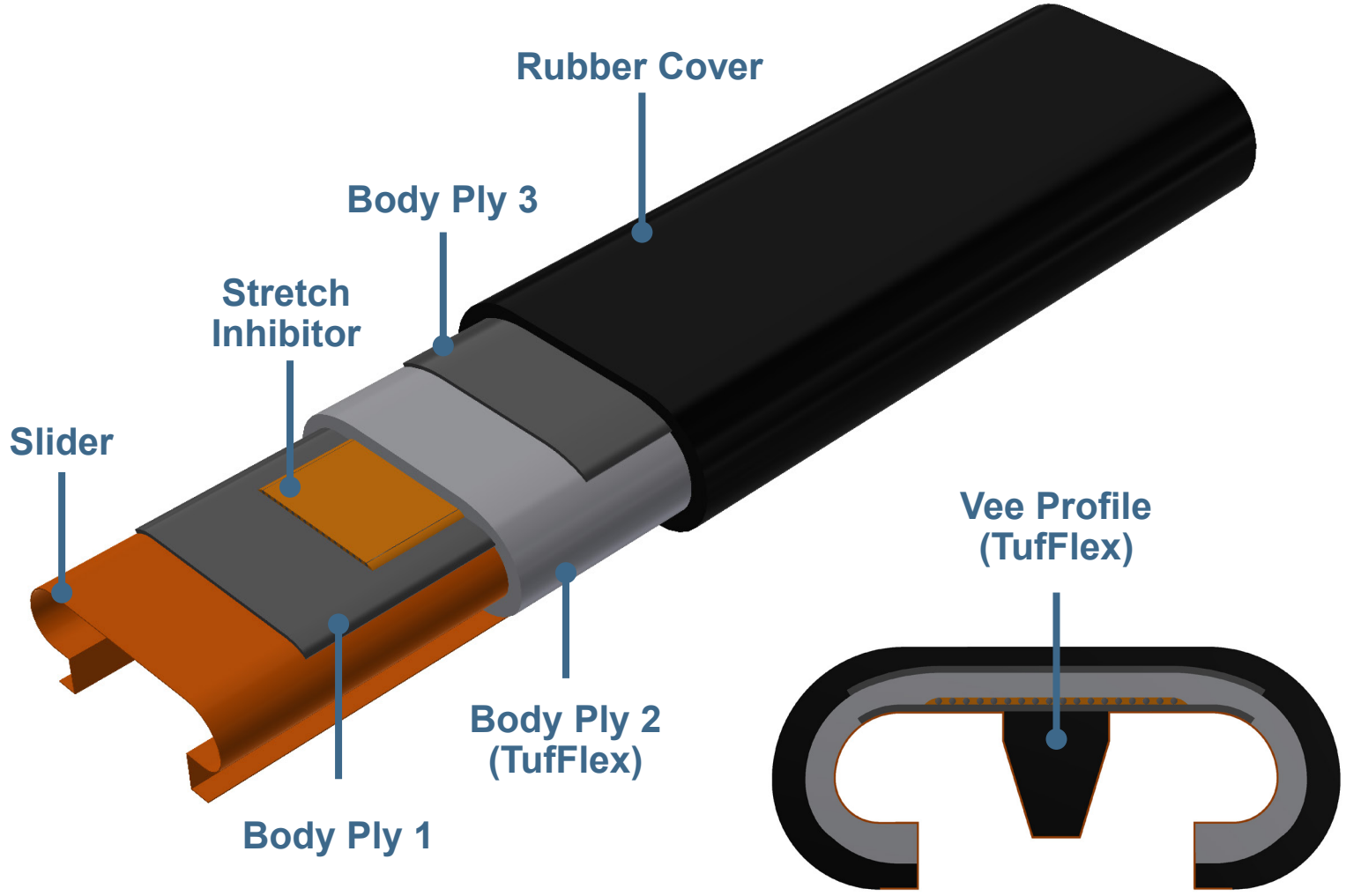
Slider Options:

Nylon – Indoor / Outdoor – Very durable slightly more abrasive – most common.

Cotton – Indoor Only – Less abrasive than nylon but cannot get wet.

Polyester – Indoor / Outdoor – Less abrasive than Nylon-often specified for plastic guides.

TufFlex handrails consist of multiple layers of rubber and fabric. These layers add to dimensional stability and lip strength. If the bond between layers is compromised (delamination), the handrail loses stability and strength.



Anatomy: NT (TPU)

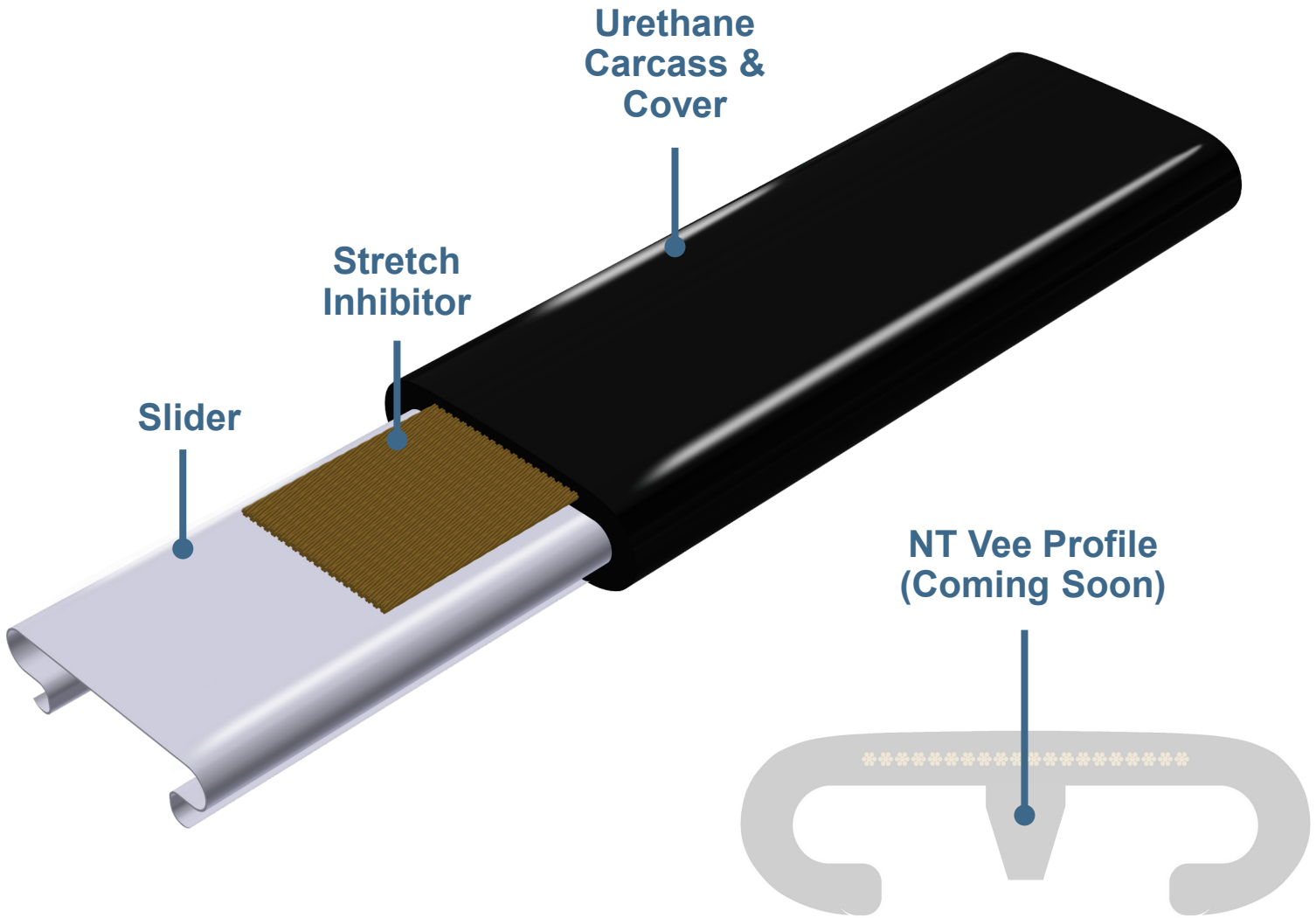
Slider Options:

Polyester Only – suitable for indoor or outdoor use.

NT handrails consist of only 3 components.

Stability and strength are provided by the material properties of the thermoplastic polyurethane.

This eliminates the possibility of delamination of layers which can occur with rubber handrail.



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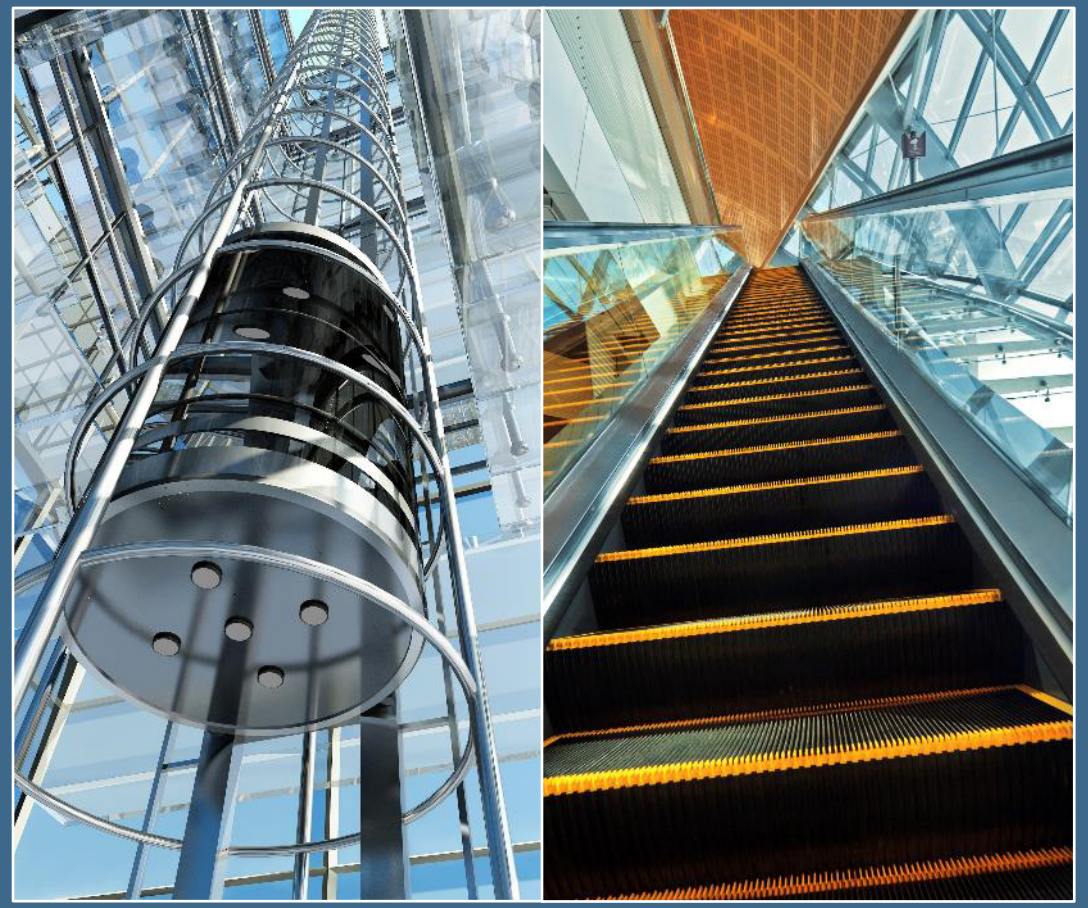
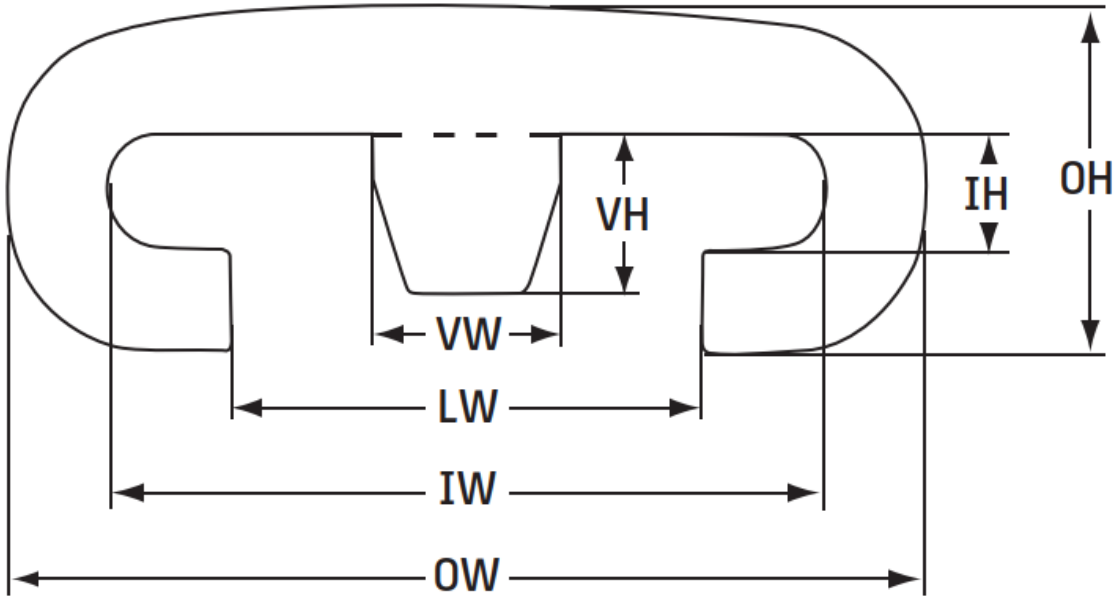


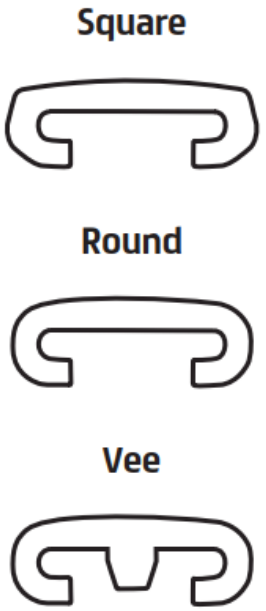
Physical Properties

Dimensional Stability

Handrails need to maintain key dimensions during their operational lifetime. Lip width, inner height and inner width are critical, as they interact with, and contact, the escalator. These dimensions need to maintain clearance to escalator guides and rollers to minimize wear.

OW: Outer Width
OH: Outer Height
IW: Inner Width
IH: Inner Height
LW: Lip Width
VW: Vee Width
VH: Vee Height





Important Properties

Lip Strength: Resistance to spreading the lips apart – is critical in keeping the handrail on the guides during operation.

Dimensional Stability: Critical to maintain a cool running handrail that stays on the guides.

Flexibility: Flexible along their length to withstand the repeated forward and backward bending during operation.

UV Resistance: Use of UV resistant packages allow handrails to resist UV degradation.

Traction / Friction: Slider material must have good traction for drive but also low friction to reduce heat from friction.

Moisture Resistance: Outdoor handrail must have synthetic slider material to resist mildew and rot from moisture penetration.

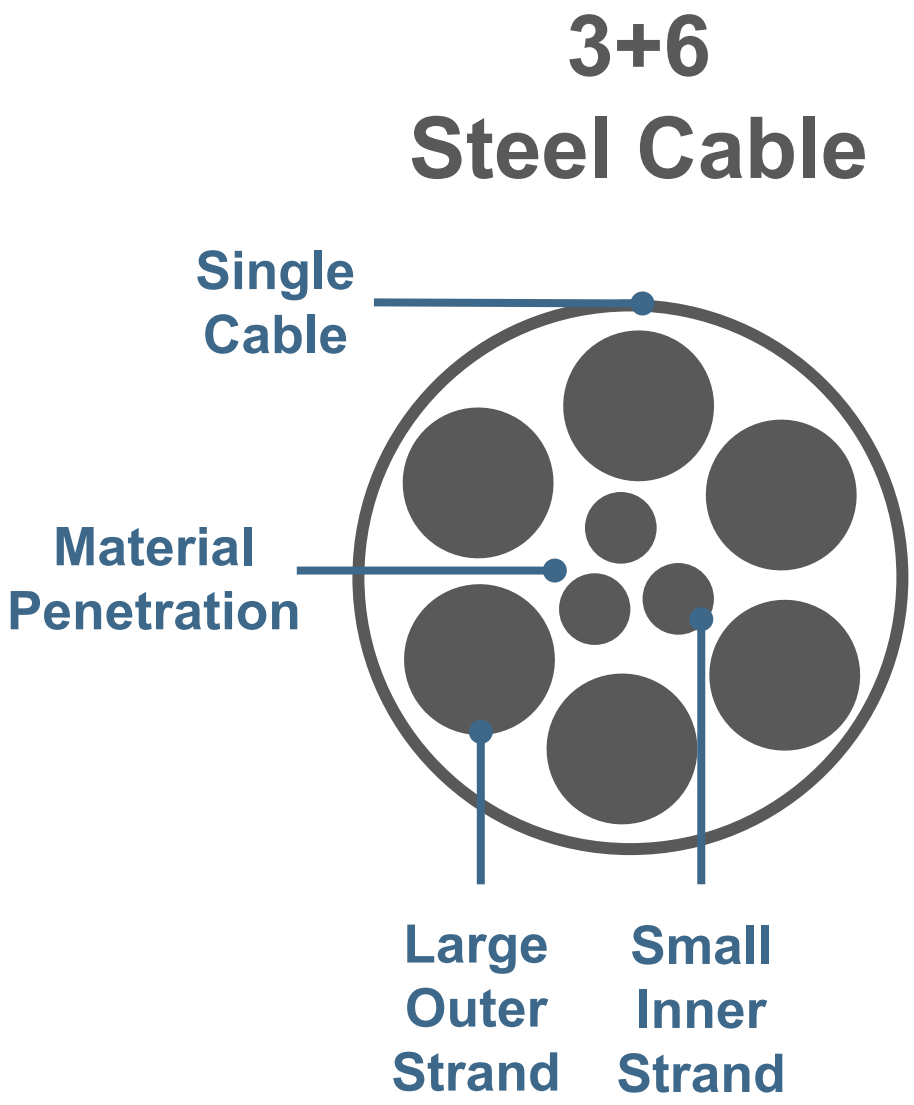
Stretch Inhibitors

Stretch Inhibitors in modern handrails are made up of twisted steel wires. Wires must be capable of continuous flexing while also maintaining high tensile strength and dimensional properties. Resisting both ***stretching*** and ***shrinking***.

Yes, handrails can shrink! This occurs when wires begin to fret against each other during flexing and is accelerated with wire that has poor material penetration.

Once wire begins to fret, tiny particles of steel begin to oxidize causing particle expansion. Larger particles displace the wire cords outward effectively tightening the wire twist, shortening the wire length.

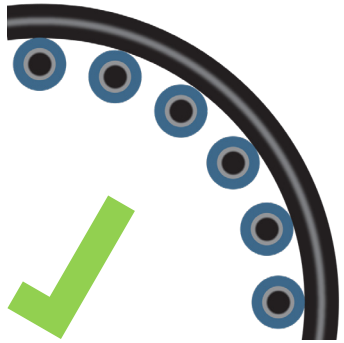
A 3+6 pattern is used in all handrails to improve rubber and urethane penetration.



Bend Radius Limits

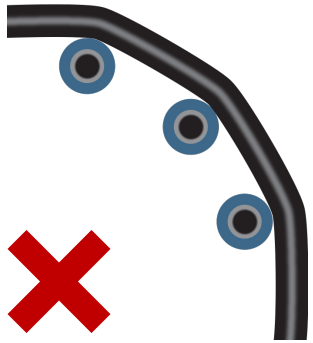
Handrails are designed to be flexible along their length. However, there are limits which should not be exceeded. Larger handrails require greater radius limits.

Bend radius can be controlled by proper roller placement and spacing.



Closely Spaced Rollers

- Creates One Large Radius
- Decreased Lip Area Stress
- Longer Life



Widely Spaced Rollers

- Creates Multiple Small Radii
- Increased Lip Area Stress
- Shorter Life

Bending Forces

A handrail bending during operation is under elongation and compression stress.

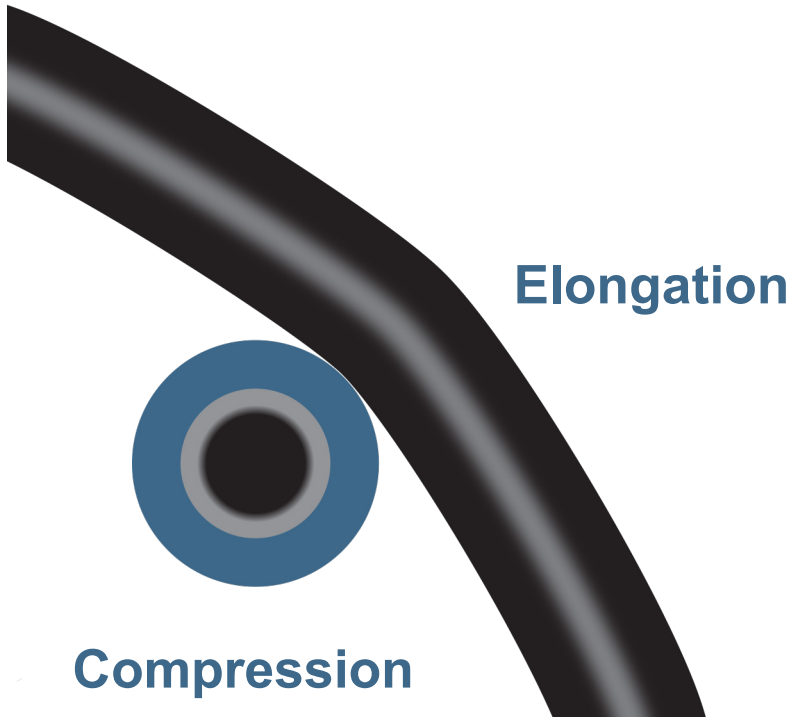
Smaller bend radius, increased wrap or larger handrail profile, all increase stress on the handrail.

Forward Bend

- Lips & Shoulders Compressed
- Face & Crown Elongated

Reverse Bend

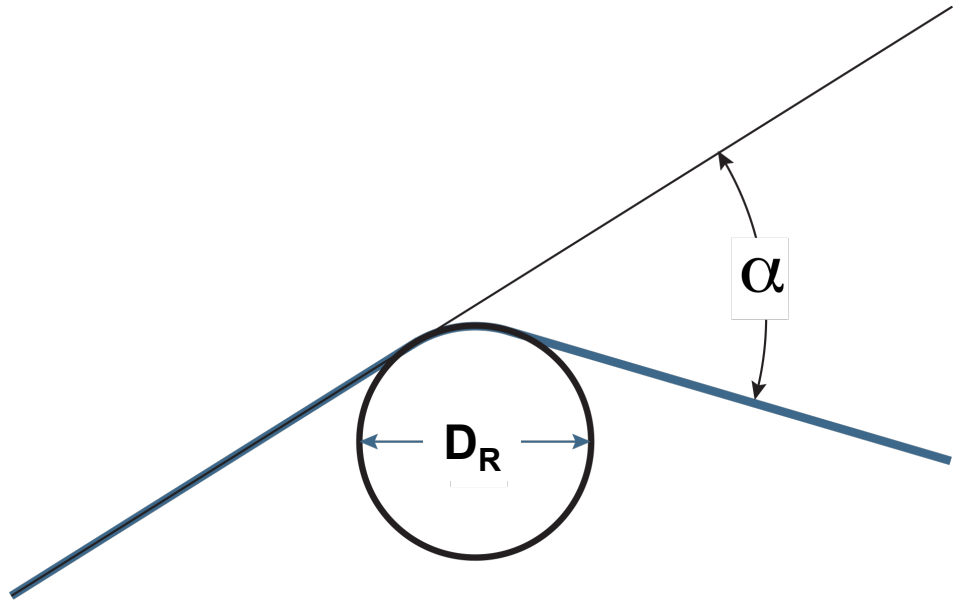
- Lips & Shoulders Elongated
- Face & Crown Compressed



Excessive Wrap

Handrails should never bend sharply around a single roller. This is referred to as excessive wrap. The example below is for 80NT style handrail. Wrap over single rollers exceeding the maximum will result in significant reduction of service life.

Roller Diameter	Max Wrap Angle
Min D_R ≥ 50	α ≤ 13°
Min D_R ≥ 60	α ≤ 15°
Min D_R ≥ 70	α ≤ 25°



Handling & Minimum Bend Radius

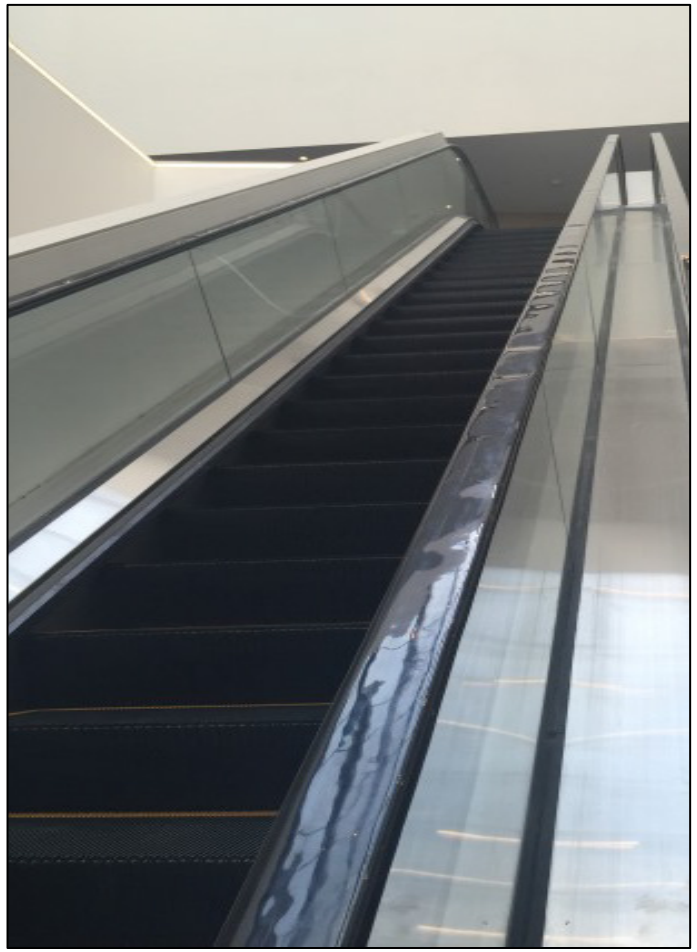
Improper handling and storage can impact handrail life.

Pulling from a single point will exceed minimum bend radius and create permanent deformations referred to as a kink or buckle.

Kink: a permanent deformation of the stretch inhibitor (wire).

Buckle: a permanent deformation of the shoulder / lip.

Handrail should never be bent or coiled in a way that deforms the normal shape.



Kinks

Buckles

Adjustment Considerations & Examples

Excessive wrap can occur if a roller cluster is adjusted incorrectly.

Schindler 9300 Escalators

May have issues if the handrail is installed using the upper end of the adjustment range. It is not recommended using the top 30% of the length adjustment range as the cluster will be too close to the drive wheel and the handrail will have excessive wrap over the final cluster roller.

Otis 506/508 Escalators

Roller clusters can be rotated on the downward side of the drive. This can cause the handrail to wrap around a single roller on the entry or exit side of the cluster. Careful attention to handrail path is required.

Kone Escalators

Some have length compensation devices that consist of a bow rollers that can pivot on one end. If adjusted too far from horizontal, the handrail will wrap excessively around one of the end rollers. Diligence must be used when maintaining these units to keep the cluster as close to horizontal as possible. The pivot point is also adjustable in a track to help keep the cluster horizontal.

Drive Systems & Handrail Tension

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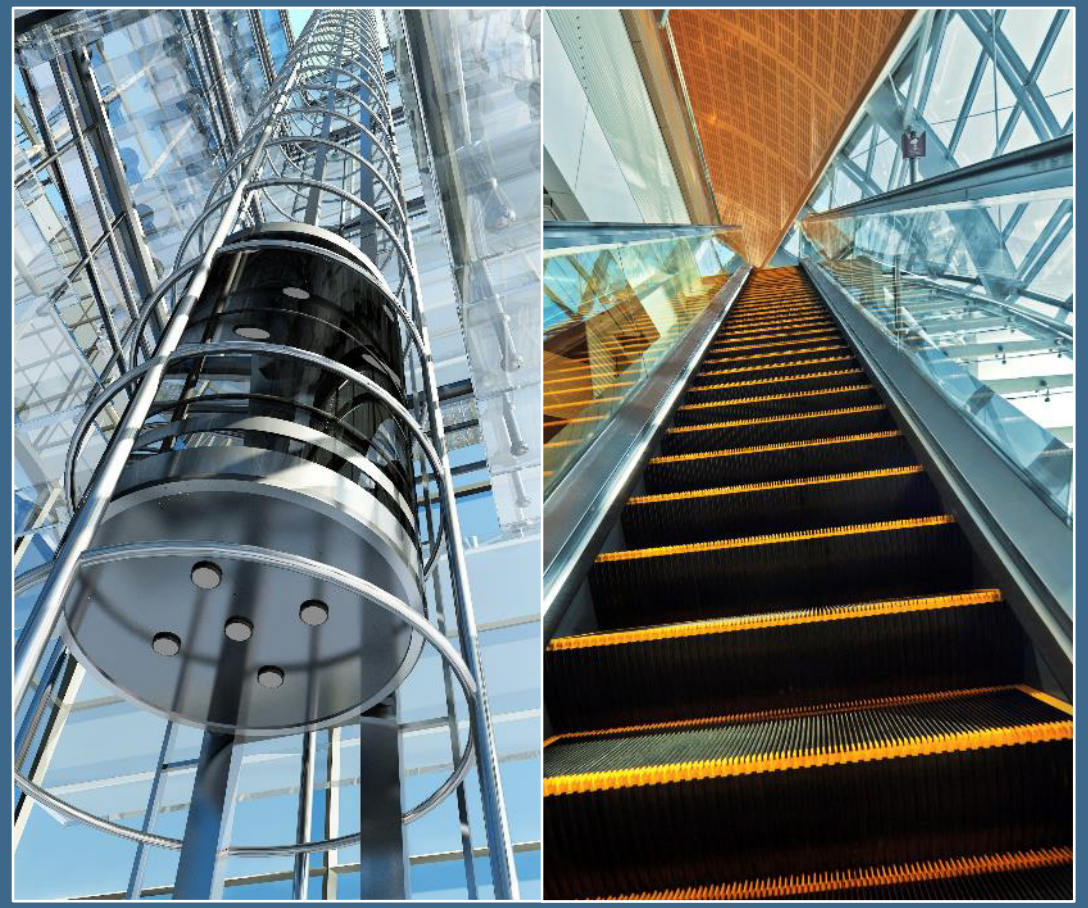


Newel End Drive

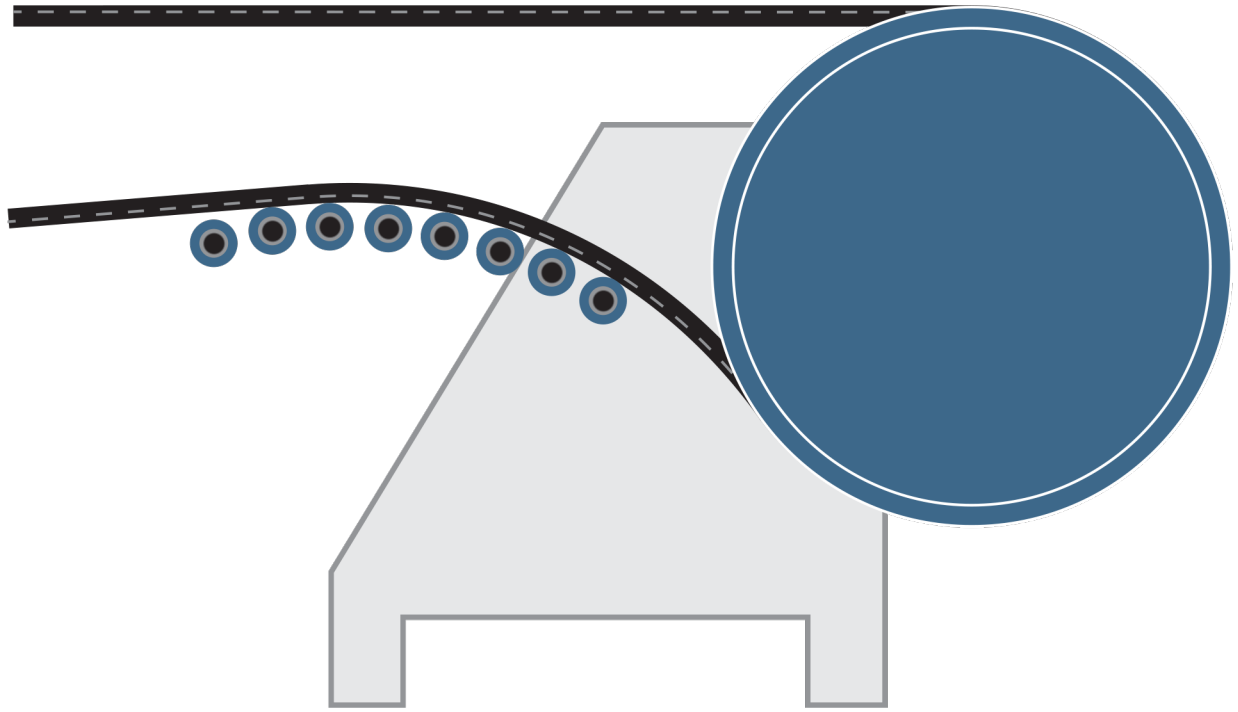
Originally, there were only newel end drive types which are less common today.

Typically, these are solid balustrade units.

Handrail newel ends are large wheels (with or without lagging), capable of Flat or Vee profile

Tension and drive force are one and the same with this type of drive.

To gain additional traction (drive) tension must be applied to the handrail.



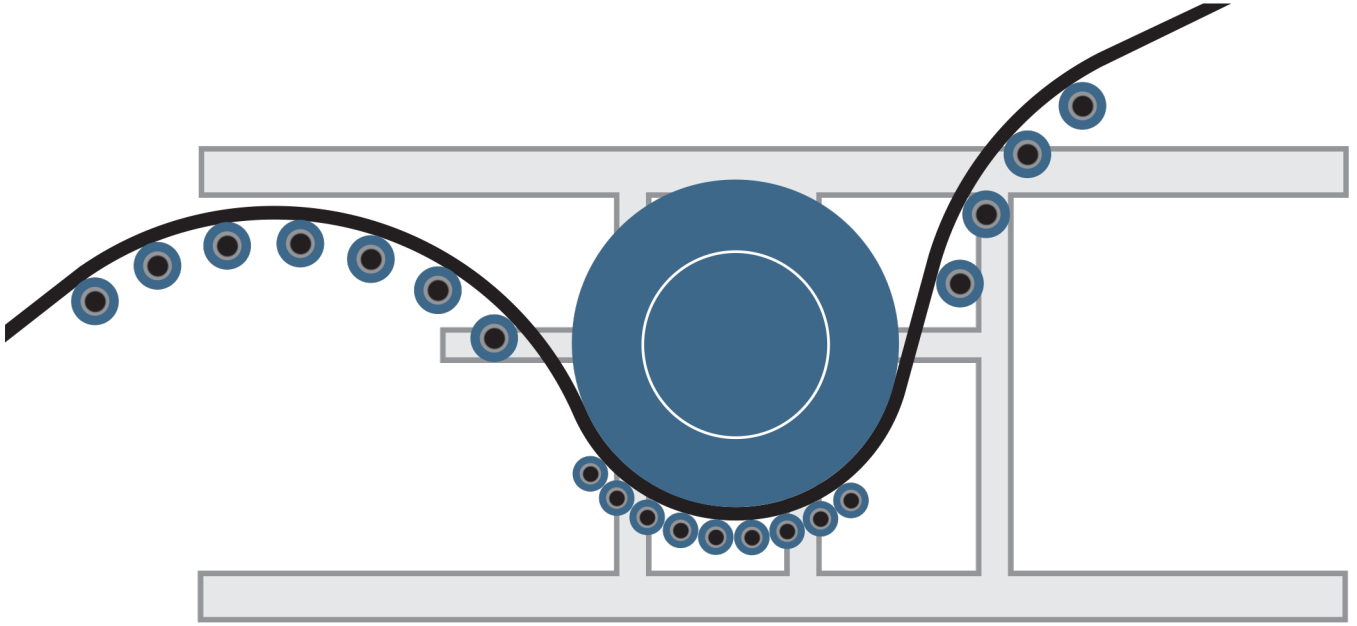
Reverse Bend Drive: Overview

Handrail drive wheel was moved down into the truss, forcing handrail to bend backwards at a smaller radius than the previous newel end drive required.

Tension and drive force are separated with this design but are still able to affect each other.

Drive force (traction) is increased via hugger belt, roller chain or pressure rollers which press handrail onto drive wheel, *adjustable with spring preload.*

Handrail should follow designed travel path at lowest possible tension setting, always maintaining contact with reverse bend roller assemblies.



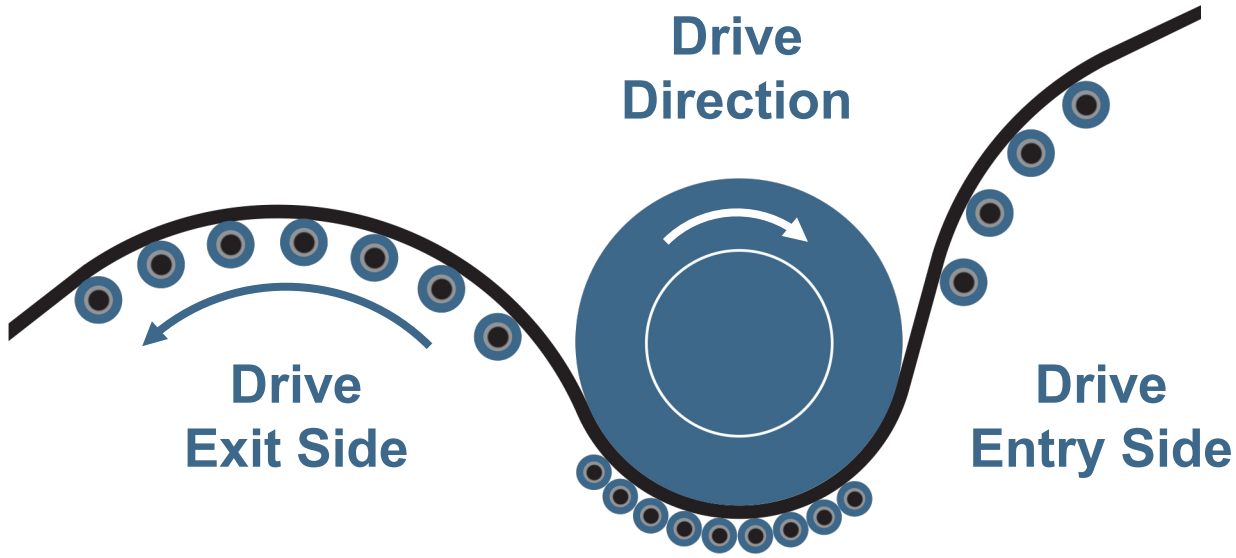
Reverse Bend Drive: Adjustment

Simplified drawing at right represents typical reverse bend drive operating in up direction as indicated by arrows.

Reverse exit and entry to operate in down direction.

If handrail is adjusted too slack (loose) it will lift from roller clusters on exit of the drive during start up or under passenger load.

Adjust slack to ensure handrail maintains contact with exit side rollers.



Linear Drive

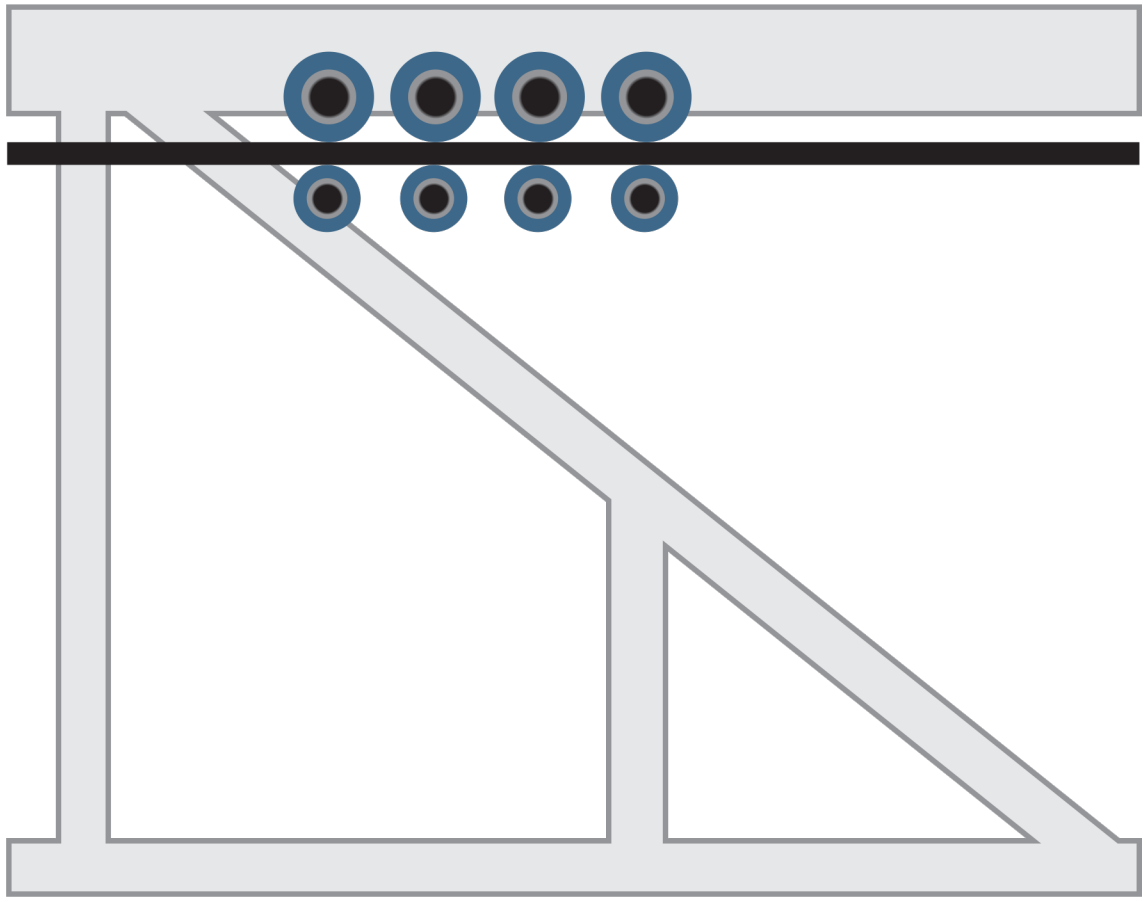
Designed to be compact and modular (more than one can be used for long rises).

Eliminates or reduces the severity of reverse bends.

Tension and drive force are separated with this design.

Relies on pinch force of pressure rollers against handrail and drive rollers for drive.

Tension should be left as low as possible with the handrail continuing to follow the designed path of travel.



Warning Indicators

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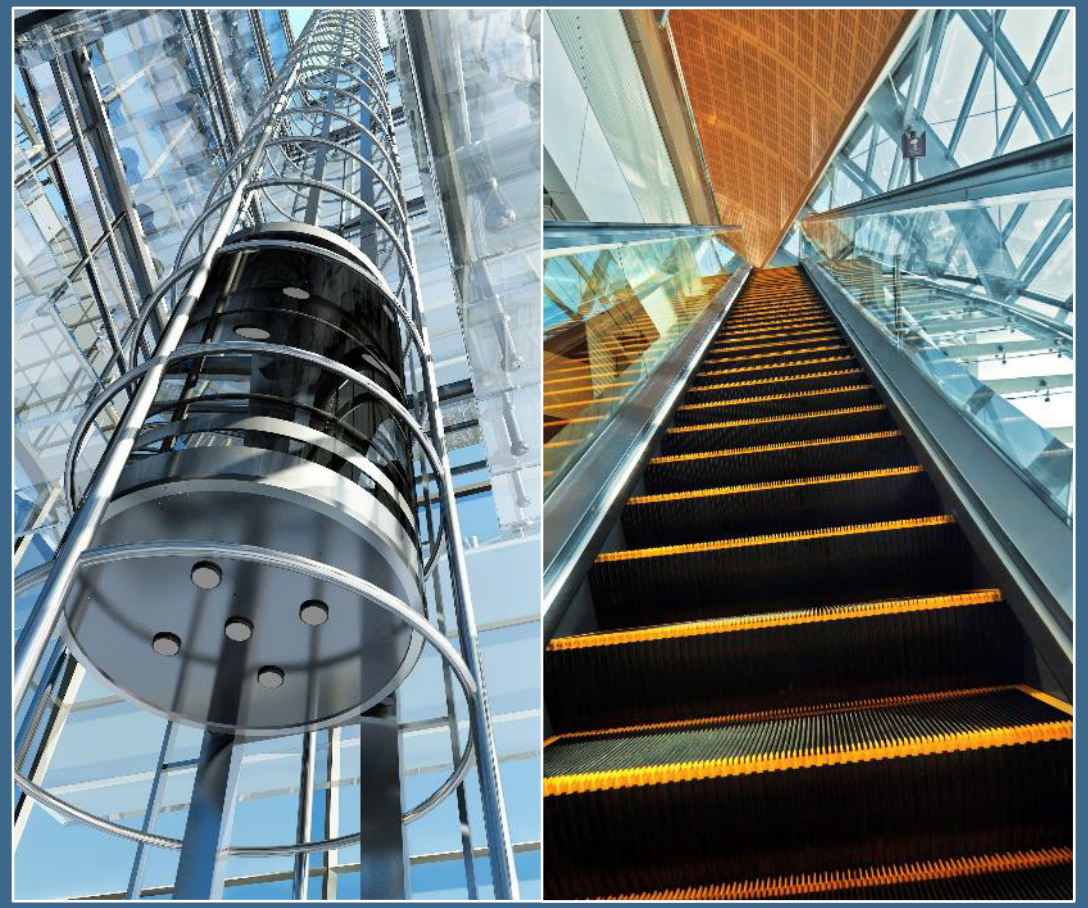


Warning Indicators: Heat

A ***warm*** (or ***hot!***) running handrail is telling you there is a problem.

Handrails normally operate 5˚C warmer than ambient temperatures due to drive forces, bending and guide friction.

If a handrail begins to exceed 5˚C increase, excessive friction or excessive drive force is being applied to the handrail.

Inspect escalator or moving walk for proper handrail adjustment.

Tension – Tracking – Drive Force

Guides should be cleaned and vacuumed to eliminate debris, then carefully inspected for broken or missing pieces that may have been deposited elsewhere in the system.

The ***only*** exception to the temperature rule above is handrail exposure to sunlight. Temperatures can be extremely high in this environment and will shorten expected life.

Warning Indicators: Wear

Small amounts of dust accumulation should be considered normal. The handrail fabric rides against the guides and while designed to do this – there will always be a small amount of wear.

Excessive dusting can be an indication of poor tracking, excessive handrail tension / drive force or breakdown of materials due to age.

Handrails should ***never*** make hard contact with any guide or rollers except at the newels and drive. Outside of these areas, the handrail should be **“floating”** with minimal contact force.

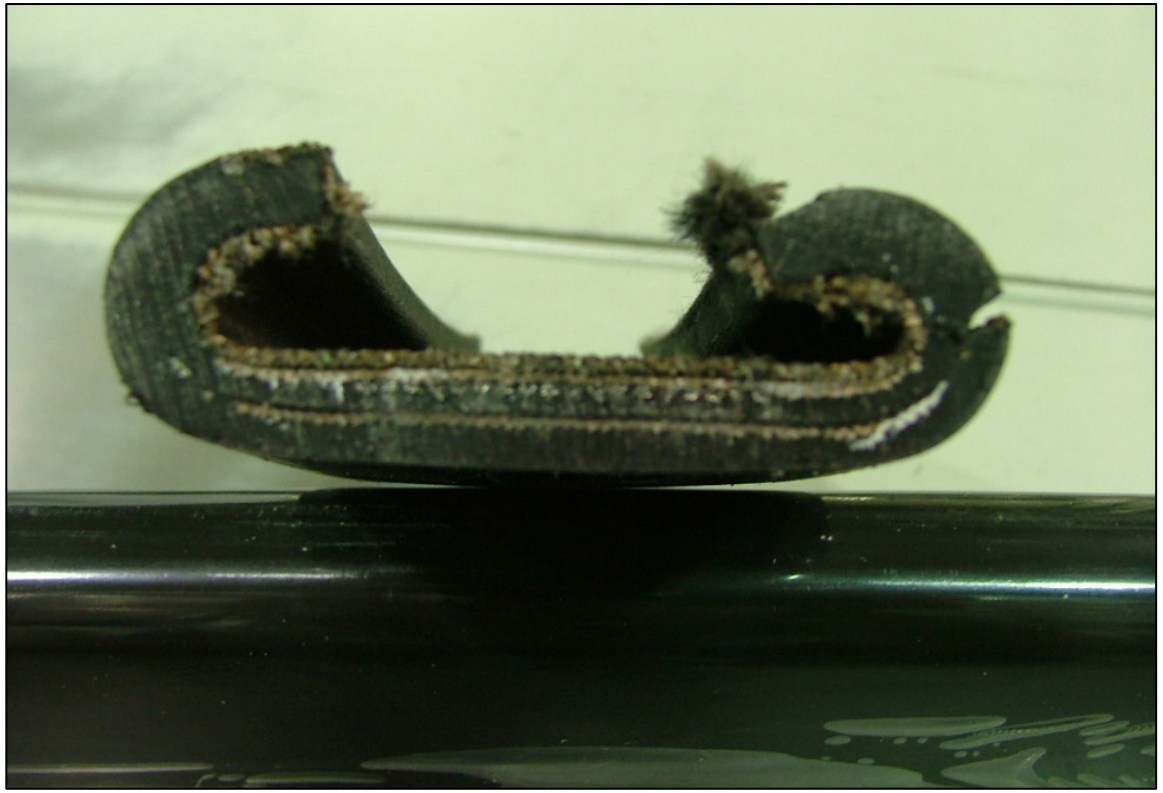
Inspect the escalator guide system and drive system for excessive contact or sharp edges.

Guide rollers should ***never*** be used to **“steer”** the handrail through the drive. The drive should be adjusted to ensure true handrail tracking through the system without the lip contact of drive rollers / wheel or guide rollers.

When a handrail is changed, tracking will change and should be adjusted as needed.

Ex: Dusting

Ex: Tracking



Handrails must be centered on drive wheels and not contact lip area to avoid type of damage shown above. This is normally caused by incorrect tracking through the drive system.

Ex: Delamination

Root Causes:

- Poor Layer Adhesion
- Excessive Pressure / Tension

Separation between the internal fabric and rubber layers of a rubber handrail.

Excessive drive pressure and handrail tension can cause internal friction between layers, breaking down the bond between materials.

Warning Indicators: Age

Environment

Heat, Moisture and UV Exposure can all reduce handrail life when compared to operating in a climate-controlled environment. Handrails will age faster in more extreme environments. Environment plays a major role in handrail longevity and is the second largest aging factor after maintenance.

Excessive Dusting

Materials breaking down from age (handrail is properly adjusted and maintained). If a handrail is dusting excessively and *is not considered old*, this is a sign of excessive contact within the escalator that should be investigated **immediately.**

Cover Material Surface Cracking (Weather Checking)

Rubber material has lost its elastomeric properties and is no longer able to withstand the continuous flexing required. These cracks will eventually cause handrail splitting. Handrails showing weather checking should be monitored and scheduled for replacement.

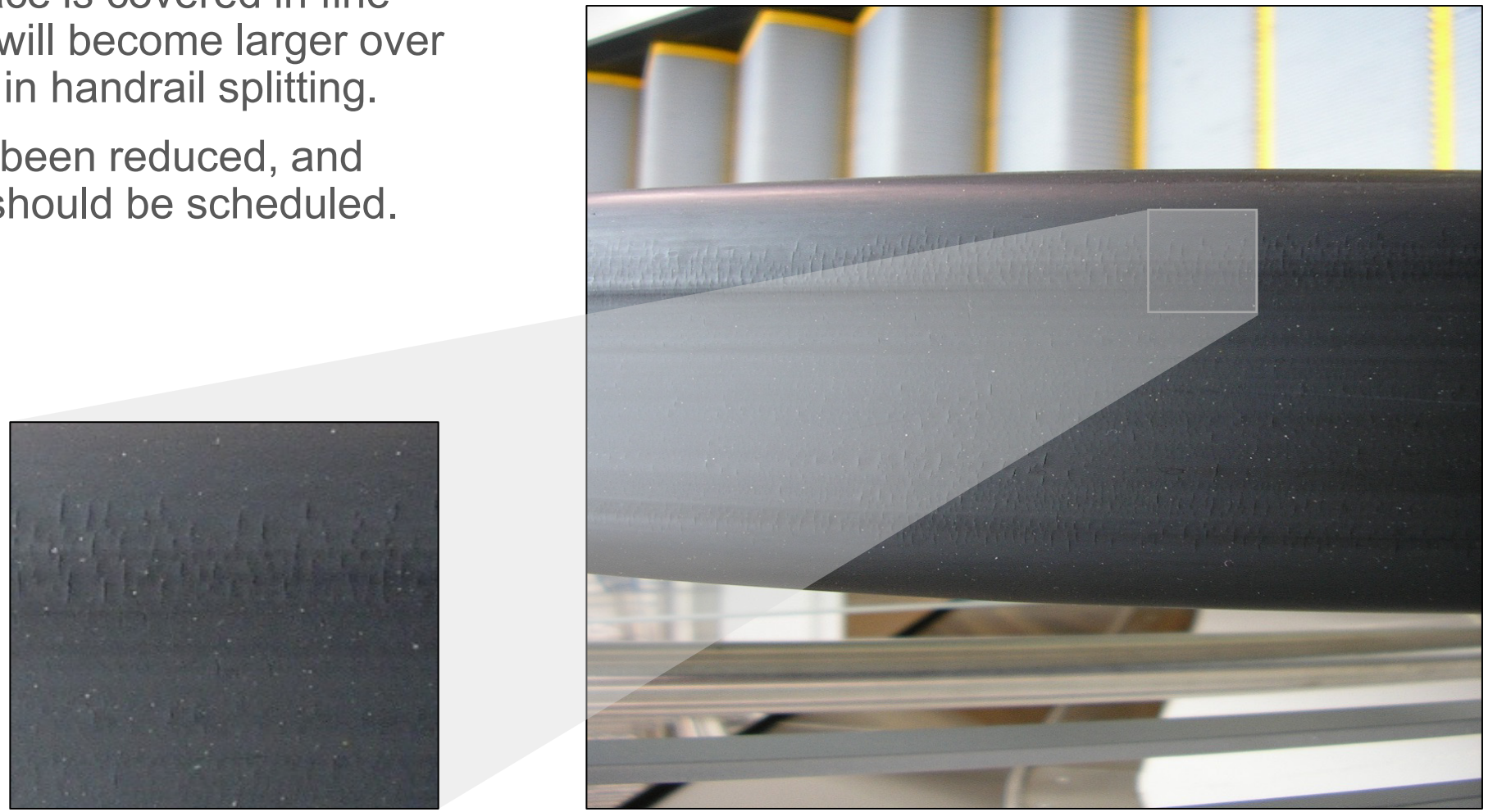
Improper Cleaning Products

Harsh solvents or other chemicals can damage handrails and may show as premature aging. Use only **approved cleaners.**

Ex: Age / Surface Cracking (Weather Checking)

Handrail surface is covered in fine cracks which will become larger over time resulting in handrail splitting.

Elasticity has been reduced, and replacement should be scheduled.



Summary

Handrails are designed to be both flexible and dimensionally stable. Varying drive types require slightly different setup strategies to ensure optimal performance. Handrails will display early warning signs if operating improperly.

Preventative Maintenance

Lack of maintenance is the leading cause of early handrail replacement. Guides and newel end rollers should be inspected and cleaned (vacuumed) on a regular basis – at least quarterly. Replace worn or seized components promptly to prevent damaging the handrail.

Maximize Handrail Life

- Ensure Proper Tensioning & Tracking
- Uphold Minimum Bend Radius Tolerance
- Follow Approved Handling & Storage Methods
- Schedule Regular Maintenance & Performance Inspections
- Maintain Finish Using ***Only*** Draka EHC Cleaners & Polishes

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