

ELEVATOR GUIDE RAILS INSTALLATION AND ALIGNMENT

by Asray Sanayi Ve Ticaret Ltd. Sti.

Elevator guide rails are components of elevator systems that define the path along which the elevators ride. An elevator should not be expected to operate regularly and safely on guide rails that do not possess the minimum quality standards and that are not installed properly. Data receivers which transmit to the control system the information about the position of elevators, doors, door locks and safety brakes are designed on the assumption that guide rails will follow certain paths. Guide rails are manufactured in fully equipped factories possessing high-quality measurement systems. However, guide rails manufactured in these factories may be installed into poorly built elevator wells at construction sites. The quality level expected of elevators can be achieved only if the manufacturing and installing processes are coordinated successfully. Consequently, we have allocated more room for practical information herein which might be handy for a field technician rather than information on manufacturing processes and calculation methods and techniques.

Here are the conventional expectations of guide rails according to EN 81-1 Standards:

"Guide rails. Their joints and attachments will be sufficient to withstand the loads and forces imposed on them in order to ensure a safe operation of elevators.

"The aspects of safe operation of lift concerning guide rails are:

a) Car, counterweight or balancing weight guidance shall be assured.

b) Deflections will be limited to such an extent to ensure the following:

- ◆ unintended unlocking of the doors will not occur
- ◆ operation of the safety devices will not be affected
- ◆ collision of moving parts with other parts will not be possible.

"Cabin, counterweight and balancing weight will be guided by at least two rigid guide rails made of steel."

Under normal circumstances, guide rails simply define the elevator paths that elevators ride along and are assumed to be spared from the loads and forces imposed on the elevator cars. However, guide rails are subject to forces imposed on them and withstand these forces under the following circumstances:

1. Running conditions with the load unevenly distributed on the car floor
2. During loading and unloading
3. When safety gear is activated

Manufacturing and installing guide rails are two inseparable processes that secure the safe and smooth riding of elevators. Let's look into guide-rail manufacturing and installing processes designed to achieve the best results.

Guide rails are made of steel. The tensile strength of steel raw material used should be at least 370N/mm² and no more than 520N/mm² according to ISO 7465:2001 standard. For this purpose, it is recommended to use steel grade St 360-2 according to DIN 17100 standard and steel grade E-235B according to ISO 630:1995 standard (Photo 1).

Raw steel (Photo 1) goes through a hot rolling process (Photos 2 and 3) and is formed into a T profile. Thereafter, T profiles can be formed into high-quality guide rails using two different manufacturing methods.

1. Cold Drawing (Photo 5)
2. Machine Process (Photo 4)

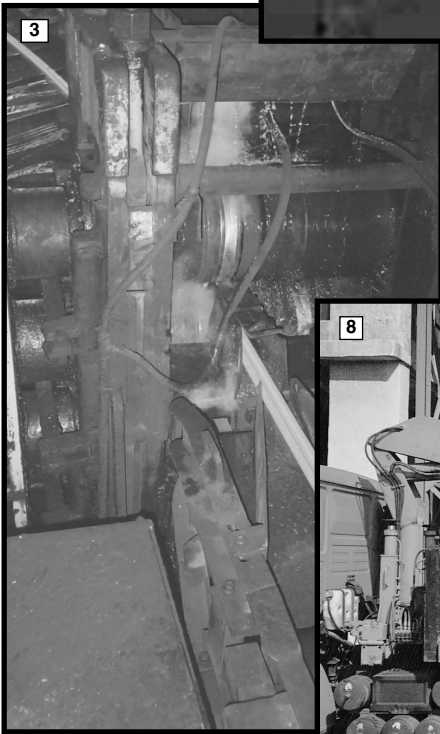
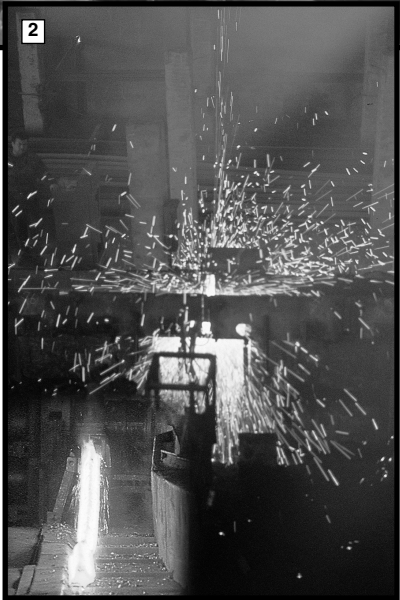
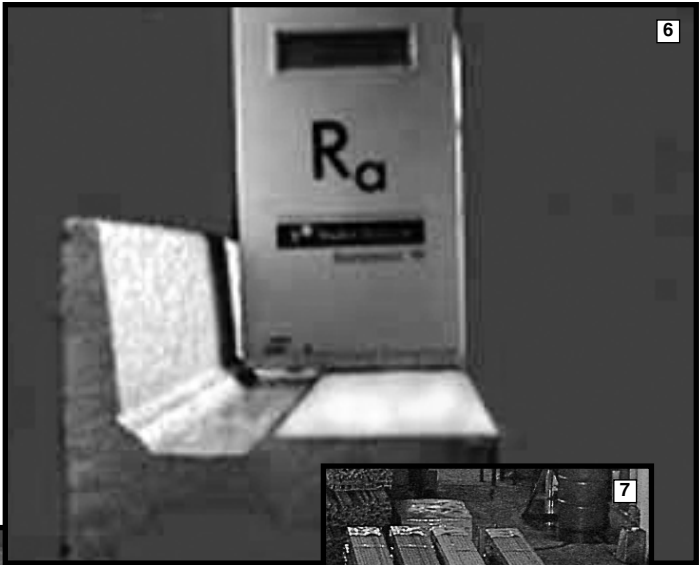
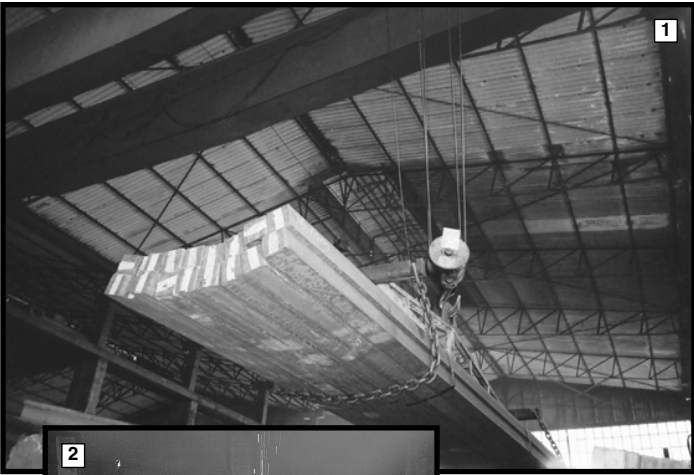
The reason why hot rolled T profiles are treated in those processes is those processes improve the quality of measurement and the smoothness of the surface. Surfaces of guide rails should be smooth and homogenous.

According to ISO standards 7465, "A" indicates cold drawn, "B" indicates machined guide rails and "BE" indicates high-quality guide rails.

Photo 6 shows the surface roughness measuring process. Guide rails manufactured in factories are packed and shipped in such a way that they would not be affected by environmental conditions (Photo 7). The guidelines set forth below should be followed during the loading and unloading of guide rails at construction sites.

Guide rails should be shipped in packages as much as possible. The use of crane trucks and forklifts when loading and unloading will minimize the risk of damaging key and keyways and the straightness of the guide rails. To ensure minimum damage, it is necessary to use crane trucks and forklifts (Photo 8).

Guide rails have to be kept in their packages at construction sites until they are installed in order to prevent them from being hit or smashed by heavy objects or consequential damages. Guide rails should be moved into elevator wells with maximum care and should be lifted with cranes or similar equipment as much as possible. The most common incident that happens while moving guide rails is the plunging of guide-rail ends into the ground, crushing their joints. We cannot completely avoid plunging and crushing guide rails, but we can guard them to a certain extent by fixing a piece of metal sheet that looks like a fishplate onto ends of guide rails (Photo 9).



Some manufacturers place plastic caps onto the ends of guide rails just to point out delicate parts. Assuming that these plastic caps will guard the guide rails and relying on the plastic caps will eventually lead to incidents which may damage guide rails. In a collision between a steel guide rail and an object as hard and as big, plastic caps will be too weak to prevent possible damage.

The surfaces of key and keyways and fishplates should be completely cleaned before connecting the guide rails. If there are damaged spots due to collision on these surfaces, they can be smoothed out by using a thin file (emery board) or sand paper (Photo 10). Using other heavy-duty tools like abrasion machines might cause even more damage (Photo 11).

Two secondary elements and their relationships with guide rails are extremely significant when installing guide rails. One of them concerns the braces that fix guide rails to the building. There should be enough room when fixing guide rails with braces in order to allow movement. Large scale stress due to heat-related enlargement can cause guide rails to deform if welded to the braces. Corrosion can cause further bonding over time. For example, a guide rail supported with braces with 2.5 meter intervals will be inclined to stretch : $\Delta L = LO \times \alpha \times \Delta t = 2500 \times 0.000012 \times 50^\circ\text{C} = 1.5\text{t mm}$. Again, the guide rails of an elevator that operates in a 50-meter-long elevator well with 50°C temperature differential will stretch 30 millimeters. The significance of the freedom of movement the braces have needs to be better understood.

To apply a substance (e.g., grease) on the brackets could help prevent possible bonding between guide rails and braces. Theoretically, it is assumed that braces contact guide rails at certain points. The larger the surface of the contacts the stronger the aggregate friction and bonding becomes due to corrosion.

Another important element is the fishplate. The linearity of fishplate surfaces contacting guide rails (Photos 14 and 14a) and the inertia of fishplates are extremely significant. Defects on the surface of fishplates are as significant as the straightness of guide rails. On the other hand, low inertia of fishplates directly affects the smoothness of the elevator ride. Thus, large elevators need thick and modified fishplates as shown in Photo 12.

The most important operation begins after moving guide rails and fishplates appropriately to the elevator well; that is placing the guide rails in the right positions and mounting them onto the walls. The following geometrical positioning should be ascertained when installing guide rails:

1. They have to be placed parallel (Photo 15).
2. They have to be placed vertical (Photo 16).
3. Surfaces on which the skates roll have to be placed on the same plane (Photo 17).

It is necessary to use some apparatus to secure the above positioning of guide rails. For instance, the apparatus shown in Photo 17 and Photo 13 is a simple and practical alternative to ensure linearity and facing surfaces of guide shoes are on the same plane.

Maximum tolerances allowed in accordance with EN 81-1 are shown below:

- a) five millimeters on both sides for safety mechanism car, counterweight and balancing weight guide rails.
- b) 10 millimeters on both sides for counterweight and balancing weight guide rails when there is no safety mechanism cabin.

If guide rails are not positioned as explained above, the following outcomes may arise:

1. When guide rails are not in vertical position:
 - ◆ Extra force will be imposed on guide rails, guide shoes and the elevator car.
 - ◆ Overall efficiency of the elevator will diminish.
 - ◆ Riding will be less smooth.
2. When guide rails are not positioned parallel:
 - ◆ That means the distance between the two guide rails is not the same all the way through. The elevator car will sit too tight between unparallel positioned guide rails at some points and too loose at others. Therefore, the car will vibrate when going through loose points and run less smoothly when going through tight points. Also, the rides through the tight points will cause inefficient running of the elevator and overburden the drive system. It is a fact that in some flawed installation cases, drive systems had been overburdened to the extent that the performance of the battery-operated rescue unit fell short of operating the elevators.
3. When the surfaces the guide shoes slide through are not positioned on the same plane:
 - ◆ Guide shoes will be short lived, because they will contact the guide rails linear instead of planar.
 - ◆ Functioning or emergency brake will also be problematic due to linear contact.
 - ◆ The elevator will make more noise than usual.

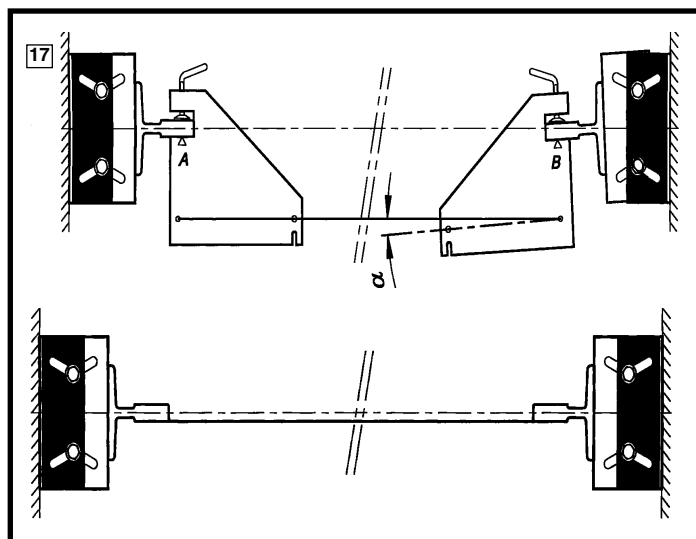
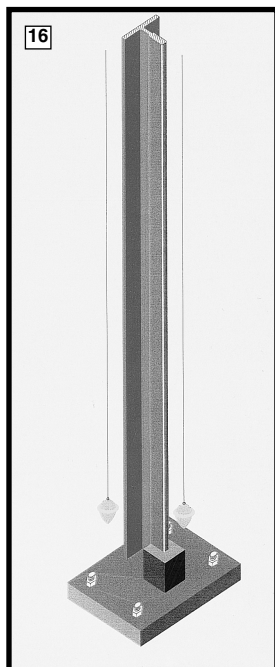
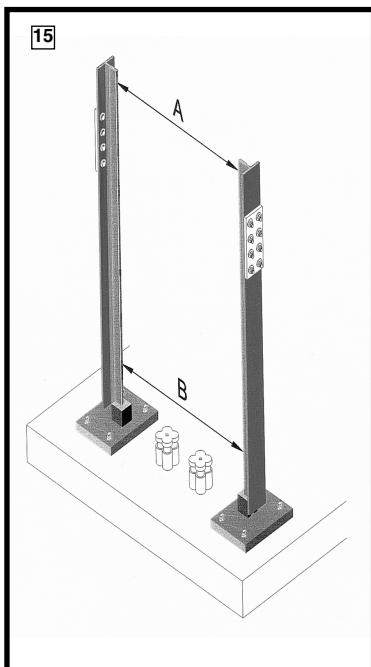
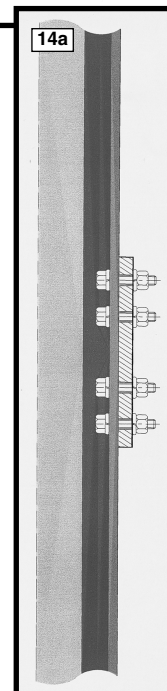
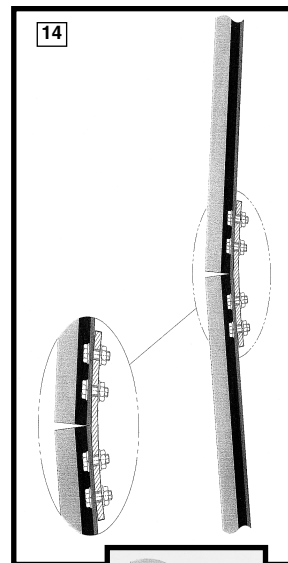
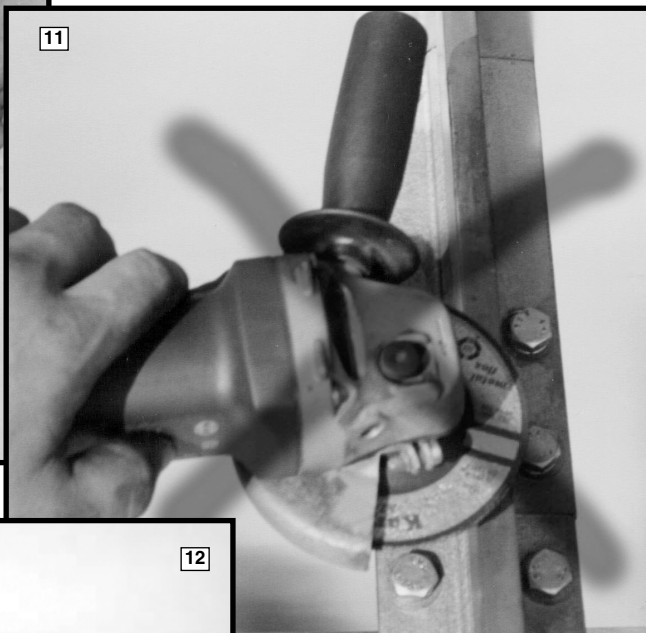
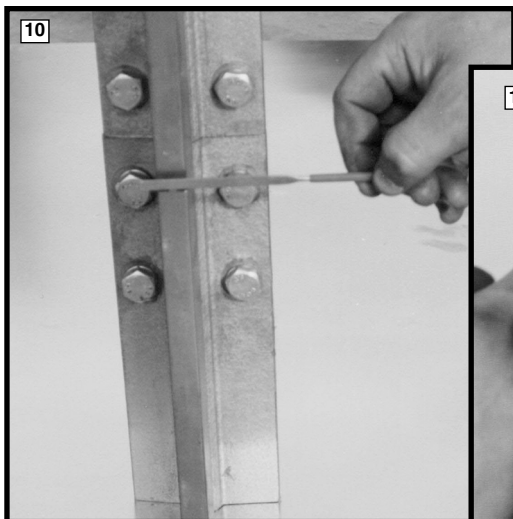
The life of guide rails and whether to replace guide rails when refurbishing elevators is a very controversial subject. The expected life is almost next to infinite in comparison to the other components of an elevator.

Guide rails should be replaced:

1. If damaged due to safety gear activation. In such a case, guide-rail surfaces will be mashed and dented. Such surface flaws will cause the guide shoes to be short lived, trigger emergency brakes and cause rides to be less smooth.
2. If the building is exposed to disasters like earthquake and fire. Such out-of-the-ordinary impacts may bend guide rails, resulting in improper functioning.
3. If an accident ends up damaging the guide rails.

The quality of the elevator operation is dependent on the installation of a properly positioned and properly maintained guide rail system. Consequently, it is important for the aforementioned precautions and installation procedures to be followed.





RIDING PATH: INSTALLATION AND ALIGNMENT

by the Savera R&D Team

Guides are still considered a unitary component, which is a mistake, because what is really important is the riding path, which includes the guides fully installed. Another common mistake is to place greater importance on the cost of the installation, rather than on making sure that the riding path meets the conditions required for the designed installation.

Alignment of Guides

Alignment of guide-rail joints is of the utmost importance for final comfort and it affects the whole speed range. Alignment on current guide rails also depends on the assembly staff, as screw clearance on one of the axes can lead to great misalignments. The parameter which affects comfort is the change in slope that produces lateral accelerations. The problem occurs when there are much higher slope changes in the guide joints than those produced inside the guide rails.

In the beam flexion theory, deformation is represented by magnitude y . Along a single guide rail the variation of this deflection y – guide rail deformation – and also of $y' = dy/dx$ – beam inclination angle at this point – has a continuous behavior, in such a way that the angle variation or second derivative $-y''$ has a constant value

along the guide rail (see Figure 1).

Nevertheless, when two or more guide rails are assembled, if appropriate steps are not taken, this continuity at the joints is not maintained. Even when having two extremely high-quality guide rails, if the assembly is not made correctly it finally leads to a decline in the global quality.

The most important effect at the joints is the sudden change of the angle or variation of slope $-y'$. As can be seen in Figure 2, normally when two guides are assembled, the existing angle at the joint is not the same on the left side (end of guide #1) as on the right side (beginning of guide #2), so that $y'_{\text{left}} \neq y'_{\text{right}}$ with variation values five times higher than the values found inside the guide rail. This discontinuity or sudden change in the angle at the joints implies a very big variation in the second derivative or, what is the same, big accelerations when the elevator travels over these points.

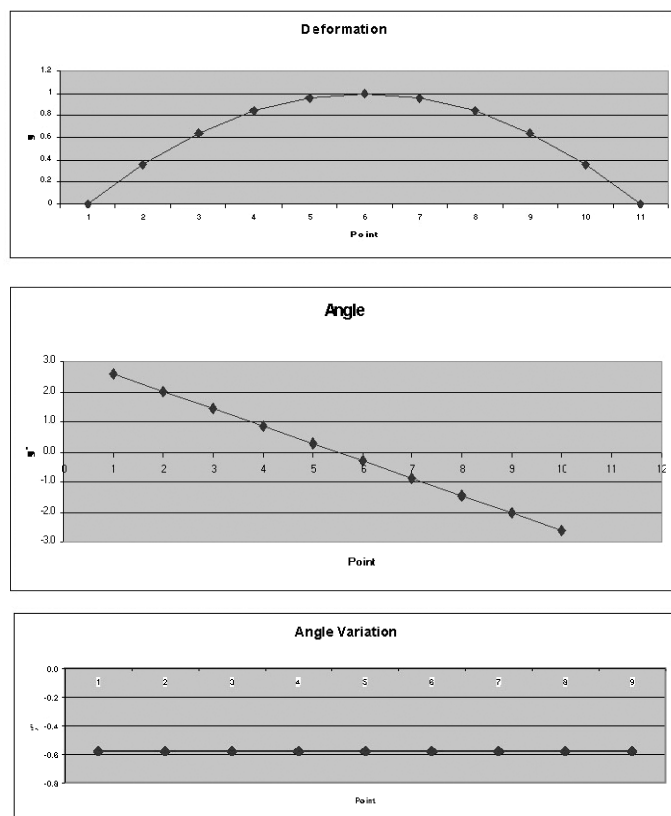


Figure 1: Single guide rail

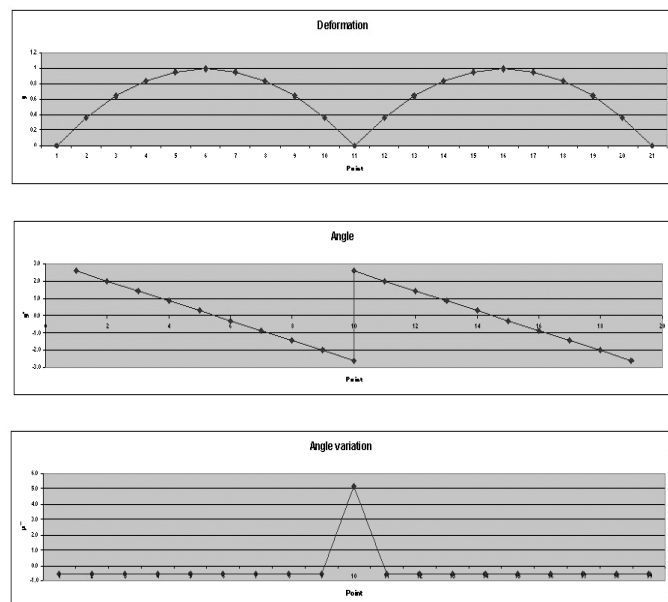
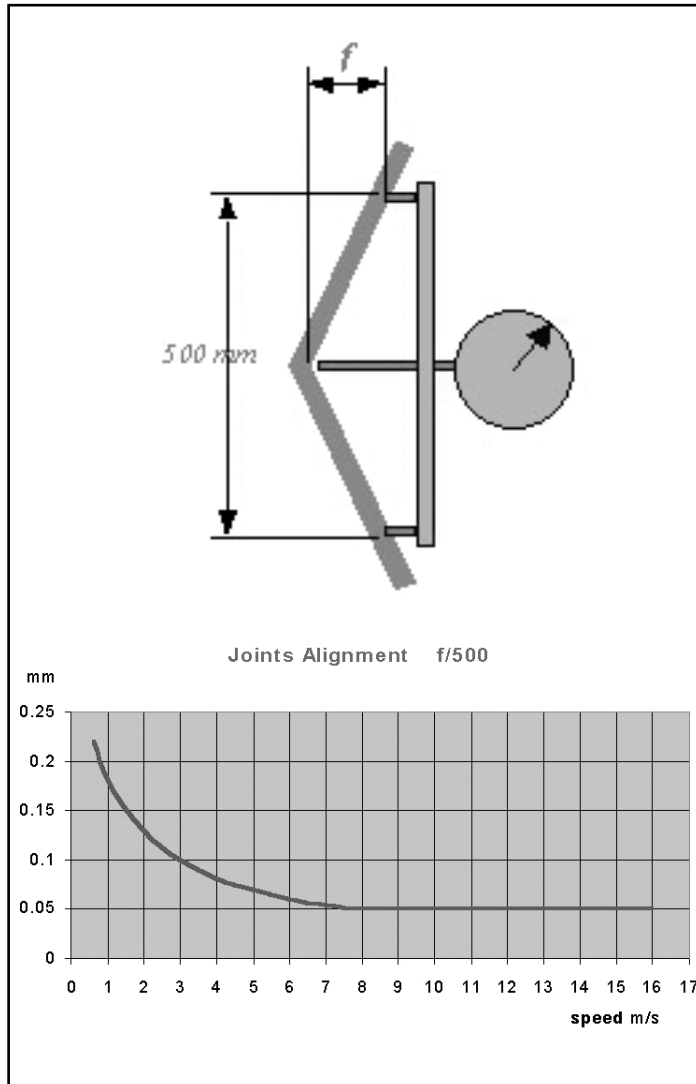


Figure 2: Assembly of two guide rails

The solution that SAVERA has adopted for eliminating this discontinuity of the angle or slope is the installation of the Autoline System®, which guarantees that at the guide joints:

1. $y_{\text{left}} = y_{\text{right}}$
2. $y'_{\text{left}} = y'_{\text{right}}$
3. $y''_{\text{left}} = y''_{\text{right}}$

having a continuous guide rail and therefore lower accelerations when the elevator travels over the joints. Consequently, comfort is guaranteed, particularly at high speeds.



We have used $f/500$ (Figure 3) to define alignment limits in a simple way. The speed of the lift determines the precision required in order to maintain the same level of comfort. Our idea is to supply another kind of guide, automatically aligned simply by tightening the screws in such a way that the riding path is like a continuous guide rail without any influence from the joints. As mentioned before, we recommend the use of the Autoline System, which is a system with different solutions for different customer needs.

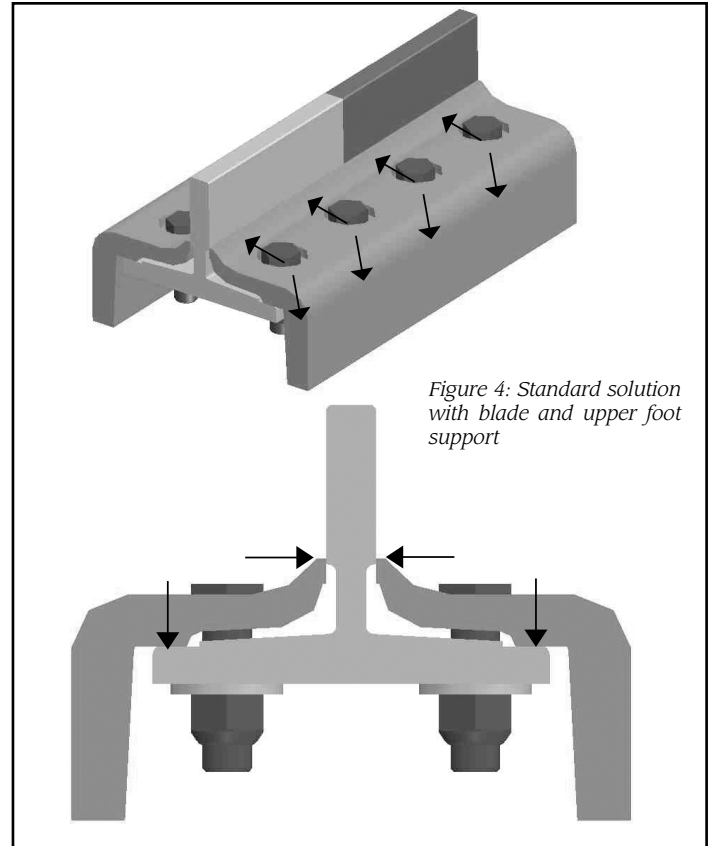


Figure 4: Standard solution with blade and upper foot support

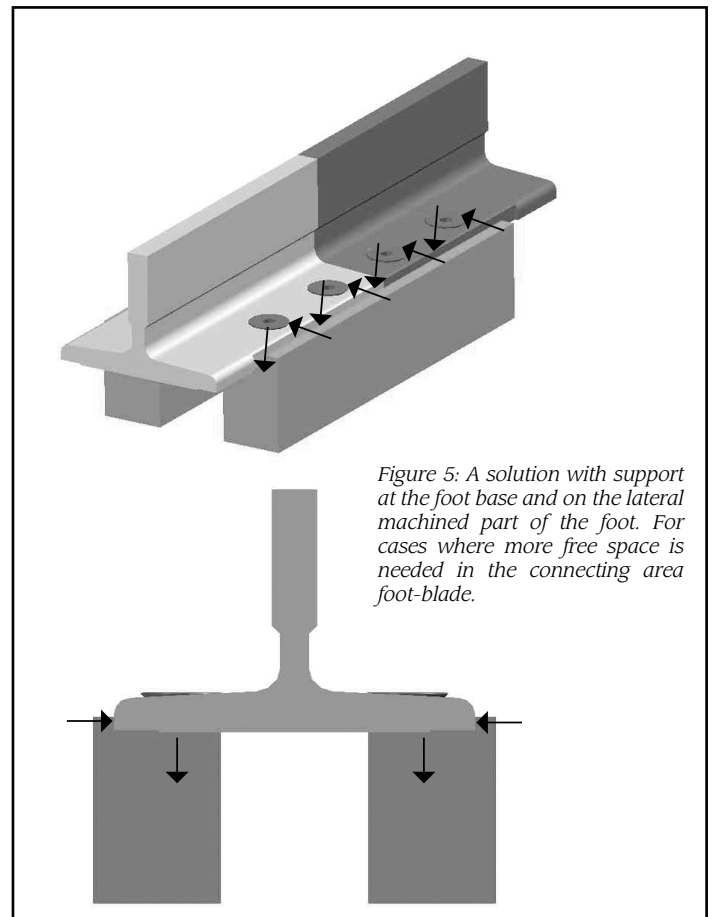


Figure 5: A solution with support at the foot base and on the lateral machined part of the foot. For cases where more free space is needed in the connecting area foot-blade.

By using Autoline, we have the following advantages:

- ◆ Automatic alignment on the two axes simply by tightening the screws
- ◆ No need for post-alignment control
- ◆ The rigidity of the plates supported on the two axes is high, since there can be no movement between guide and plate
- ◆ It behaves like a continuous guide rail

Installation of the Guides

Guide-rail installation requirements that must be met are:

- ◆ Having adequate means for correct installation
- ◆ An ease of use not requiring special training of staff
- ◆ Precision and reliability to ensure the quality of the installation
- ◆ Easy viewing of misalignment with regard to the references

To ensure correct positioning of the riding path with regard to the plumb lines used as an assembly reference, it is advisable to use tools similar to those in Figure 6. The template ensures that the distance between the guides and alignment on the YY axis is correct (see Figure 7).

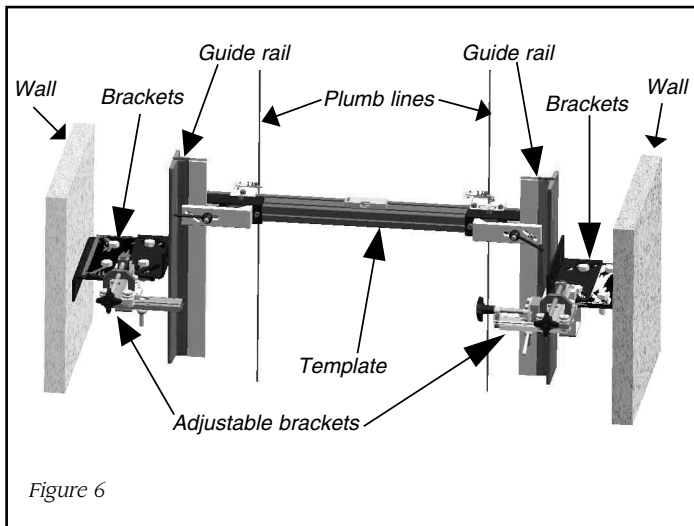


Figure 6

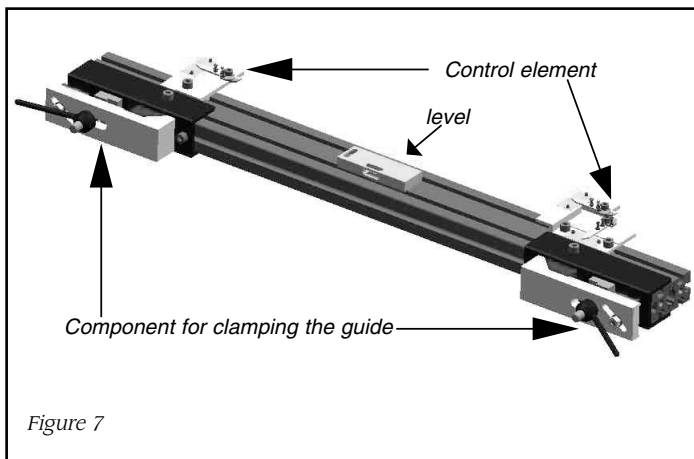


Figure 7

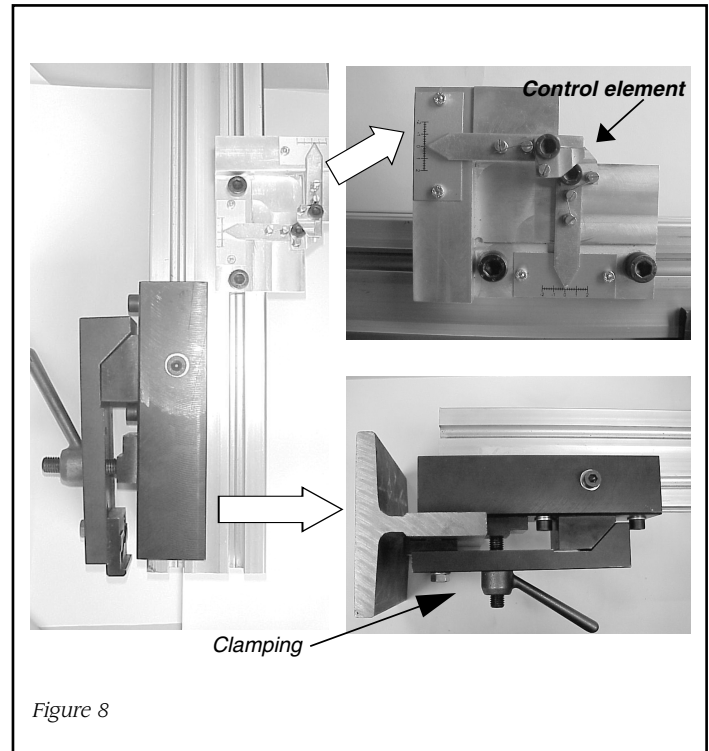


Figure 8

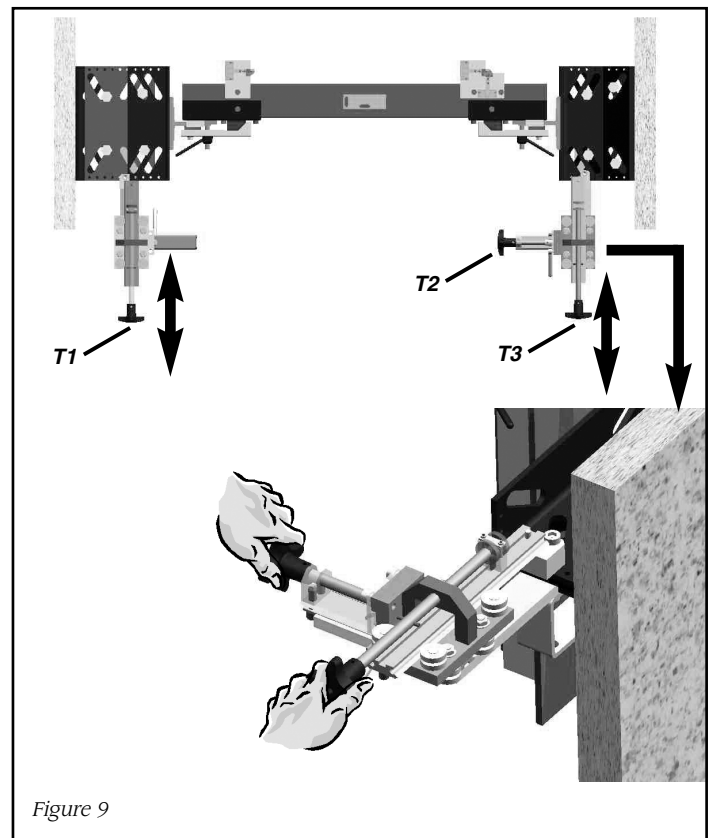
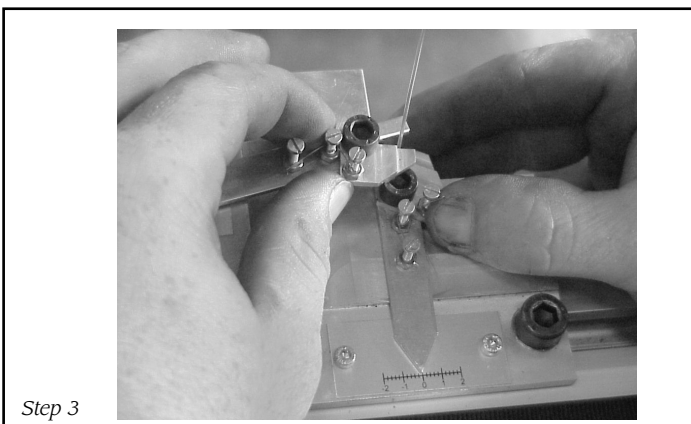
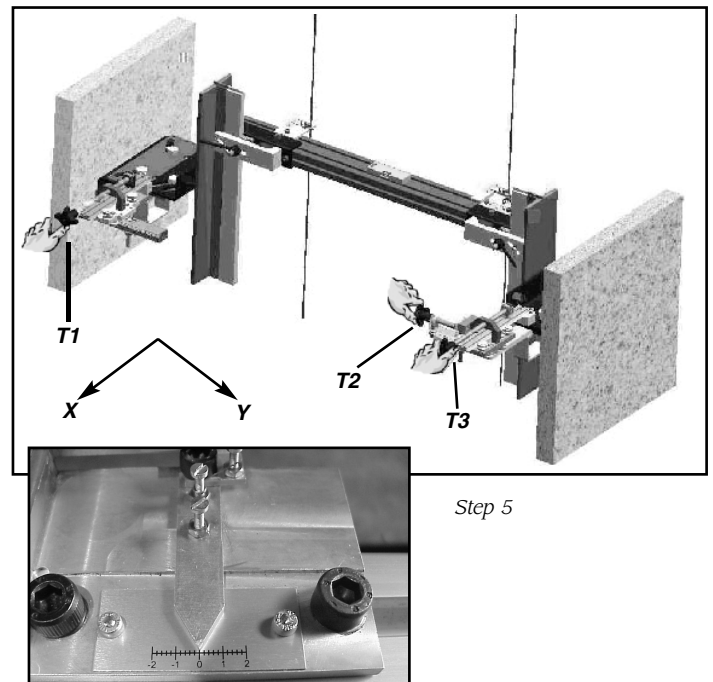
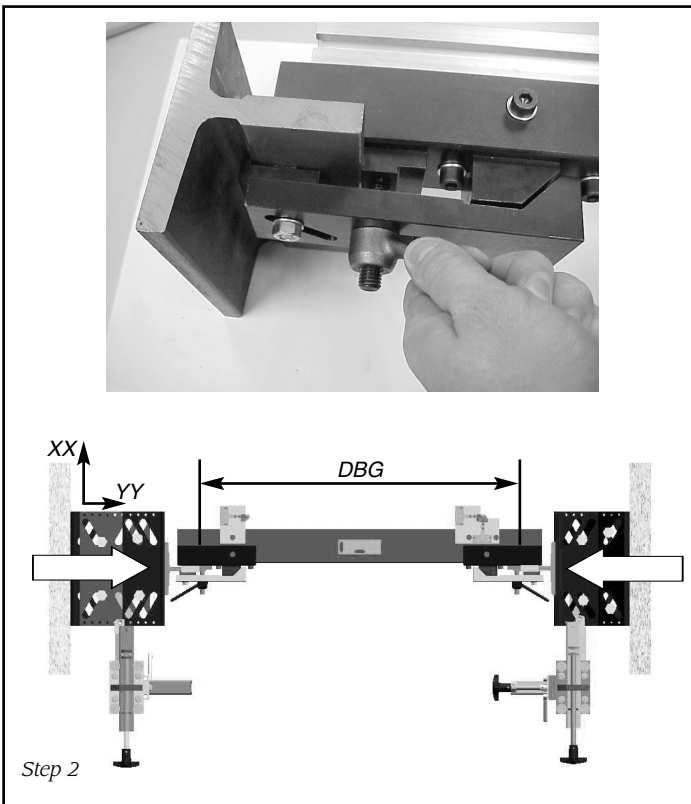
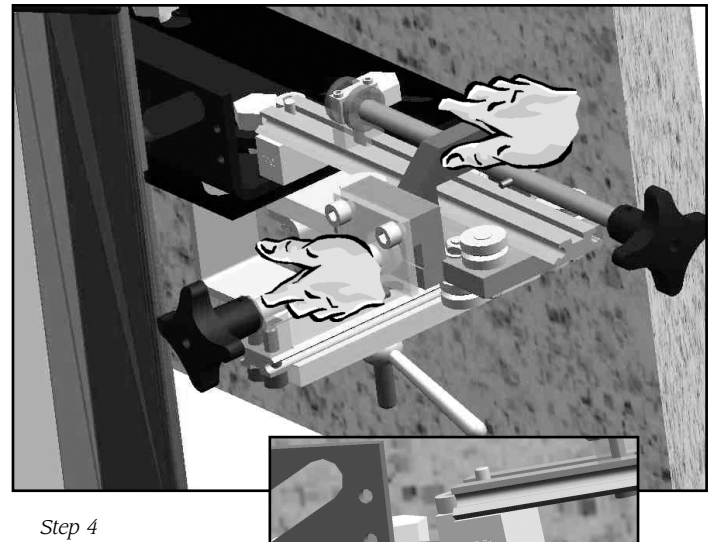
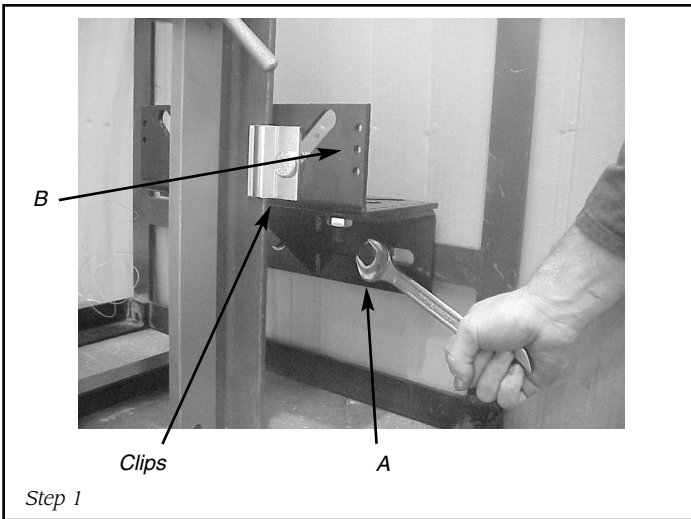


Figure 9

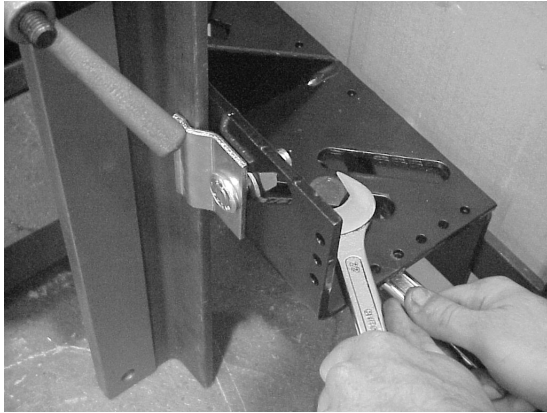
Adjustable Bracket

This comprises two components which adjust the position of the system formed by the template and the guides (see Figure 9).



Steps for Correct Assembly

1. Attach bracket A to the wall. Assemble bracket B without tightening the screws. The guide must be rigidly anchored to bracket B by means of the clips.
2. Clamp the guide with the template. In this operation, the distance between guides (DBG) is set, and the guides are aligned with the YY axis.
3. Place the plumb line in the control system as shown.
4. Assemble the bracket adjusters on both sides. The system designed allows for easy and reliable assembly. The bracket adjuster is joined to the brackets by means of the system as shown.



Step 6

5. Adjust the position of the whole unit composed of template and guides to the position of the plumb line.
 - a. Turn the T1 screw until the needle is in the central 0 position.
 - b. Turn the T2 screw until the needle is in the central 0 position. The whole unit will move along the Y axis.
 - c. Turn the T3 screw until the needle is in the central 0 position.
6. To set the final position, the bracket screws must be tightened. For this, all the control system needles must show 0.

Using the assembly system described, an assembly precision of 0.2mm can be achieved.

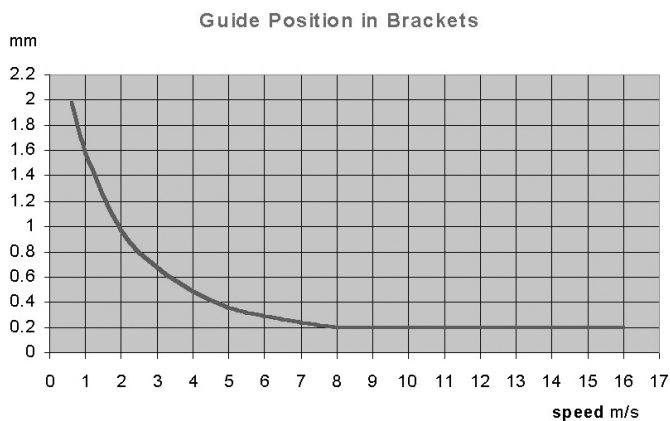



Figure 10

The precision required for positioning the guides on the brackets depends on the speed of the lift. In Figure 10 we can see that there is no linear variation and that there is a limit of 0.2mm, above which comfort is not improved.

Summarizing, it is essential to set the appropriate parameters for each installation and to focus on the concepts which are critical for final comfort. It is very important to obtain quality from the design stage by choosing suitable components and setting the correct parameters. 

ELEVATOR RAIL INSTALLATION AND ALIGNMENT

by Steve Wurth, Wurtec, Inc.

There are nearly as many ways to install and align elevator guide rails as there are elevators. Installation techniques vary by company and even by geographical area. Experimentation on new and different techniques have been tried, and will continue to be tried, since the installation and alignment process can consume many hours and can make or break a job. The intent of this article is to focus on two of the more traditional methods. These methods have largely been accepted over the years as a tried-and-true way to install and align elevator rails. While other methods may prove faster, they normally require special equipment.

The hoistway survey is the first part of any successful rail installation. During the survey installation, personnel must determine the vertical plumbness of the hoistway, whether it was built square and is in its proper location within the building. If there is more than one elevator, and they are adjacent to each other, the multiple hoistways must also be evaluated to ensure that their relationship to each other is correct. Particular attention must also be paid to ensure the elevator fronts line up and are parallel with each other. The end result of the survey is to ensure that the hoistway is built properly to allow the installer to place the elevator(s) into the hoistway in such a way as to satisfy all requirements of the job specifications.

A properly done survey requires that the installation personnel walk the floors taking measurements at each level. Many installers will drop a plumb line in each corner of the hoistway to which they can measure. This allows them to determine if the hoistway is plumb. A more recent method of determining if the hoistway is plumb is to use a self-leveling laser to project a beam the length of the hoistway. Measurements can then be easily taken from each floor to the laser beam. Once all measurements are taken, the installer can determine the exact location of each elevator within the given hoistway and if they can satisfy all the job requirements.

When the exact location of each elevator has been determined, the installer can drop the plumb lines that will be used to align the guide rails. The lines dropped are typically .029-diameter-piano wires. In order to drop these plumb lines, a target is erected at the top of the hoistway that secures and defines the location of the dropped lines. The target can be built of lumber or brackets to which lines are attached. A common method is to install a top bracket and elevator rail with a plumb-line clamp attached to it

(see Photo 1), and drop the line from the plumb-line clamp. No matter what the construction of the top target, it must dictate the location of all the stacks of elevator rails.



Photo 1:
Plumb-line
clamp

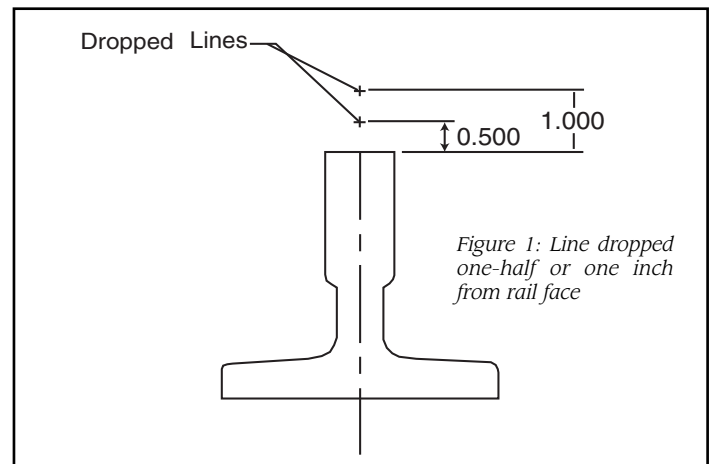


Figure 1: Line dropped
one-half or one inch
from rail face

Most installers will drop one line for each rail stack. The line will be dropped centered left to right and one-half inch or one inch away from the rail face (see Figure 1). After the lines are properly located and dropped from the top target, tension must be applied to the line. This tension keeps the lines straight and minimizes the amount of deflection and variation caused by wind, bumping the line, etc. Tension is normally applied by tying weight to the end of the line. Some installers like to submerge the weight in a container of liquid. The liquid acts to dampen the

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pendulum effect of the weight and therefore the movement of the line. Many installers will tie weight on their lines only until the first set of rails are installed. Once the first set of rails is installed they tension the line using a



*Photo 2:
Tensioning
device*

tensioning device. This eliminates all possibility of sway, and allows them to re-tension the line as it stretches (See Photo 2).

With the installation of the plumb lines complete, the first rails can now be installed in the elevator pit. There is normally some pit work that has to be done first, but for the sake of simplicity, it will not be covered in this article. The first main rail, sometimes referred to as the “king” rail, is installed in its proper location and aligned plumb with the dropped line. An alignment gauge is used to quickly allow the installer to set the location of the rail to the dropped line (see Photo 3). The gauge is placed on the



*Photo 3:
Alignment
gauge*

rail face, and the rail is moved until the plumb line is oriented in the center of the alignment hole. The first rail is installed in its correct location and secured. The opposing rail is then installed in the same fashion. Once both the pit rails are installed, they must be aligned to each other. This operation, sometimes called “facing” the rails, is normally done using an alignment gauge or tram gauge that ensures that the faces of both rails are parallel with each other and that distance between guides (DBG) is correct. It is critical that the first set of rails be installed properly. These rails are the foundation of the rail stack.

All of the above work is accomplished by walking the building floors and by working from the upper most level and the elevator pit. Once the bottom set of rails are installed, the installer needs to concern himself with determining the safest and most efficient way to transport the sometimes tons of rails vertically through the hoistway. Consideration must also be given to providing a safe work platform for the installers. A work area will be required at every rail bracket location to allow the installer access to the rail bracket and eventually access to the attachment of the elevator rail to the bracket. Most installers agree that the most efficient way to provide this access is to install a moving platform in the hoistway.

Two types of temporary moving platforms are the false car (sometimes called skip or go devil) and the floating stage (shafter). Essentially, the false car is a custom scaffolding that is built to ride the elevator rails. Normally, a wire-rope-climbing device is attached to the false car and propels it. The false car comes complete with a set of safeties that act as a secondary safety device and secures the car to the rail and prevents its unintentional downward movement. The false car is recognized as the more stable of the two methods, but is limited by the fact that it can only be used on the part of the elevator hoistway that has rails installed. The floating stage is propelled through the hoistway using the same type wire-rope-climbing device, but does not ride on the elevator rails. Instead, it swings like a large basket in the hoistway. This type of floating stage normally requires not only a wire rope to climb, but also a second safety wire rope that runs through an overspeed governor. The overspeed governor acts as the secondary safety device.

Having decided which method to use to provide a work platform at each bracket location, the next step is to “stack” the remaining rails. If a false car is the chosen method of providing a work platform, then the rails are stacked one set at a time. These rails are normally hoisted into the hoistway using a capstan-type electric hoist (see Photo 4). The capstan-type hoist is preferred over a drum hoist because it will move the material

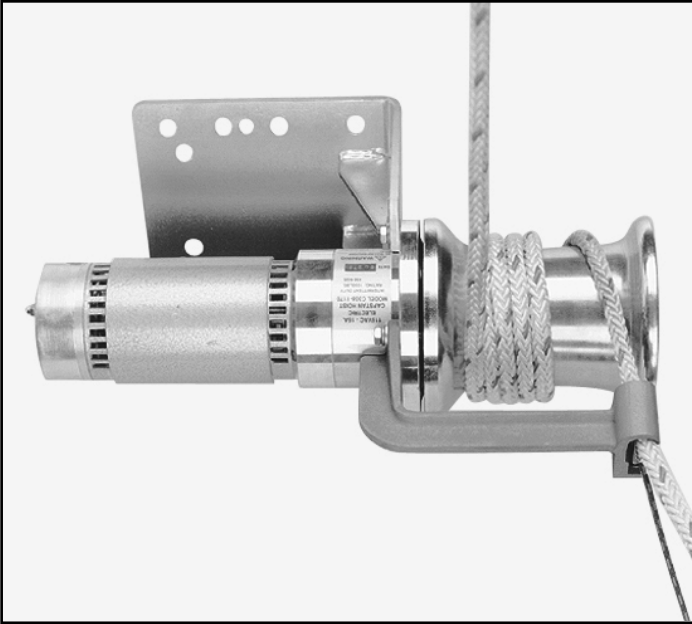


Photo 4: Capstan-type electric hoist

up faster and allow the hoist rope to free fall down, which is also much faster. The rails are hoisted, placed on top of the previous rail and aligned, and the process is repeated.

If the swing stage is chosen as the method of providing a work platform, the rails can be stacked one at a time using the same capstan hoist, or they can be hoisted several at a time, one attached to the end of the other in a type of rail string. Using the string method allows several rails to be hoisted at a single time and also requires a hoist with much greater lifting capacity. When rails are installed using this method, most installers will install the respective rail brackets prior to the string of rails being hoisted. This allows them to hoist a string of rails, temporarily attach them to their respective brackets, then come back and align them.

No matter which method is used to “stack” your rails, you must make sure that they are aligned properly. All the rails must be aligned much like the starter rails were aligned in the pit. The last operation required once all the rails have been installed and aligned is to dress the rail joints. Depending on the quality of the rail being installed, more or less dressing of the joint may be required. The rail joint is dressed with a rail file that is approximately 14 inches long and is most effective when mounted to a file holder. The file holder allows the installer to apply pressure where needed to smooth the joint and blend one rail into the next. It must be stressed that the quality of the elevator ride is directly related to the quality of the rail-joint alignment. Properly aligned rails and smooth rail joints will provide a smooth ride. 🌐