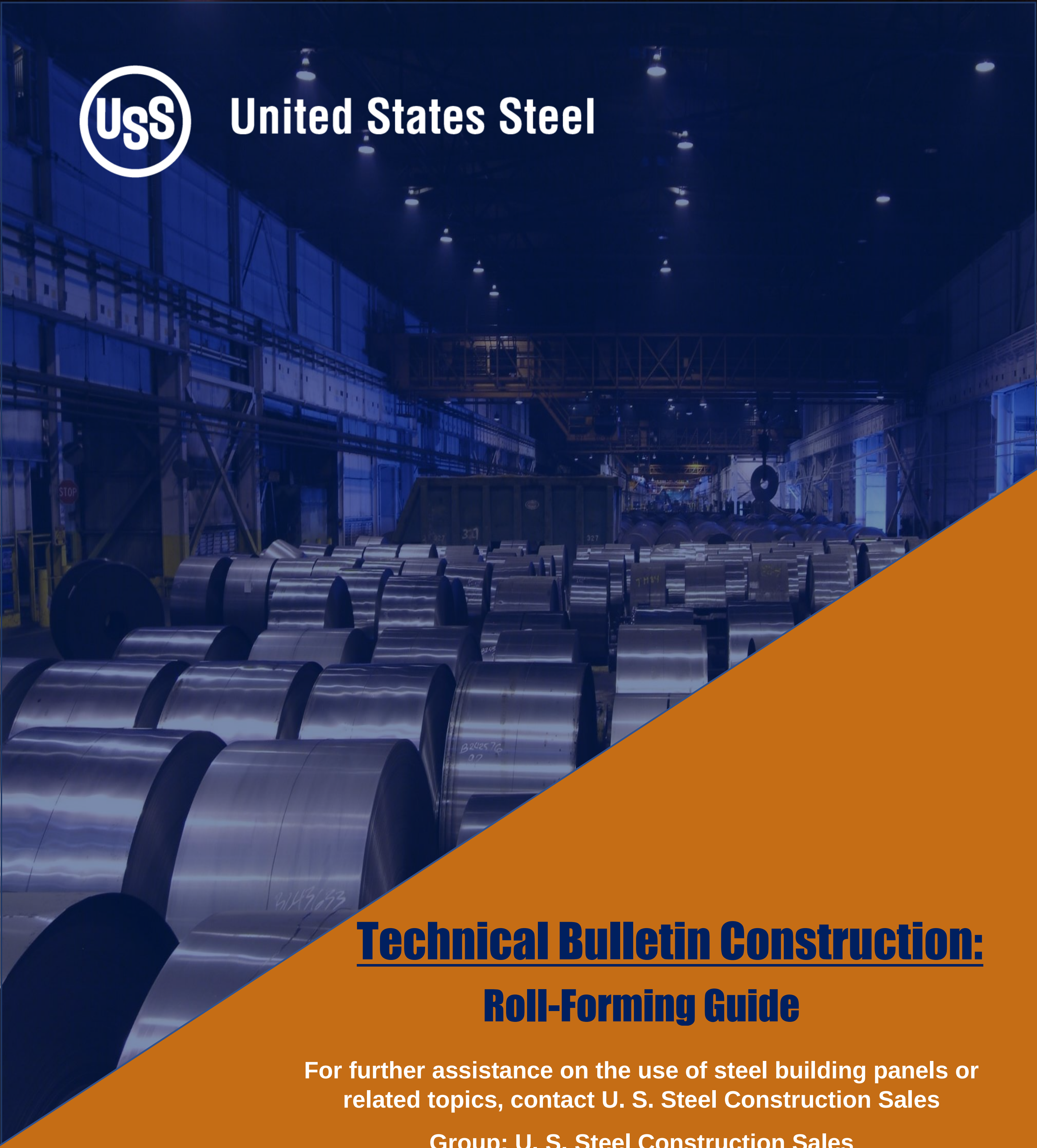
United States Steel



Technical Bulletin Construction:

Roll-Forming Guide

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales

Group: U. S. Steel Construction Sales

600 Grant Street Room 1714 Pittsburgh, PA 15219

1-877-798-7909

constructionsales@uss.com

Roll-Forming Guide for Building Panels

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel

Introduction

Roll-forming was a major contributor to the widespread use of coated sheets for building panels. Roll-forming significantly increases panel stiffness, provides an improved architectural appearance and disguises joining seams. The process of roll-forming metal building panels is conceptually straightforward, but it must be well understood and controlled to be successful. This guide identifies and explains many of the common issues encountered in roll-forming. The factors that contribute to possible problems (material, design and manufacture) are described in order to identify the potential countermeasures to overcome these difficulties. In addition, two case studies presented in the guide highlight the examples of specific field problems and the steps taken to address them.

General Concepts

Roll-forming is a process in which the shape of a metal panel is developed by gradually bending the metal through a series of roll stands, or passes. Each stand must generate the appropriate amount of deformation for which it was designed. In general, the level of deformation at each stand is not constant due to adjustments for springback and the preservation of dimension. Since the tooling is designed to control the outside dimensions of a panel, roll formers are usually designed to overwork the metal in specific stands. Problems in the forming system or tooling design may exist if materials have to be overworked in the stands/tooling other than those designed for overwork. Therefore, when roll-forming problems occur, it is important to examine each stage of the process and not merely the stand at which the problem initially appears.

The goal of a smooth roll-forming operation is achieved when there is uniform metal deformation throughout the line. Roll formers are designed to be reasonably quiet during the operation. They are not designed to run with material “popping” and wrinkling throughout the operation. If this occurs, the operation needs to be investigated.

Two basic types of roll-forming systems are utilized: a precut line and a postcut line. A precut line shears the incoming material to a specific length prior to roll-forming. During postcut line operation, the roll formed panel runs continuously and is sheared to the required length after roll-forming. Figure 1 on page 15 illustrates an example of both types of systems.

1 GALVALUME® is an internationally registered trademark of BIEC International Inc. and some of its licensed producers.

Roll-Forming Guide for Building Panels

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel

Material

One of the principal parameters that define the success of a roll-forming operation is the nature of the material. In order to design the optimal process, the tooling designer should be provided material information to be used prior to the tooling designing. This includes material mechanical property ranges, gauge tolerances and shape tolerances. In addition, different metallic coatings (hot-dip galvanized or GALVALUME®1 Coated Sheet Steel), organic coatings or paint will result in differences in performance even with the same set of tooling due to their different frictional characteristics.

The designer requires a clear understanding of the gauge tolerance to be supplied. Ideally, a more robust operating window can be achieved if the full range of tolerance is provided to the tooling designer. The tooling designer will generally design the tooling to the thickest gauge. Ordering the tooling to a full ASTM tolerance while receiving materials with a half or one quarter standard tolerance will produce a roll former with a less robust operating window than either the designer or the panel manufacturer intended.

Alignment

Mill alignment is critical. Since tooling is designed to specific tolerances, the forming rolls and their components must be aligned to each other both horizontally and vertically. The rolls must be aligned both side-to-side and pass-to-pass. Forming material with the gauge either lighter or heavier than that for which the tooling is designed can result in problems indicative of mill misalignment.

Using material thinner than the designed gauge can result in manufactured panels with finished radii greater than the intended design. This is usually offset by over-tightening the rolls, which causes a deterioration of tool life. Processing heavier gauge material than intended can also lead to larger radii than designed. When running thicker material, the tooling will make contact on the side of the tool radii leaving no center contact with the tooling. Since the material is not in proper contact with the tooling, gap differences from side to side become more critical. Small side-to-side roll gap differences can result in twist, bow or sweep problems.

Roll-Forming Guide for Building Panels

Setup

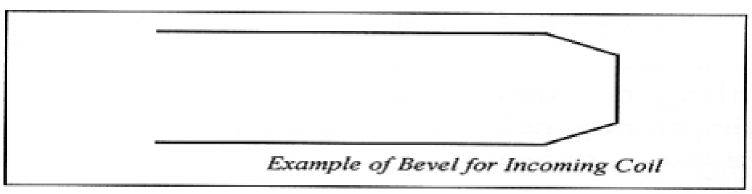
Following the initial setup by the roll tooling manufacturer, feeler or wire gauges are most often used to set the gaps on roll-forming stands. This should ideally be done each time the metal being utilized changes significantly in gauge. Operators must be sure to periodically check for tooling wear and/or machine wear. Gear and bearing backlash of as little as 0.002 inch from stand to stand can alter the shape of the finished product and produce parts that are not in compliance. The operator should maintain a logbook for the setup on each panel configuration. Additionally, the necessary adjustments made to maintain an acceptable panel should be recorded. This can be an invaluable tool for assisting other operators as well as for aiding in the maintenance of the system.

Each stand consists of top and bottom rolls designed to provide the necessary part dimensions. The position of the top roll can be adjusted via screws to change the gap between rolls, thereby changing the forming pressure applied to the metal at each stand. The final roll gap adjustment on each stand should always be down to compensate for the gear and bearing tolerances inherent to each stand.

As rolls wear, bending points can become less precise. This can alter the working surface of the roll and result in panels with radii that are less „crisp" or precise. Roll wear is generally offset by reducing the roll gap on one or more stands. In the extreme case, this can cause a variety of problems, such as roll fight, metal marking and wandering line on the radii of finished panels. Over-tightening of stands with worn tooling can cause twist, bow and sweep.

Threading

Tooling is generally designed to form panels from the center of the strip outwards. When threading a strip into the line, it is recommended to cut a bevel on each side of the incoming strip. This enables the strip to feed through the line on the center.



Example of Bevel for Incoming Coil

Many operators thread material into the line with a square cut edge. Although this can be successful, it often leads to problems in the later stands. If the strip moves even slightly off center in the early stands, the problem will be magnified in the later stands. When this occurs, the operator may have to cut a portion of the strip from the line, which will not feed through the balance of the line due to jams or wrinkles. When this type of problem is encountered, often simply cutting a bevel on the incoming strip will eliminate threading issues.

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel

Roll-Forming Guide for Building Panels

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel

Cut-Off

Cutoff dies or shears are available in many types and variations. The most common types utilized for building and roofing panels are the slugless crop die and the flying shear, or cutoff die. The cutoff operation accurately cuts the part to the desired length in a manner that is essential to the continuous operation of the line.

Slugless crop dies generally have a short stroke length, possess contoured blades, and rapidly cut-off the finished part. Since the cut-off action is extremely fast, an accurate cut can normally be performed without an interruption to the continuous operation of the line. Proper set-up in this type of operation is critical.

Line speeds, die speeds and die clearances must be closely established and monitored to prevent blade drag. This condition can result in panel buckling. Removal of the buckled panel from the line is time consuming and may result in damage to the cutoff die, or in extreme cases, to the roll tooling. Even if the part does not buckle to the point that it jams the line, improperly timed cutting can cause problems upstream in the roll former.

Momentary interruptions in the later roll-forming stands while the initial stands are still driving material can result in a wide variety of problems and/or imperfections. Minor buckling in the intermediate stands can result in oil canning type imperfections as well as other twist or dimensional issues in the finished panel. If the line is set-up with extremely loose tooling clearances, the effect of momentary line interruption from the cutoff operation may be seen all the way to the uncoiler. In this instance, the alignment of the entire line becomes integral to the cut-off operation. For example, if the uncoiler is out of alignment, the momentary line interruption could „pull" the material in a skewed manner from the uncoiler and potentially cause oil canning, twist or sweep problems.

A flying shear, or cut-off die, may be required with an increase in the line speed or panel height configuration. This allows the shear or die to attain the speed of the line prior to the cutoff operation. The timing of the shear is critical in this operation.

Momentary interruptions in the latter roll-forming stands, as described above, will generally be larger in magnitude and more serious in nature as the speed of the cut-off operation increases. The blade or die should always be cut to an approved part. Improperly designed/machined tools must be avoided because they result in tight clearances, induce blade drag, tool drag, or loose clearances, which result in burrs on the finished panel.

Roll-Forming Guide for Building Panels

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel

Lubrication

The most commonly used lubricant to aid the roll-forming of building panels is vanishing oil. This product provides the necessary lubrication for the forming process and also has the advantage of evaporating over time to permit ease of handling and installation at the construction site. However, the vanishing oil or other lubricant should contain at least 95% solvents or be a water-based lubricant that leaves minimal residue. Care should be taken to allow the roll formed panels to be completely dried prior to shipment. No lubricants should be used on either acrylic coated GALVALUME® or Galvanized steel that U. S. Steel identifies as ACRYLUME®2 or ACRYZINC®3, respectively.

Inadequate lubrication can cause problems with the roll former operation and/or in the finished panel. A common problem within the roll former is the bonding (welding or fusion) of coil coated products to the roll tooling. This is time consuming to remove. Some companies have had some success by mounting SCOTCH-BRIGHTTM rolls4 on the tooling to continuously remove coating build-up or by polishing the rolls while in operation. Problems can also extend to the finished panel. Part configuration, forming issues, oil canning, twist, bow, and improper finished dimensions can all result from inadequate lubrication.

What to Look for

With a working knowledge of the panel configuration and the roll former setup procedures, the root cause of many problems can be determined at the plant level. Generally, the most important factor to keep in mind is that roll-forming issues must be approached from a systematic point of view. That is, everything must be considered from the incoming material properties, lubrication, roll former setup, uncoiler, and cut-off methods to the inspection details of the finished product. All or any of these factors can impact the acceptance of the finished part.

When observing a roll-forming line to determine the cause of a problem, two basic questions need to be addressed:

1. What is the Imperfection? It is important to define the nature of the problem to be solved: edge wave, oil canning, panel dimension.
2. What are the Tool Gap Settings? Gaps should initially be set at the material gauge with final adjustments made to achieve the desired final dimensions.

2 ACRYLUME®2 is a registered trademark of United States Steel Corporation.
3 ACRYZINC®3 is a registered trademark of United States Steel Corporation.
4 SCOTCH-BRIGHTTM is a registered trademark of 3M Corporation.

Roll-Forming Guide for Building Panels

The material in this paper is intended for general information only. Any use of this material in relation to any specific application should be based on independent examination and verification of its unrestricted availability for such use, and a determination of suitability for the application by professionally qualified personnel. No license under any United States Steel Corporation patents or other proprietary interest is implied by the publication of this paper. Those making use of or relying upon the material assume all risks and liability arising from such use or reliance.

Inspect the Finished Panel

1. **Does It Hold Dimension?**
   Ensure that the material is within the ordered width and property tolerances. Check the gaps in the overbend stands for proper gauging.

2. **Where Does the Imperfection Appear?**
   Inspect and check the tooling and gap settings where the imperfection occurs and, in the stands, upstream. Adjust to appropriate settings.

3. **Are There Tight or Loose Areas on the Finished Panel Radii?**
   These imperfections typically denote improper tooling adjustment or worn tooling or bearings. Ensure that the tooling has proper gap settings. Inspect the tooling for worn areas (chrome coating loss or increased radii due to wear). Inspect the line during operation for bearings with excessive movement. Occasionally, a worn bearing will make noise during operation. If bearing wear is isolated and is consistently in one stand, it would be prudent to inspect the tooling in the entire line for alignment, wear and proper gap settings.

4. **Do the Radius Lines Appear to Wander Down the Length of the Panel?**
   Dry material, worn tooling, and improper tool alignment can cause this problem.

Material

1. **Does One Coil Perform Differently Than the Next?**
   Check for and establish the differences between the two coils. Differences in gauge, oiling, and properties can affect the final part.

2. **Has the Gauge Changed Or is It Out of the Ordered Tolerance?**
   The operator must know the expected gauge tolerance. Often tooling gaps are established around the midpoint of the range of the ordered gauge tolerance. Tooling adjustments may be necessary when working at the extreme ends of the material gauge tolerance, especially if the tooling was not designed to accommodate the full range of gauges anticipated.

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel

Roll-Forming Guide for Building Panels

Observe Line in Operation

When Free (No Material) and Loaded

When the Line is Running Free

1. **Does the Tooling Run Eccentrically or Wander with Respect to Other Stands?** This is an indication of bent shafts, worn bearings, worn or misaligned tooling. If the tooling visually wanders from side to side, either the bearings are worn or the shaft locknut has come loose, or a shim has worn or fallen out. When the tooling is running in an elliptical pattern (egg shape, or up and down) the shaft itself may be bent. This will require checking the shaft for run-out with a dial indicator for the amount of movement.
2. **Are There Areas Where Excessive Material Has Been Stripped Off During Forming?**
   This normally indicates dry material, tight clearances or improper tooling setup. Tooling stands where material slivers and/or debris accumulate should be closely monitored, as this can lead to premature wear and finished panel imperfections. Material run with insufficient lubrication (dry areas) will run with increased friction in these areas during forming. This can cause material to be scraped during the roll-forming process, especially on the panel edges. In some cases, running dry material can raise the temperature of the tooling sufficiently to reduce the die clearances from heat expansion.
   Tooling that is gapped to less than the material being formed, or tooling that is out of alignment from stand to stand, can also cause this problem. Although it is sometimes not possible to prevent material debris accumulation on some stands, tooling should be gapped and checked for alignment frequently.

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel

Roll-Forming Guide for Building Panels

The material in this paper is intended for general information only. Any use of this material in relation to any specific application should be based on independent examination and verification of its unrestricted availability for such use, and a determination of suitability for the application by professionally qualified personnel. No license under any United States Steel Corporation patents or other proprietary interest is implied by the publication of this paper. Those making use of or relying upon the material assume all risks and liability arising from such use or reliance.

When the Line is Loaded

1. **Does the Material Track Properly into and from the Line?**
   Material that has differential lubrication edge-to-edge, material with significantly different thickness edge-to-edge or tooling that is out of adjustment can cause tracking issues.

2. **Does the Imperfection Appear at One Stand?**
   If this is the case, ensure the tooling is gapped properly at both the imperfection stand and also at the stands prior to where the imperfection occurs.

3. **Does the Cut-Off Operation Run Transparent to the Line?**
   Drag or an out-of-time cut-off operation can induce a variety of imperfections or problems. In a post-forming cut-off process, the cut-off should not alter the continuous forming of the panel. Dull cut-off dies or knives can impart sufficient drag in the cut-off operation so that the formed panel actually begins to buckle in the cut-off operation. A similar condition is possible if a flying shear is out-of-time with the speed of the forming operation. Both of these conditions should be addressed when they first appear, as permitting them to continue will eventually cause the panel to buckle in the line prior to the cut-off.

4. **Does the Material Pop, Crackle, or Wrinkle at One Stand?**
   This is often the result of either tooling misalignment or the material entering the rolls in a skewed fashion. Roll-forming should be approached from a systematic point of view; each stand is designed to perform a specific amount of forming.

Inspection

Inspection is probably the most subjective portion of the roll-forming operation. It is important to have consistency between inspectors in order to ensure proper acceptance of panels. Once part dimension is achieved, the visual inspection regarding the acceptable amount of oil canning, twist and bow is typically not measured and not standardized. This makes solving these types of problems difficult. Therefore, it is crucial to define standardized acceptability criteria. Generally, plants rely on one or two people who are usually the most experienced to determine acceptability. An alternative, and preferable, practice is to develop a set of standard panels and/or panel photographs. This allows the operator to determine quickly when the roll-forming line is starting to produce suspect panels. This will enable line issues to be addressed before rejections occur. Visual standards have been found to be an extremely useful tool for solving visual imperfection issues. Additionally, it is recommended to maintain a log of imperfection type, imperfection frequency and corrective actions in order to aid in troubleshooting.

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel

Roll-Forming Guide for Building Panels

Conclusion

Successful roll-forming relies on a combination of factors, including material properties, tooling set-up and roll former operation. As problems arise, it may be difficult to ascertain which factor is negatively impacting the finished panel to the point of rejection. This is why it is imperative to view the roll-forming process from a systematic point of view. With this approach, it is possible to determine the root cause of the problem and take the appropriate corrective course of action.

For further assistance on the use of steel building panels or related topics, contact U. S. Steel Construction Sales Group:

U. S. Steel Construction Sales
600 Grant Street
Room 1714
Pittsburgh, PA 15219
1-877-798-7909
constuctionsales@uss.com

United States Steel