FASTENERFACTS

An Informational Series From All-Pro Fasteners

Fastening vs. Welding:

Fabricating Better Joints

INTRODUCTION

Welding is a proven method of securing infrastructure-related and fabricated metal joints, and is often the preferred method in a wide range of applications. However, welding it is not without drawbacks that can affect its suitability for a number of applications. As an alternative to welded joints, engineered fasteners can provide significant time and cost advantages, depending on specific project factors and design requirements.

When evaluating whether welding or fastening is best for a particular installation, a variety of factors must be considered. In the final analysis, the type of joint to be specified and fabricated depends on project factors as well as operational preferences.

Project factors that guide the selection of joint type include: the weldability of the materials to be fastened (including surface coatings that may be affected by heat), joint types, installation processes and logistics, inspection requirements, cost, labor availability, accessibility, environmental conditions, safety, and future maintenance/repair considerations. Any or all of these variables can be a potential factor in deciding whether to fasten or weld a joint.

This paper will discuss some primary considerations involved in choosing between welded joints or fastened joints, or some combination of both. By taking these factors into consideration, design engineers, project managers, fabrication supervisors, and construction management can make design and joining decisions that improve performance, increase safety and productivity, and control costs, while meeting and exceeding performance requirements over the lifecycle of the project.

WELDING OVERVIEW

The process of welding creates permanent joints by fusing two elements with extreme heat, then allowing them to cool in a fixed position. Various types of joint configurations, such as butt-, corner-, edge-, lap-, and tee-welded joints, are determined by the position of welded elements relative to one another.

Welding is a manual process that is typically performed by certified welders using specialized equipment. Specific energy sources may also be required, depending on the type of weld being performed.

Workplace safety is important regardless of joint type, but welding comes with more task-specific risks. In shielded metal arc welding (SMAW), an electric arc is produced between a coated metal electrode and the steel components to be welded. Precautions must be undertaken to avoid burns, vision damage, fume or gas inhalation, radiation exposure, electric shock, and/or fires.

Welding inspection methods can vary depending on the project. Visual inspection is the most common method, carried out before, during, and after welding. Other, more expensive inspection methods may utilize specialized equipment under the operation of American Welding Society (AWS) certified inspectors.

While individual welds can be inconsistent in strength along a joint, proper inspection of welded materials (via visual inspection, x-ray, or other methods) can ensure that components are properly jointed.

Pros of Welded Joints

- Welding produces a permanent, physical connection between metals. In doing so, it delivers high levels of strength and structural performance.
- Welding eliminates the need to perforate materials, as is the case with some methods of fastening. This characteristic can contribute to the structural integrity of welded installations.
- Welding is often the preferred method in many applications, due to contractor familiarity, work crew experience, tension and load characteristics, and other considerations.

Cons of Welded Joints

- Welded joints are more rigid than fastened joints.
- Welds are more susceptible than mechanical fasteners to fatigue.
- Welds are much harder to remove, replace, or repair than fasteners.
- Welding comes with more task-specific safety risks on the job site.
- The inspection process has a higher degree of cost and difficulty than that of fastened joints.
- Welding is more expensive than fastened joints, in most cases.
- Welding relies on specialized and certified labor, affecting availability, scheduling, and cost.
- Compared to mechanical fasteners, welds are more difficult and expensive to repair in the field.

FASTENING OVERVIEW

Fasteners can be used to create temporary or permanent joints. The ability to create temporary joints allows fasteners to be adjusted, removed, replaced, and/or repaired at any point in the future, without damage to the underlying fastened components.

Fastened joints use a variety of fasteners to hold structural elements in place at a specific position. These joints can incorporate the use of plates or angles, allowing the deflection of these elements to add structural flexibility during load transfer. Importantly, fastened joints allow more movement with less structural stress when compared to welded joints. Fasteners can be used in the creation of tension joints, shear joints, or bending joints.

Installed at equal distances, with equal torque and clamp, fasteners provide an equal amount of strength at each joint, without significant variance. This characteristic makes them an ideal choice from the standpoint of consistent weight loading and distribution.

The cost of fastened and welded joints varies by project, but fastened joints are typically less expensive than welded joints.

The inspection process for fastened joints is relatively straightforward and does not require specialized equipment. Inspectors must ensure that bolts have been tensioned, verifying that fastener stick-out is “positive” or “zero” (i.e., no threads are ending inside the nut), and in the case of some lockbolts, check that ends have been properly snapped off.

Pros of Fastened Joints

- Fastened joints allow more movement with less structural stress.
- Fastening does not require certified labor or specialized equipment to install.
- Fastening has no specific safety risk, other than working at height.
- The price of fastened joints (including hardware and labor) is generally less expensive than welded joints.
- Fastened joints can be easily inspected, adjusted, or replaced when needed.
- Fastened joints offer faster installation in the field.

Cons of Fastened Joints

- Additional fastening hardware is required at the site of installation.
- In some applications, materials must be perforated to accommodate the fastening process.

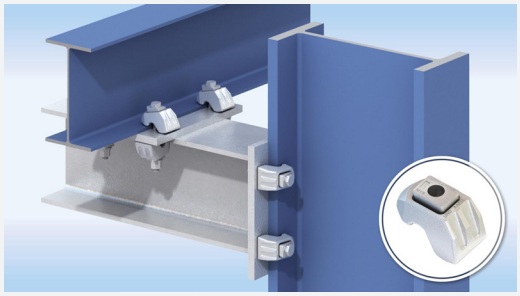
LINDAPTER® ADVANCED CLAMPING SYSTEM

For the most secure fastening solution for a number of applications, All-Pro Fasteners offers the proven Lindapter® steel clamping system. Employed in a wide range of applications, including structural steel connections, crane rails, lifting points, steel flooring, and pipe/conduit supports, All-Pro’s Lindapter solutions eliminate the requirement to both drill and weld steel. This unique joining technology delivers streamlined installations and reduced costs, while preserving the integrity of the steel.

APPROVED STEEL CONNECTIONS

The Lindapter Girder Clamp is the world’s only structural steel clamping system that is approved by ICC-ES (International Code Council Evaluation Service), and compliant with the IBC (International Building Code).

As a verified alternative to high-strength bolt assemblies prescribed in AISC 360, the Lindapter Girder Clamp (Types AF and AAF) may be used to resist axial tension and slip due to load combinations that include wind load or seismic load in all Seismic Design Categories A through F.



The Lindapter Girder Clamp solution allows contractors to achieve high strength connections in the field without any welding, by quickly clamping two steel sections together and tightening with regular hand tools. The Girder Clamp's adjustability creates additional time savings, as it permits easier alignment of steel sections in the field without the need for temporary tack welding or redrilling. The system is compatible with almost any steel profile including W and S beams, channels, and angles, and is used worldwide on applications across the construction spectrum from industrial to architectural structures.

The Hollo-Bolt®, another Lindapter product, was launched in 1995 as the first expansion bolt for structural steel approved by ICC-ES for use as a structural connection in all Seismic Design Categories A through F. This labor-saving blind connection is designed for joining structural steel to Hollow Structural Section (HSS) or other steel members, where access is difficult or restricted to one side only. Unlike alternative connection methods such as welding, a Hollo-Bolt is quickly and conveniently installed by simply inserting the fastener into a pre-drilled hole and tightening with a torque wrench, leading to significant savings in time and money.

For a video on ICC Approved Steel to Steel Connections, visit https://www.youtube.com/watch?v=GCMezf-xxrw.

To request a free Lindapter catalog, please contact an All-Pro Fasteners specialist.

For more information, you can also visit these pages on the All-Pro Fasteners website:

Steel Connections

https://apf.com/wp-content/uploads/2020/04/lindapter-steelconnections.pdf

HSS Connections

https://apf.com/wp-content/uploads/2020/04/lindapter-hssconnections.pdf

Pipe/Conduit

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Steel Floor

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PROJECT FACTORS

The decision of whether to use welded joints or fastened joints is best made on the merits of each project. Both options are adaptable for a wide array of applications, and either method can bring unique advantages and disadvantages to a specific job.

Materials

An analysis of the materials to be fastened is one starting point in determining whether a welded or fastened joint type can or should be used. It is important to consider that welding dissimilar metals or pieces of varying sizes can be a challenge. It is also important to note that welding can compromise the strength of some materials (e.g., aluminum), as a result of the heat-affected zone around the weld. The intense heat generated by welding can make material adjacent to the weld brittle and more prone to breaking. For example, many aluminum welds have microscopic cracks when they cool, as the result of the high shrinkage rate of aluminum.

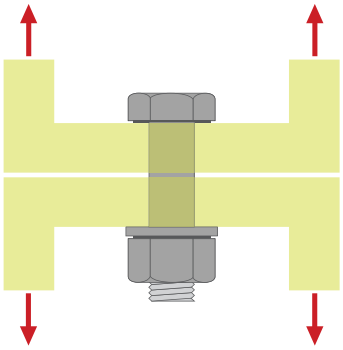
Surface Coatings

Along with the weldability of materials, attention should be given to potential damage that can be caused to surface coatings during the welding process. In areas adjacent to the weld, coatings can be damaged by the heat generated during welding. If the materials to be jointed feature surface coatings (e.g., for chemical resistance or corrosion protection), it may be best to avoid welding altogether.

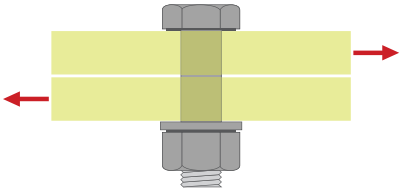
Load, Sheer and Bending Joints

There are several ways loads are applied to fastened joints, leading to the labeling of joints as tension joints, shear joints, or bending joints.

In a tension joint, the fastener serves as a clamp, supporting a load force that is parallel to the fastener's axis. A tension joint's performance and longevity depend in large part on achieving the correct clamping force. This ensures the bolted connection's ability to maintain preload, in order to avoid joint failure caused by fastening fatigue, stress corrosion cracking, hydrogen embrittlement, or loosening due to vibration.



Tension Load



Shear Load

In a shear joint, load forces are at a right angle to the fastener's axis. In "bearing type" shear joints, joint strength is strictly determined by the shear strength of the fasteners. In these cases, precise fastener tension is less critical, as long as it maintains the fastener in the assembly. Other shear joints use initial clamp load to resist slip and are sometimes referred to as a friction-type or slip-critical joints. These types of joints are commonly found in the construction industry.

Bending joints are fastened joints that are exposed to a bending force, meaning that the fastened joint is subject to both shear and tension load forces. This combination can have a significant impact on the joint's strength and behavior.

Inspection Requirements

Welding typically requires a more complex inspection process, employing specialized inspection teams and equipment on critical installations. Fasteners are subject to visual and manual inspections, thereby simplifying the inspection process.

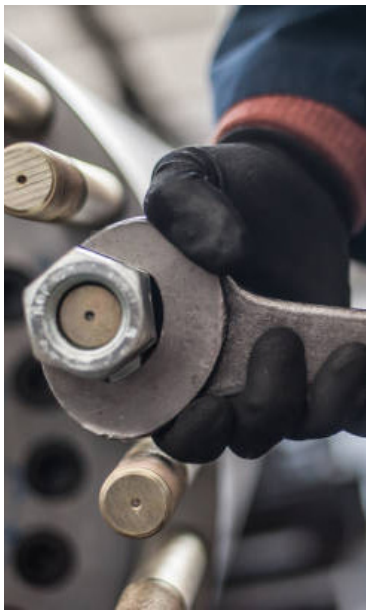
Longer term, inspections of fasteners remains easy. Fastened joints require only simple visual inspections to check for corrosion or other weakening factors, without the need for specialized equipment (such as x-ray devices), as is sometimes required for the inspection of aging welds.

Time Savings

The welding process is typically much more time consuming than fastening, particularly when detailed inspections are required. Fasteners, on the other hand, are relatively quick to install, and simpler to inspect, resulting in significant total project time savings in many applications.

Damage from Heat

The welding process generates intense heat that can compromise the strength of some materials (e.g., aluminum), and cause damage to surface coatings in areas adjacent to the weld. In these cases, consideration should be given to the use of fasteners as a mechanically safer alternative. Fasteners have no undesired effect on the strength of fastened materials, or the integrity of surface coatings. Additionally, fasteners can be manufactured with a wide range of coatings to provide uniform protection against corrosion and other environmental forces.



Labor Considerations

Welding requires skilled technicians who are often highly paid and, in some industries and geographical areas, may be difficult to find and retain. Welding also requires the use of specialized equipment, which adds expense on top of labor costs.

Fasteners can be installed by regular craft labor crews using inexpensive equipment such as wrenches, torque wrenches, and drivers. Usually, no training is required to install fasteners, so high-priced skilled labor is not required. The ability to utilize regular crews can lead to significant cost savings and simplified worksite scheduling. The selection of appropriate equipment for modern mechanical fastening should be undertaken in conjunction with the fastener supplier.

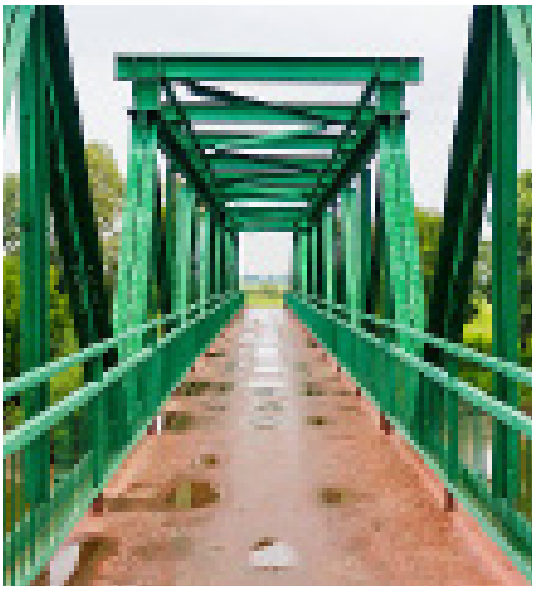
Logistics

While welded joints eliminate the use of hardware at the job site, fastened joints do offer advantages when it comes to handling and logistics. All-Pro Fasteners offers a variety of custom manufacturing, inventory management, kitting, and distribution options that ensure the on-time delivery of the right hardware to efficiently support the requirements of any industrial, construction, or infrastructure-related installation.

Environmental Factors

Any application requiring corrosion or chemical resistance, or other protective treatment, requires careful consideration of the suitability of welding or fastened joints. As noted above, the heat generated by the welding process can damage surface coatings, requiring the application of paint or other treatment following the completion of welding. Fasteners cause no damage to coated materials and can be manufactured with specialty coatings and plating to ensure proper corrosion and chemical resistance.

(For more information, see Fasteners & Corrosion: Avoiding Problems in Advance, part of the Fastener Facts whitepaper series from All-Pro Fasteners.)



Safety

Workplace safety is important regardless of the joint type, and welding comes with more task-specific risks. Welding is a hazardous task, and precautions are necessary to avoid burns, vision damage, inhalation of fumes and gases, UV radiation exposure, and the potential for electric shock. Random sparks generated by the welding process can be a potential fire hazard in certain applications. Spent rods and other by-products of the welding process can contribute to potential safety risks. On the other hand, fastening has no specific risk other than working at height.

Cost

The cost of fastening is generally cheaper than the cost of welding, taking into account the procurement of fastening hardware as well as installation costs. Hourly rates for welding services and equipment can be high, while labor costs associated with fastening installations can be appreciably lower. If project cost is a critical concern, fastened joints are the best option (other factors notwithstanding).

ABOUT ALL-PRO FASTENERS

All-Pro Fasteners supplies high-quality fastener products to meet a wide range of industrial, manufacturing, and fabrication applications. The teams at All-Pro Fastener go the extra mile with customized inventory management, kitting, custom shipping, and more — offering a full range of service and support that makes your business more efficient.

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