Supporting presentation for lecturers of Architecture/Civil Engineering

Chapter 09
Joining & Fabrication of Stainless Steels
Contents

1. Joining
2. Fabrication
# 1 - Joining

Applicable joining processes: all of them!

<table>
<thead>
<tr>
<th>Process (Refs)</th>
<th>Videos</th>
<th>Preferred process for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding (1-5) (widely used)</td>
<td>MIG Welding TIG Welding Welding robot</td>
<td>High strength of the joints No dismantling</td>
</tr>
<tr>
<td>Fastening (widely used)</td>
<td>Example</td>
<td>Easy on-site assembly Assembling dissimilar materials (wood, glass...) Dismantling at a later stage</td>
</tr>
<tr>
<td>Brazing/Soldering</td>
<td>Soldering</td>
<td>Water tightness (Used mostly in roofing)</td>
</tr>
<tr>
<td>Mechanical Press-fitting</td>
<td>Press-fit_example</td>
<td>Permanent joining of tubes Water tightness (Used mostly in roofing)</td>
</tr>
<tr>
<td>Adhesive Bonding</td>
<td></td>
<td>Surface finish integrity</td>
</tr>
</tbody>
</table>

*Updated 2018!*
Joining Stainless Steels

Arc Welding

Advantages of arc welding
- weld properties equal to that of annealed condition
- provides the strongest joints
- can be done on site or in the shop
- joins thin and thick material of any shape
- joins similar or dissimilar metals (usually carbon steel with proper choice of filler material)
- resists fatigue and cyclic loads
- same corrosion and heat resistance as the annealed base metal

Limitations of arc welding
- not possible with all grades
- require qualified operators and procedures
- may cause heat-induced distortions
- post-weld finishing operations are required for a good-looking finish (such as sand blasting)
- loss of mechanical properties in case of cold-worked material
Arc Welding

Video: polishing a weld
Mechanical fastening

Advantages of mechanical fastening
- Can be dismantled
- Ideal for on-site building
- Fast
- No need of qualified operators

Limitations of mechanical fastening
- Not as strong as welds
- May cause crevice corrosion (see corrosion resistance chapter)

Selecting the appropriate fastener:
The German Institute for Building Technology* has issued recommendations for the selection of fasteners according to the environment. Please read Reference 4, Table 1a (exposure classes) and Table 8 (stainless grades by class)

* Deutsches Institut für Bautechnik (DIBt)
Press fitting
(a process used for tubes only)

Advantages of press fitting
- Perfectly tight for liquid and gases
- Fast
- No flame
- Perfectly clean surfaces
- No need of qualified operators

Limitations of press fitting
- Cannot be dismantled
- Require sleeves for each tube diameter
Adhesive Bonding

Advantages of adhesive bonding

- makes a joint almost invisible, enhancing product appearance
- provides uniform distribution of stress and a greater stress-bearing area
- joins thin and thick material of any shape
- joins similar or dissimilar materials
- minimizes or prevents electrochemical (galvanic) corrosion between dissimilar materials
- resists fatigue and cyclic loads
- provides joints with smooth contours
- seals joints against a variety of environments
- insulates against heat transfer and electrical conductance
- is free from heat-induced distortions
- dampens vibrations and absorb shocks
- provides attractive strength/weight ratio
- is frequently faster or cheaper than mechanical fastening

Limitations of adhesive bonding

- does not permit visual examination of the bond area
- requires careful surface preparation, often with corrosive chemicals
- may involve long cure times, particularly where high cure temperatures are not used
- may require holding fixtures, presses, ovens and autoclaves, not usually needed for other fastening methods
- should not be exposed to service temperatures above approximately 180 °C
- requires rigid process control, including emphasis on cleanliness, for most adhesives
- depends on the environment to which it is exposed
Adhesive bonding applications

Attaching of banister elements *(Delo-Duopox AD895)*
- Fills gaps, suitable for small and large bonding gaps
- Good chemical resistance and aging resistance
- For interior and exterior use
- Efficiency: flexible modular system in banister construction. The additional process steps required for welding, such as grinding or polishing, are avoided

Stainless steel panels (Grade 1.4404) are attached to the outer walls of this 6-storey office building in Hannover (Germany) using an adhesive bonding system without the need for additional mechanical fastening.
Adhesive bonding is used for the assembly of door handles.

<table>
<thead>
<tr>
<th></th>
<th>With stainless steel</th>
<th>Silcone</th>
<th>Polymer modified with silane</th>
<th>Polyurethane</th>
<th>Acrylic</th>
<th>Epoxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel</td>
<td>yes</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Carbon steel</td>
<td>yes</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Carbon steel/painted</td>
<td>yes</td>
<td>●</td>
<td>●</td>
<td>x</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Carbon steel/galvanised</td>
<td>yes</td>
<td>●</td>
<td>●</td>
<td>x</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Aluminium</td>
<td>yes</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Wood</td>
<td>yes</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Glass/ceramic</td>
<td>yes</td>
<td>●</td>
<td>●</td>
<td>x</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Plastic PVC</td>
<td>yes</td>
<td>●</td>
<td>●</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Plastic PA</td>
<td>yes</td>
<td>○</td>
<td>●</td>
<td>x</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Plastic PP/PE</td>
<td>no</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

● highly recommendable - ○ recommendable - x not recommendable

Adhesive bonding is a practical solution in building applications, when stainless steel has to be fastened to masonry or natural stone.
References on Joining

1. http://www.worldstainless.org/Files/issf/animations/WeldedFabrication/start_1.html
ndootherJoiningMethods_9002_.pdf
nt_properties.pdf
7. http://shura.shu.ac.uk/3115/
8. http://www.worldstainless.org/Files/issf/non-image-
files/PDF/ISSF_Stainless_Steel_for_Designers.pdf
10. https://www.ellsworth.com/globalassets/literature-library/manufacturer/ellsworth-
adhesives/ellsworth-adhesives-white-paper-structural-bonding.pdf
2 - Fabrication

Very comprehensive documents are available, see the list of references

Ref 1 is a training course dedicated to the fabrication of stainless steels

Chapter 2 lists a number of applications in architecture, building and construction: fabrication of all shapes and finishes is achieved routinely today
Videos on Processes

- Stainless Steel Melting and Rolling
  [https://www.youtube.com/watch?v=5zwgl-pQ6kE](https://www.youtube.com/watch?v=5zwgl-pQ6kE)
- Shearing and Bending
  [https://www.youtube.com/watch?v=VMu7_W0QE3Y](https://www.youtube.com/watch?v=VMu7_W0QE3Y)
- Water Jet Cutting
- Deep Drawing
  [https://www.youtube.com/watch?v=n-ht_5Ysurc](https://www.youtube.com/watch?v=n-ht_5Ysurc)
- Wire Bending Machine
  [https://www.youtube.com/watch?v=kDoSDiiZx6U](https://www.youtube.com/watch?v=kDoSDiiZx6U)
- Spring Forming Machine
  [https://www.youtube.com/watch?v=SwY-RT4DBxY](https://www.youtube.com/watch?v=SwY-RT4DBxY)
- Roll Forming
  [https://www.youtube.com/watch?v=44XD5mZoM_0](https://www.youtube.com/watch?v=44XD5mZoM_0)
- Machining (milling)
  [https://www.youtube.com/watch?v=LDxNDWObTyg](https://www.youtube.com/watch?v=LDxNDWObTyg)

More videos are readily available on the net
References on Fabrication

Thank you

Test your knowledge of stainless steel here:

https://www.surveymonkey.com/r/3BVK2X6