Welding Joint Design and Welding Symbols
Basic Types of Joints & Terms

(a)–Butt weld

(b)–Fillet weld

Groove or included angle
Bevel angle
Fusion zone
Base metal
Root opening
Weld face
Root face
Weld size
Leg
Weld face
Fusion zone
Toe
Throat
Thickness
Types of joints

- Edge joint
- Tee joint
- Butt joint
- Corner joint
- Lap joint
FIGURE 5-1
Types of joints.
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(A) BUTT
(B) LAP
(C) TEE
(D) OUTSIDE CORNER
(E) EDGE
FIGURE 5-2 Two ways of fitting up an outside corner joint.

Open Corner

Closed Corner

FIGURE 5-3 Edge joints.
Name three types of joints that use fillet welds?

NOTE: "fillet weld" = a triangular shaped weld in a corner
How is the size of a fillet determined?

NOTE:
While Leg Size is the usual method to specify and measure weld size, the Effective Throat is a more accurate measure of fillet weld strength!
Side Note: some considerations in selecting a type of joint to use on a fabrication.

- Accessibility for welding
- Strength requirements
- Cyclic or static loading
- Material thickness
- Welding process to be used
- Material type
- Code Requirements
- Cost
Name two edge preparations used with butt joints.

- Bevel Groove
- Vee Groove
- J Groove
- Square Groove
- U Groove
Edge preparations used with butt joints.
Name two types of V edge preparations that are recommended for braze welding butt joints.

Single V Groove

Double V Groove
Weld Joint Design (cont’d.)

- Cost
  - A number of items affect weld cost

FIGURE 5-14 Even a slight change in groove angle can save time and money.
1.1 (a) The instruction ‘weld here’ and (b–d) three ways to follow this instruction.
Welding Symbols (cont’d.)

3 parts of the welding symbol body:

- Arrow
- Reference Line
- Tail
Welds on drawings ČSN EN ISO 2553

A - size  
Z – weld sign  
n – number of welds  
L - length  
e – distance  
Z – intermittent weld  
T – technology information
\[ z = a \cdot \sqrt{2} \]

\[ a = 0.5 - 0.7t \]

Kde: \( t = \) BM thickness

Circumferential weld

Field weld
UPPER VIEW

Intermittent weld

Opposing weld
<table>
<thead>
<tr>
<th>No.</th>
<th>Designation</th>
<th>Illustration</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Butt weld between plates with raised edges (the raised edges being melted down completely)</td>
<td><img src="image1.png" alt="Illustration" /></td>
<td><img src="image2.png" alt="Symbol" /></td>
</tr>
<tr>
<td>2.</td>
<td>Square butt weld</td>
<td><img src="image3.png" alt="Illustration" /></td>
<td><img src="image4.png" alt="Symbol" /></td>
</tr>
<tr>
<td>3.</td>
<td>Single-V butt weld</td>
<td><img src="image5.png" alt="Illustration" /></td>
<td><img src="image6.png" alt="Symbol" /></td>
</tr>
<tr>
<td>4.</td>
<td>Single-bevel butt weld</td>
<td><img src="image7.png" alt="Illustration" /></td>
<td><img src="image8.png" alt="Symbol" /></td>
</tr>
<tr>
<td>5.</td>
<td>Single-V butt weld with broad root face</td>
<td><img src="image9.png" alt="Illustration" /></td>
<td><img src="image10.png" alt="Symbol" /></td>
</tr>
<tr>
<td>6.</td>
<td>Single-bevel butt weld with broad root face</td>
<td><img src="image11.png" alt="Illustration" /></td>
<td><img src="image12.png" alt="Symbol" /></td>
</tr>
<tr>
<td>7.</td>
<td>Single-U butt weld (parallel or sloping sides)</td>
<td><img src="image13.png" alt="Illustration" /></td>
<td><img src="image14.png" alt="Symbol" /></td>
</tr>
<tr>
<td>8.</td>
<td>Single-U butt weld</td>
<td><img src="image15.png" alt="Illustration" /></td>
<td><img src="image16.png" alt="Symbol" /></td>
</tr>
<tr>
<td></td>
<td>Elementary welding symbols</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Backing run; back or backing weld</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Fillet weld</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Plug weld; plug or slot weld</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Spot weld</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Seam weld</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Supplementary welding symbols

<table>
<thead>
<tr>
<th>Shape of weld surface</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Flat (usually finished flush)</td>
<td>——</td>
</tr>
<tr>
<td>(b) Convex</td>
<td>( )</td>
</tr>
<tr>
<td>(c) Concave</td>
<td>( )</td>
</tr>
</tbody>
</table>

### Combination of elementary and supplementary symbols

<table>
<thead>
<tr>
<th>Designation</th>
<th>Illustration</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat (flush) single-V butt weld</td>
<td>![Illustration]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>Convex double-V butt weld</td>
<td>![Illustration]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>Concave fillet weld</td>
<td>![Illustration]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>Flat (flush) single-V butt weld with flat (flush) backing run</td>
<td>![Illustration]</td>
<td>![Symbol]</td>
</tr>
</tbody>
</table>
(a) For symmetrical welds only

(b) To be welded on the other side

(c) To be welded on the arrow side
Examples:
## Combination of elementary symbols

<table>
<thead>
<tr>
<th>No.</th>
<th>Designation symbol</th>
<th>Illustration</th>
<th>Representation</th>
<th>Symbolization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Square butt weld</td>
<td><img src="image1" alt="Illustration" /></td>
<td><img src="image2" alt="Representation" /></td>
<td><img src="image3" alt="Symbolization" /></td>
</tr>
<tr>
<td></td>
<td>[ \parallel 2 ]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>welded from both sides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[ 2-2 ]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Single-V butt weld</td>
<td><img src="image4" alt="Illustration" /></td>
<td><img src="image5" alt="Representation" /></td>
<td><img src="image6" alt="Symbolization" /></td>
</tr>
<tr>
<td></td>
<td>[ \sqrt[3]{3} ]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>and backing run</td>
<td><img src="image7" alt="Illustration" /></td>
<td><img src="image8" alt="Representation" /></td>
<td><img src="image9" alt="Symbolization" /></td>
</tr>
<tr>
<td></td>
<td>[ [ 9 ] 3-9 ]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Combination of elementary symbols

<table>
<thead>
<tr>
<th>No.</th>
<th>Designation symbol</th>
<th>Representation</th>
<th>Symbolization</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>and backing run <img src="image" alt="9" /> <img src="image" alt="3-9" /></td>
<td><img src="image" alt="Illustration" /></td>
<td><img src="image" alt="Symbolization" /></td>
</tr>
<tr>
<td>4</td>
<td>Double-V butt weld <img src="image" alt="3" /> <img src="image" alt="X weld" /> <img src="image" alt="3-3" /></td>
<td><img src="image" alt="Illustration" /></td>
<td><img src="image" alt="Symbolization" /></td>
</tr>
<tr>
<td>5</td>
<td>Double bevel butt weld <img src="image" alt="4" /></td>
<td><img src="image" alt="Illustration" /></td>
<td><img src="image" alt="Symbolization" /></td>
</tr>
</tbody>
</table>
Dimensioning the weld

\[ s \parallel l \]

\[ z = a \sqrt{2} \]

Fig. 16.7 METHODS OF INDICATING DIMENSIONS FOR FILLET WELDS
## Dimensioning

### TABLE 16.5 PLAIN DIMENSIONS

<table>
<thead>
<tr>
<th>No.</th>
<th>Designation of Welds</th>
<th>Definition</th>
<th>Inscription</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Butt weld</td>
<td>( s ) : minimum distance from the surface of the part to the bottom of the penetration, which cannot be greater than the thickness of the thinner part.</td>
<td>see 16.4.2.2 and 16.4.2.3</td>
</tr>
<tr>
<td>2</td>
<td>Butt weld between plates with raised edges</td>
<td>( s ) : minimum distance from the external surface of the weld to the bottom of the penetration.</td>
<td>see 16.4.2.2</td>
</tr>
<tr>
<td>3</td>
<td>Continuous fillet weld</td>
<td>( a ) : height of the largest isosceles triangle that can be inscribed in the section. ( z ) : side of the largest isosceles triangle that can be inscribed in the section.</td>
<td>see 16.4.2.2 and 16.4.2.4</td>
</tr>
<tr>
<td>4</td>
<td>Intermittent fillet weld</td>
<td>( l ) : length of weld (without end craters). ( l(e) ) : distance between adjacent weld elements. ( n ) : number of weld elements.</td>
<td>see 16.4.2.4</td>
</tr>
</tbody>
</table>
Welding positions
ČSN EN ISO 6947

- **PA**
- **PB**
- **PC**
- **PD**
- **PE**

**CIRCLE**

*Angled axis*

- **Top edge**
- **H-L045**
- **L-L060**

**L=45°**

**L=60°**
Types of Welded structure

- FRAMES - Civil engineering structures - Buildings, bridges
- Mechanical engineering-frames, coverings, shafts
- Energy generation and transfer
- PRESSURE VESSELS (shells) Processing industry
- , Tubular frames-sea platforms
On following figures answer

- Material
- Function of welds
- Static, dynamic loaded structure
- Loading conditions
- Fully loaded welds?
- Working environment
- Precision of the part - Distortion, inner tension
- Productivity, Costs
- On site, jobshop welding
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To consider for design of Welded structure

- Function of welds - Static, dynamic loaded structure
- Loading conditions
- Working environment
- Precision of the part
- Productivity, Costs
- Accessibility for welding - On site, jobshop welding
- Welding process to be used
- Material type
- Code Requirements
- Cost
Butt joints

- Good force transfer
- High load capacity
- Dynamic loading – full penetration weld
- Difficult edge preparation
T-joints

- Load carrying in bending
- Easy execution
- A increase difficult
- Risk of weld quench
Corner joints

- For thin sheets
- Good smooth look
- Easy assembly
Obr. 12. Spojení dvou profilů
U pásy
Simple rules for design of Welded structure

- No weld is best
- Smaller better than big
- Humidity = Enemy
- Think how the stress pass through structure