Deposition path strategies - Wire and Arc Additive Manufacturing (WAAM) for steel – Gaz Metal Arc Welding (GMAW)
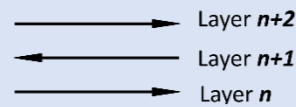
1. Errors in the start and stop points
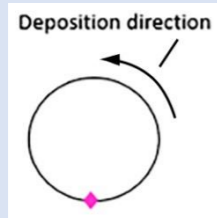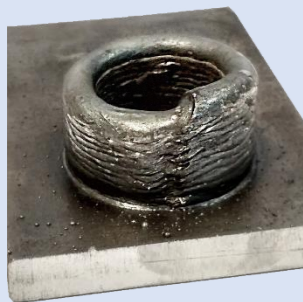
- ### Open contour

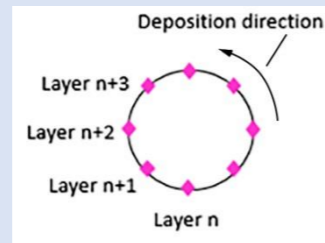**ZIG**   **VS**   **ZIG-ZAG**

Layer n+2
Layer n+1
Layer n

Layer n+2
Layer n+1
Layer n

- ### Closed contour

Deposition direction

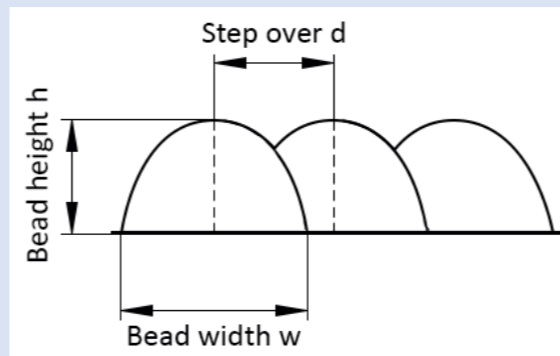♦ - start/stop point

Deposition direction

Layer n+3
Layer n+2
Layer n+1
Layer n

Rule of thumb

- Open contours: change deposition direction from layer to layer
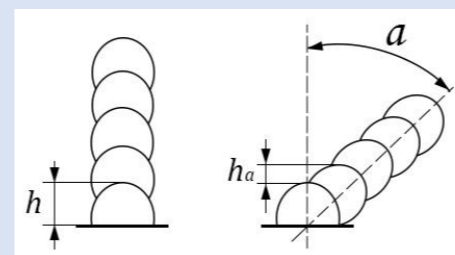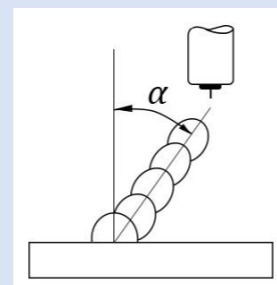- Closed contours: rotate start point as within the layer as between the layers
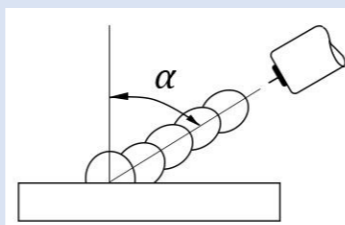
2. Determine step over value

Step over d

Bead height h

Bead width w

Step over value depend on ratio of wire feed speed (WFS) to travel speed (TS):

- If WFS/TS > 12.5 then $d = \frac{1}{2h}\left(2R^2 arcsin\frac{w}{2R} + wh - wR\right)$

  where $R = \frac{(h^2 + w^2/4)}{2h}$

- If WFS/TS < 12.5 then $d = \frac{2w}{3}$

4. Inclined walls

α a h_a h

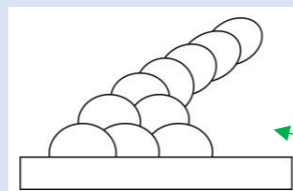$$h_a \approx h \cos\alpha$$

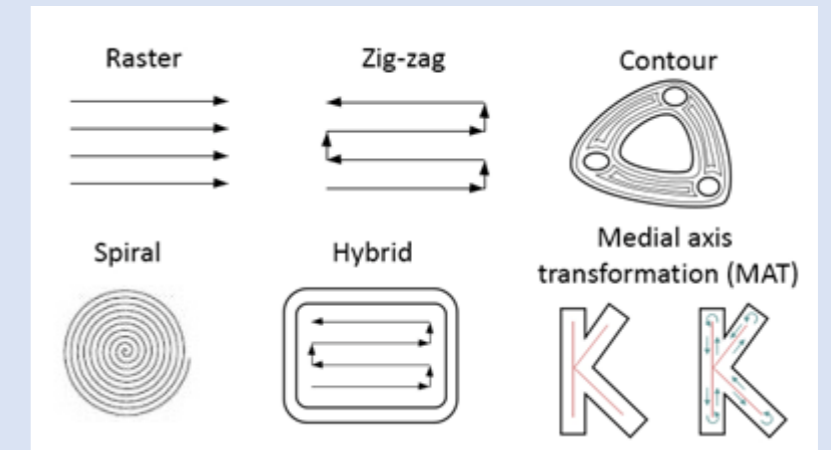### Rule of thumb

- If $\alpha < 45°$: print in PA position
- If $\alpha \geq 45°$: print in PB position.
- Rotate the table when $\alpha > 60°$ due to humps formation and gravity issues
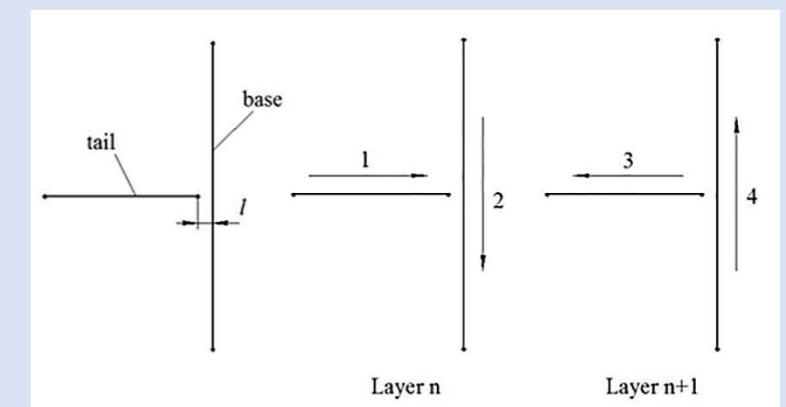- Use special strategy to overcome acute angles

3. Main strategies for solid components

Raster   Zig-zag   Contour

Spiral   Hybrid   Medial axis transformation (MAT)

Rule of thumb

- Add *1-2* contour passes when using zig or zig-zag strategy to eliminate stairs effect

5. Crosses

base
tail
1   2   3   4
l

Layer n   Layer n+1

Rule of thumb

- *L = 0.5w, crater filling time 0.5 sec*
- Print tails first, after print base and contours