SECTOR SKILLS STRATEGY IN ADDITIVE MANUFACTURING

Co-funded by the Erasmus+ Programme of the European Union

Project No. 601217-EPP-1-2018-1-BE-EPPKA2-SSA-B

CU 01: DED-ARC

Session 5.4 – Weld position & Self-supporting features

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FOR SAM PILOT ATTENDEES AND TRAINERS ONLY

MM17,21

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Welding Positions

4 Standard welding positions;

1. Flat position
2. Horizontal
3. Vertical
4. Overhead

Then add;
F = fillet weld
G= groove weld
ie 3G = vertical groove weld

In DED we are only interested in welding position

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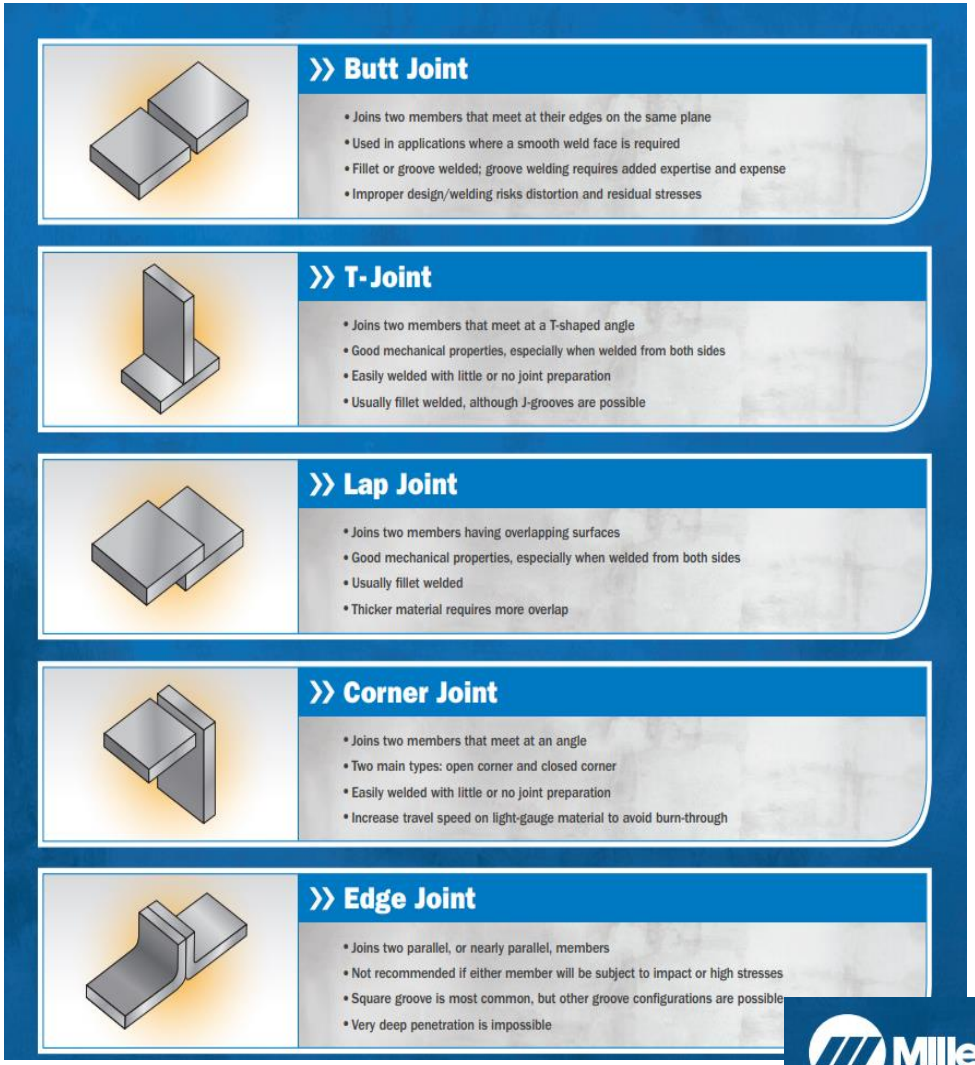
Weld Joint Types

5 primary joint types;

1. Butt
2. T
3. Lap
4. Corner
5. Edge

In DED we are not forming joints

However there are occasions where we have to resort to adding material to strengthen the part and this follows similar principles to joining



Miller The Power of Blue

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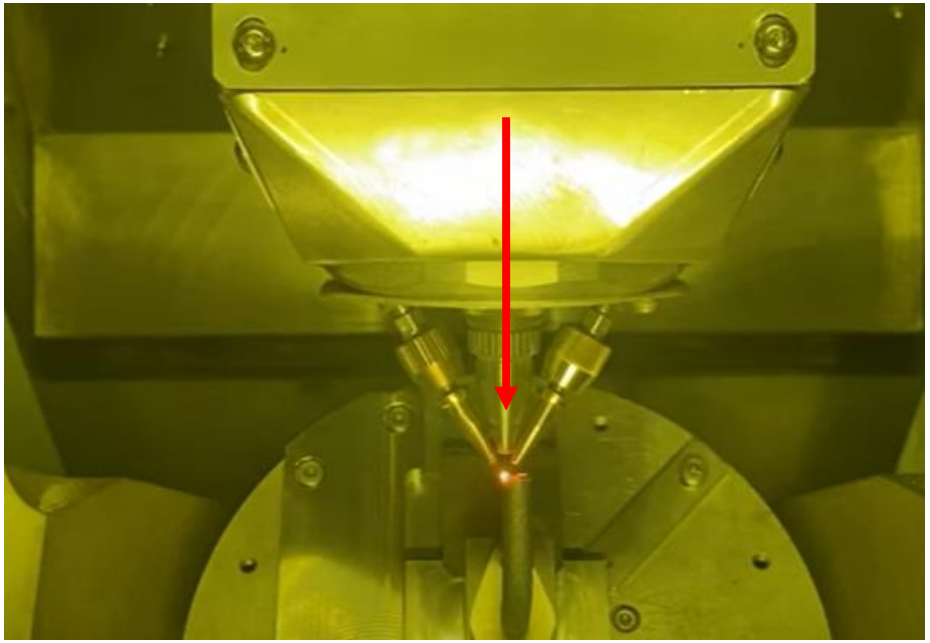
Ideally Weld Position

- Ideal position for cladding is depositing straight down
- For complex parts this means tilting the part or the torch



https://www.youtube.com/watch?v=pIb0VIzHFLU

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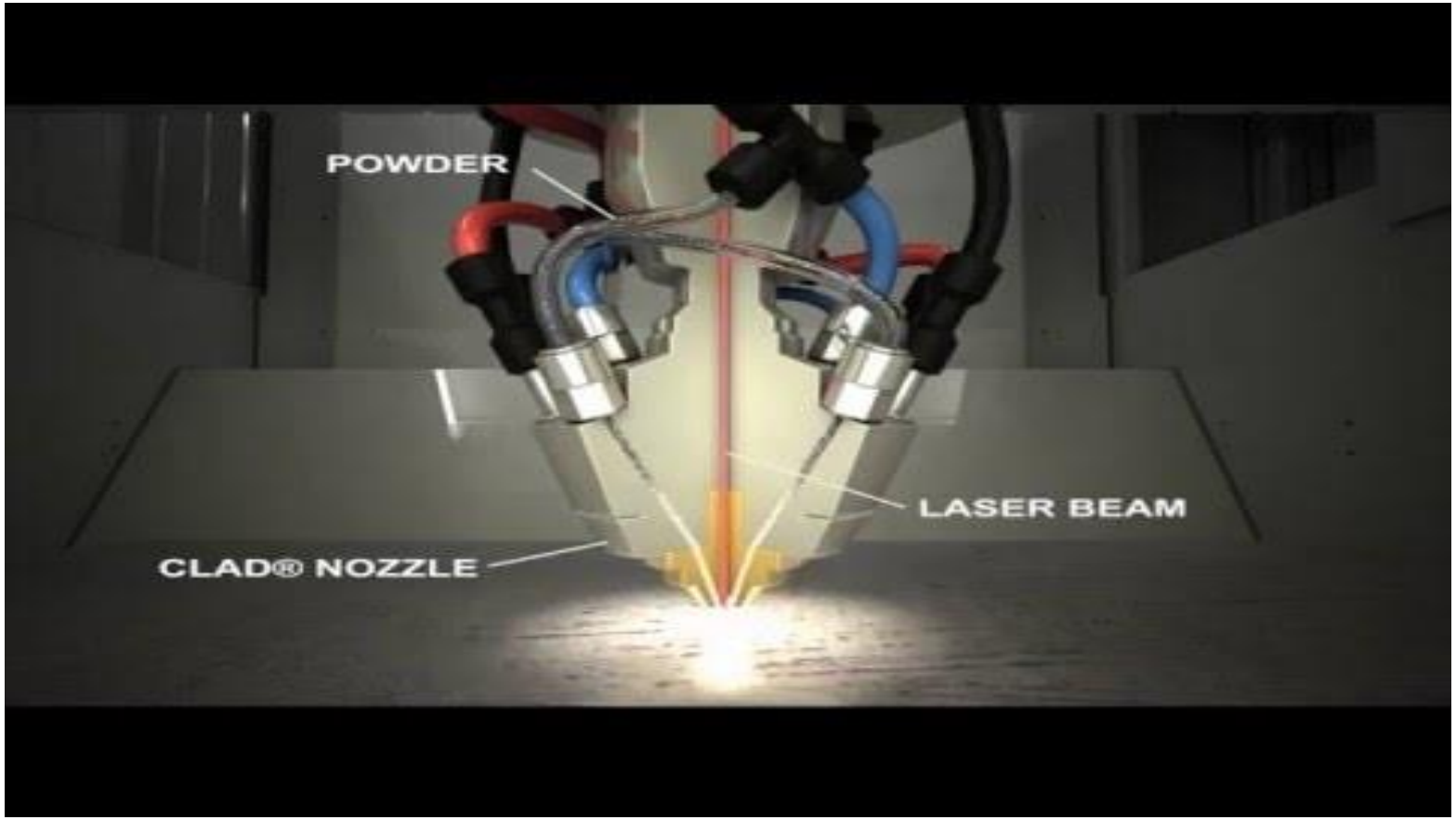

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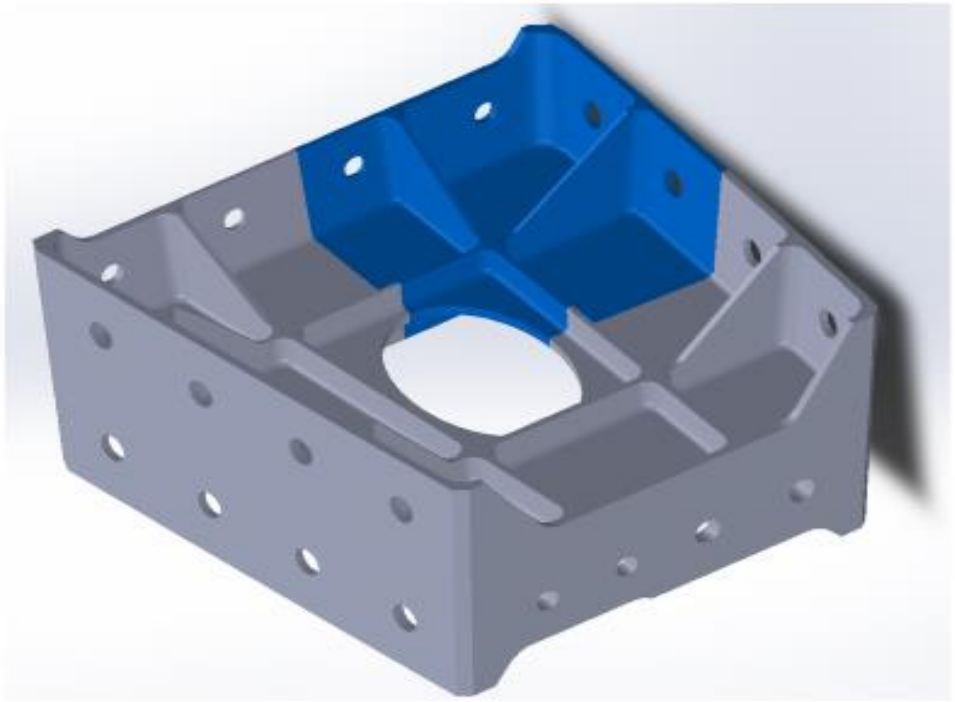
Outboard MGL Rib Quarter

Example of build strategy

Building ¼ of the MLG Rib

Single sided mode



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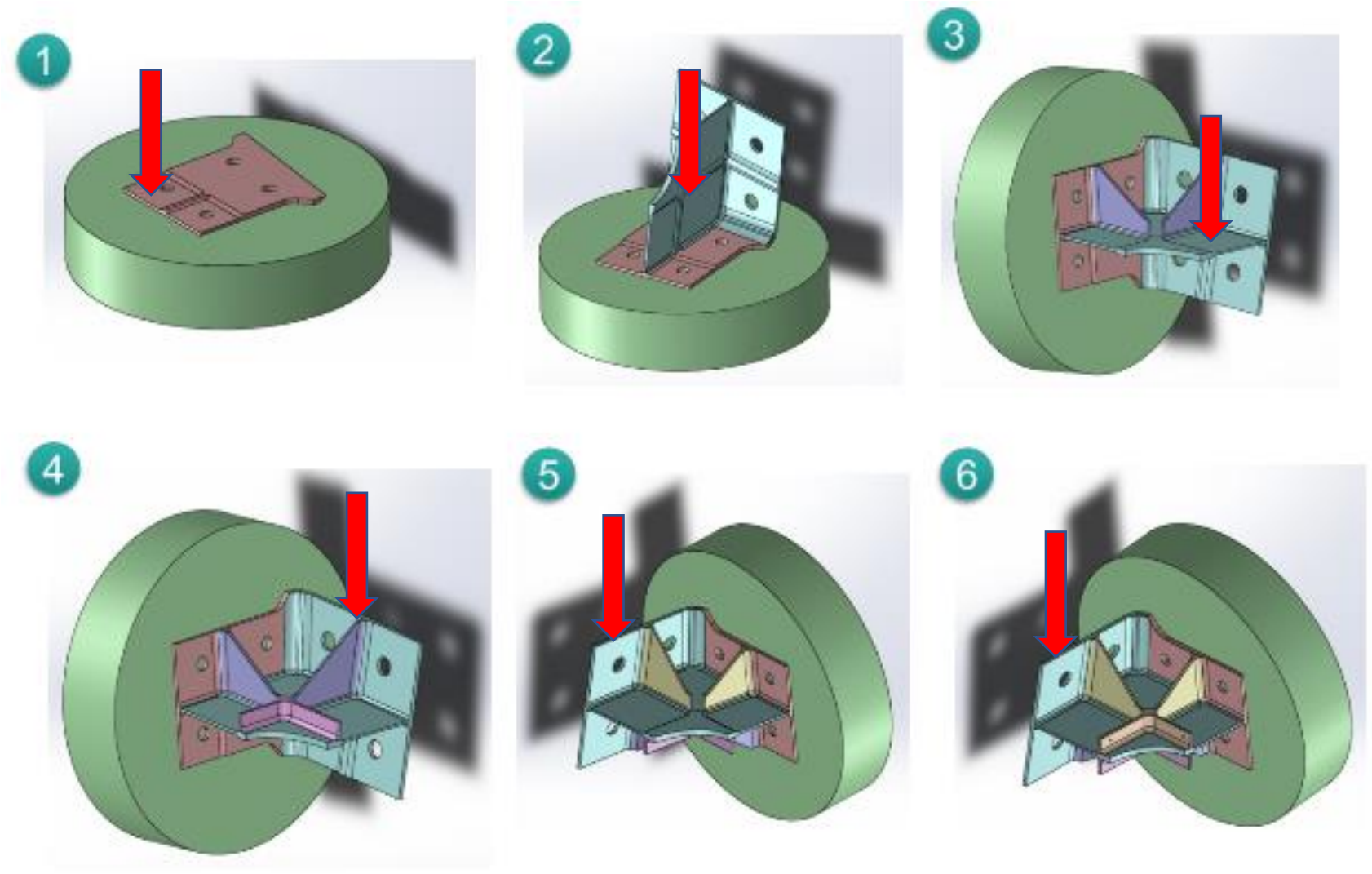

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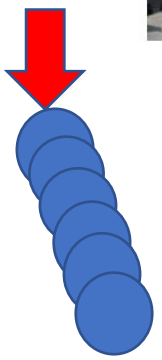
Slightly overhanging features can be create in 3-axes welding

More complex parts need tilting of weld torch and/or part



WAAM – Large parts – thin walled structure

Cranfield UNIVERSITY

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Not depositing in the flat position (1)

- In some cases this is not possible to tilt the part
- Need to adopt another welding position
- Generally slower deposition rate
- Greater likelihood of weld runs and defects
- Increased contamination in torch

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2 Key DED challenges;

- **Depositing on to include inclined, vertical and overhanging surfaces** – well developed welding solutions

- **Forming Self supporting features** – not normally required in standard welding but methods have been developed for repair which can be applied to DED

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Vertical, Inclined Overhead welding

We may need to deposit onto vertical, inclined surfaces and even weld overhead

Particularly for feature addition and repair of large /immovable parts

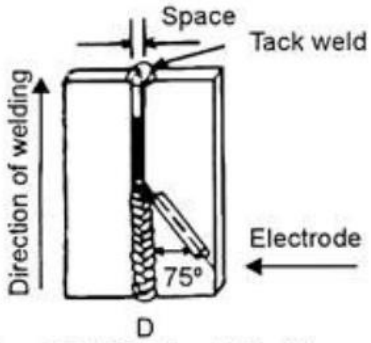


Fig. 6.21 Vertical Position

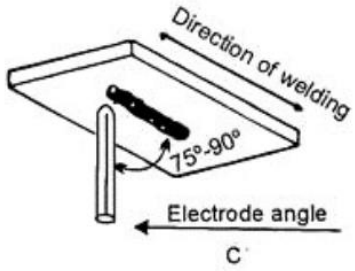
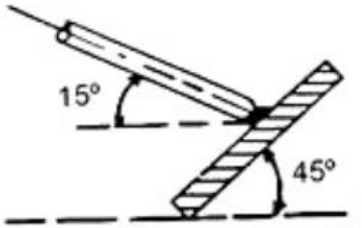
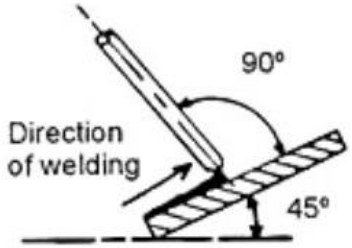


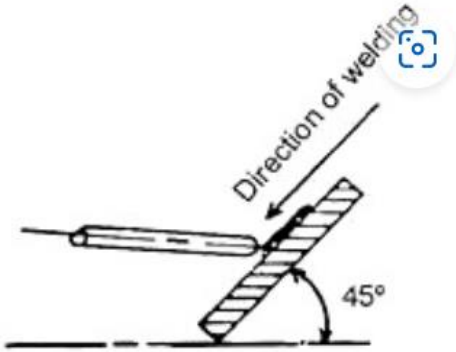
Fig. 6.20 Overhead Position



Horizontal bead inclined 45°



Upward bead inclined 45°



Downward bead inclined 45°

[Positions of Weld (With Diagram) |Metallurgy (yourarticlelibrary.com)]

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Welding Directions

There are two basic torch movements when welding vertically;

1. **Vertical-up** start at the bottom and work upwards using the preceding weld material as a support (“shelf”)

2. **Vertical-down** start at the top and work downwards, this requires more care as gravity tends to lead to weld bead dripping

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Videos

Welding in different locations….

[Learn How To Master | Stick Welding Vertical Up | 7018 Technique ! - YouTube]

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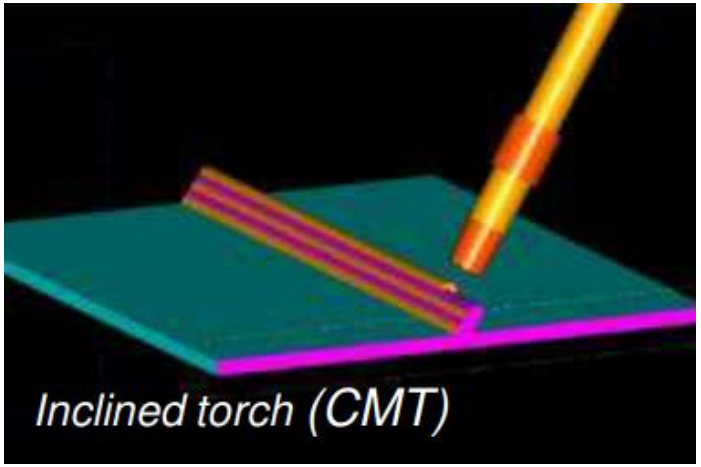
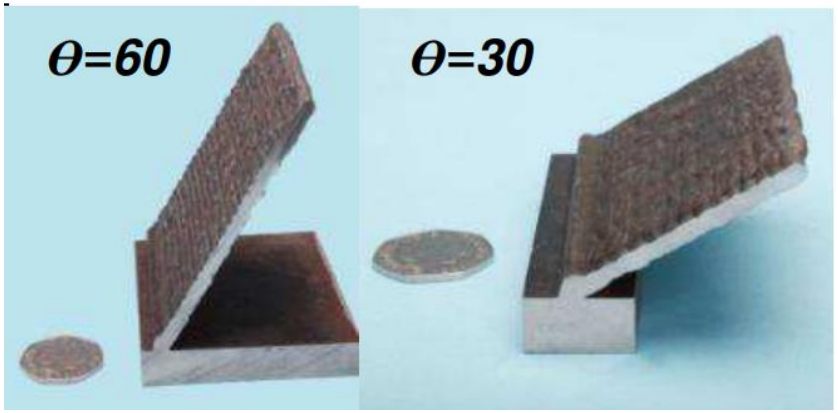
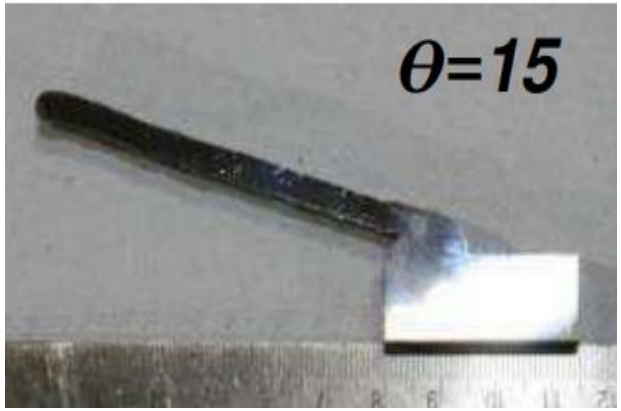
Self Supporting Features Overhangs

- Ideally incline torch
- Deposit onto the edge of the inclined plane







"High deposition rate high quality metal additive manufacture using wire + arc technology"
Dr. Paul Colegrove , Professor Stewart Williams, Cranfield University

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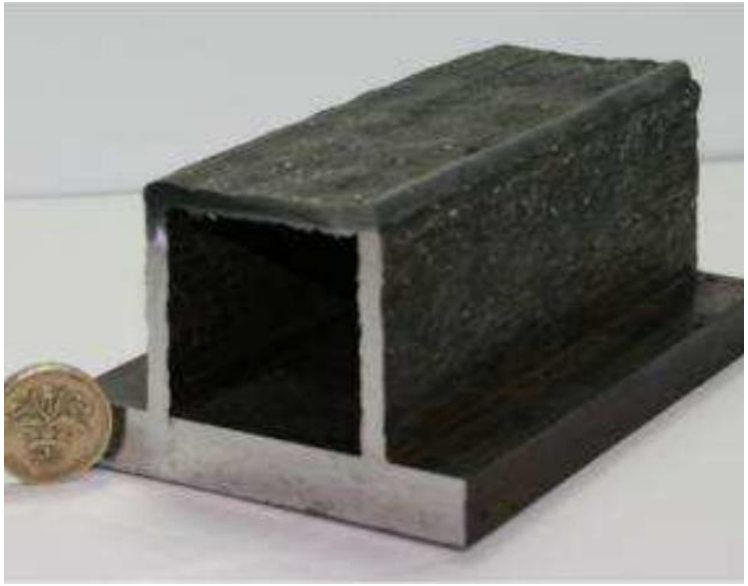
Fully enclosed section

- Deposit two vertical walls onto based plate and then build a horizontal wall between to form box channel



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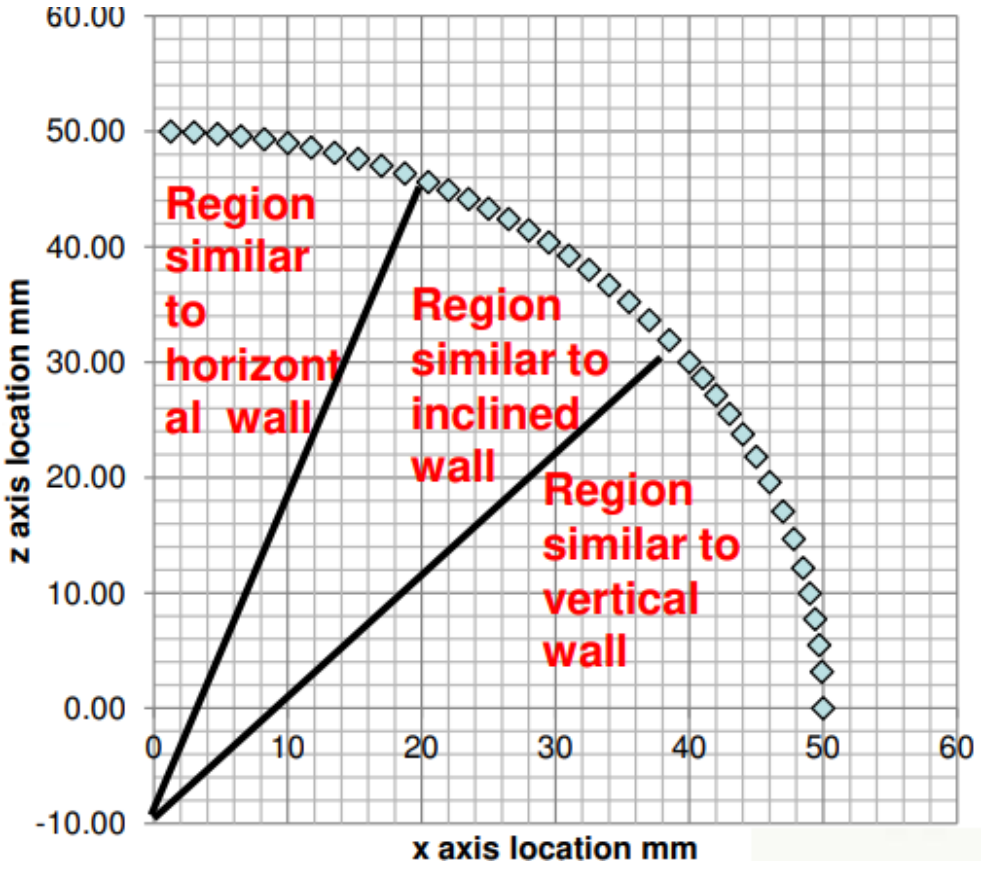

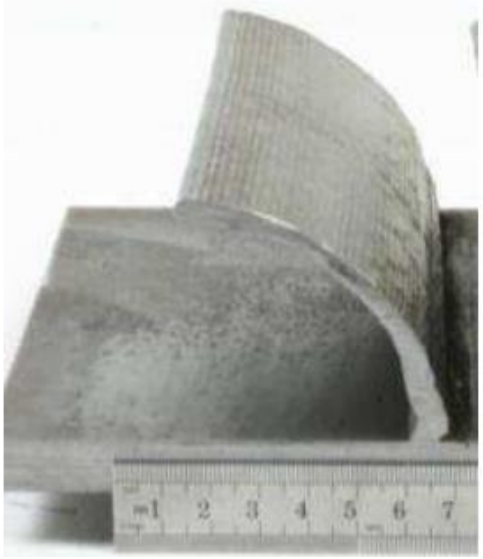

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Self supporting Channels

- As with PBF-LB it is triangular or droplet shaped channels are self-supporting

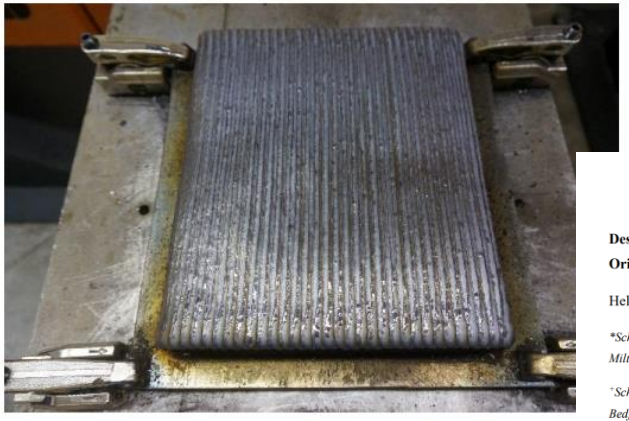

Figure 3. Example WAAM Part with Enclosed Passageway (Lijuan Sun 2015)

Journal of Engineering Design, Vol. 28, Issue 7-9, 2017, pp. 568-598
DOI:10.1080/09544828.2017.1365826

Design for Wire + Arc Additive Manufacture: Design Rules and Build Orientation Selection

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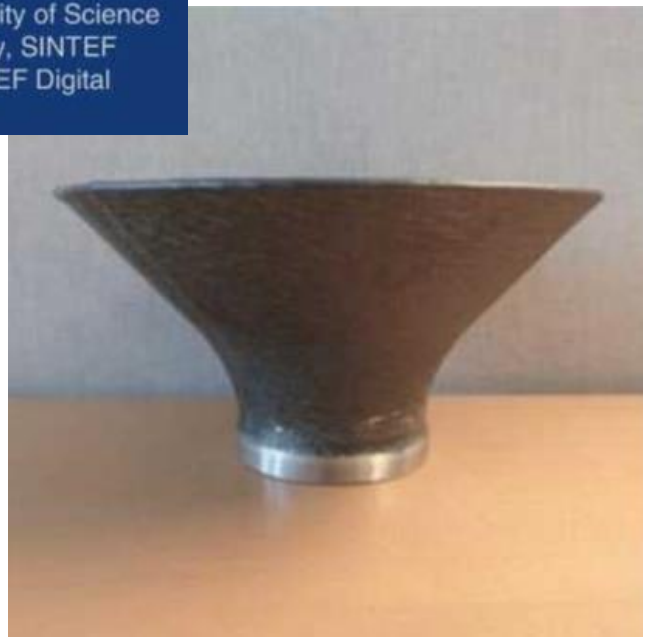
Overhang created by tilting torch

Norwegian University of Science and Technology, SINTEF Industry, SINTEF Digital



CIRP Journal of Manufacturing Science and Technology
Volume 38, August 2022, Pages 186-203

Wire-arc additive manufacturing of structures with overhang: Experimental results depositing material onto fixed substrate

Linn Danielsen Eyjemo [a], Geir Langelandsvik [b], Signe Moe [c], Morten Høgseth Danielsen [b], Jan Tommy Gravdahl [a]

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- Wire Arc Additive Manufacturing (WAAM) - YouTube

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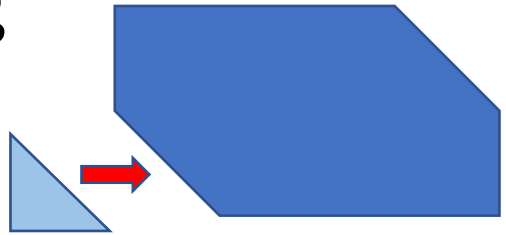
Supports, extensions and blanking

Additional material is sometimes added to DED parts;

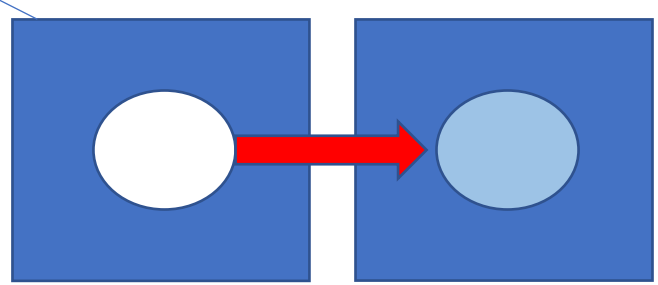
- Support overhanging section



- Extend interface with build plate to prevent separation under stress

- Blanking over holes to make the deposition process simpler

In most cases the additional material will be removed later



Need to strike a balance between additional material/ time versus the ease of deposition

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www.skills4am.eu

Thank you & Questions ?

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