Induced Ductile to Brittle Transition Impact Cut (IDBTIC)

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The Project Aims and Objectives:

1. To investigate a new cutting technique based on an impact shattering method, which utilising the embrittlement concept of Ductile to Brittle Transition (DBT) of mild carbon steel types.
2. To investigate thermal distribution and fracture propagation in for the shattering process of Offshore Monopile Foundations (OMF).
3. To evaluating the effect of the new cutting technique (embrittlement cutting) on the overall decommissioning time and cost.
4. To reduce the overall environmental footprint (CO_2 equivalents) by 25% and cost of the decommissioning process by 20% for the OMFs.

The Project Research:

Will add value to the offshore decommissioning industry by developing a novel cutting method based on the DBT of ferritic steel types, which will be faster, cheaper and more environmentally friendly than the conventional cutting techniques.

Desired Outcomes:

The project will lead to a cheaper, faster and more environmentally friendly cutting method than the existing methods for the removal of offshore structures like OMFs allows. Specifically reducing environmental footprint (CO_2 equivalents) by 25% and the cost of the decommissioning process by 20% for the OMFs, due to the development of the faster cutting method of the novel Cooling Cutting Technique (CCT).

Carbon Steel Specifications:

Type: **ISO EN 1.0577 (S355J2)**
Thermal Conductivity: **50 W/m*K**
Density: **7850 kg/m^3**
Specific Heat: **470 J/kg*K**

OMF Wall Specifications:

Wall Thickness [b]: **100 mm**

Liquid Nitrogen [LN_2] Specifications:

Temperature: **-196 °C**
Heat Transfer Coefficient: **128 W/m^2*K**

Ambient Specifications:

Bedrock Temperature [t_a]: **20 °C**
Heat Transfer Coefficient: **25 W/m^2*K**

Cooling Element Specifications:

Surface Width Size: **100 mm**

Impact Energy (IE) depending on Cooling Temperature:

Impact Energy @ 20 °C: **210 J/cm^2**
Impact Energy @ 0 °C: **135 J/cm^2**
Impact Energy @ -45 °C: **15 J/cm^2**

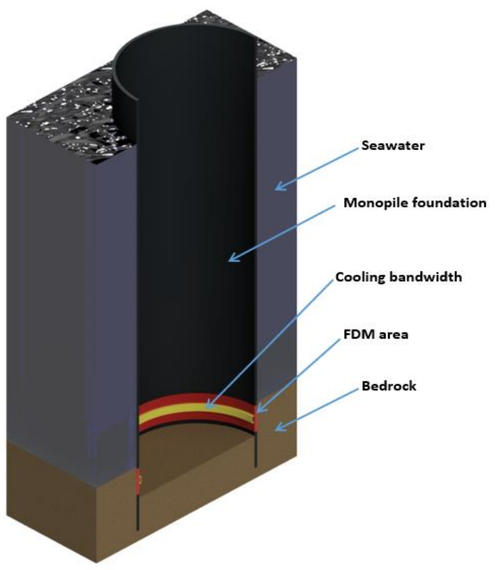

Figure 1 - 3D Model showing the OMF with the Cooling Element in yellow) and the Finite Difference Method (FDM) Area (in red)

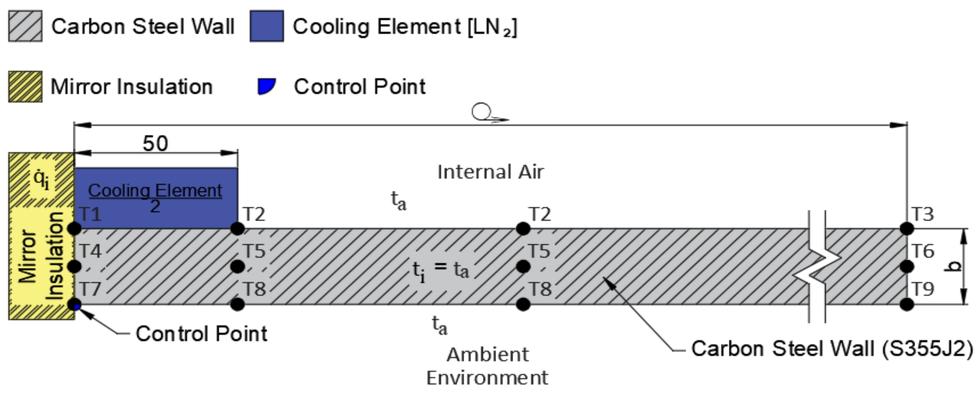

Figure 2 - 2D Model for the FDM Analysis of Cooling Time to reach -45 °C @ the Cooling Point depending on Ambient Conditions

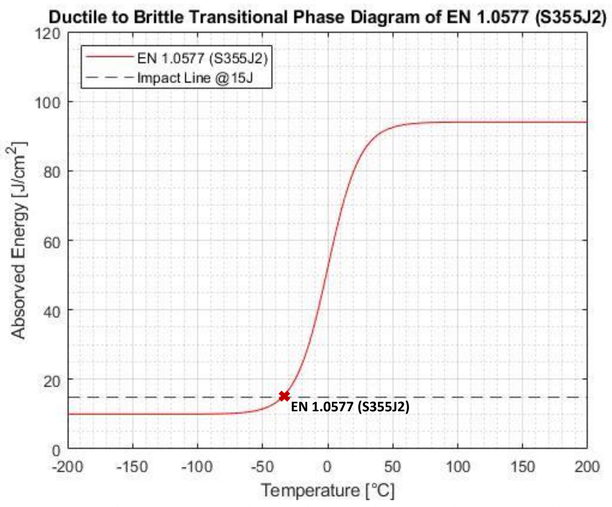

Figure 3 - DBT Phase Diagram for EN 1.0577 (S355J2)

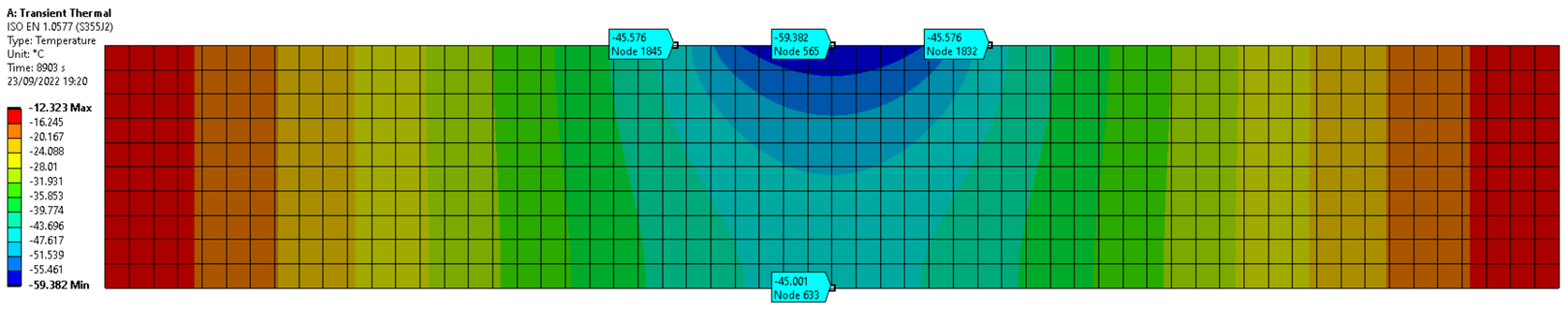

Figure 4 - Transient Heat Transfer Simulation for the OMF Wall to reach -45 °C (15 J/cm^2) on the outer surface of the wall

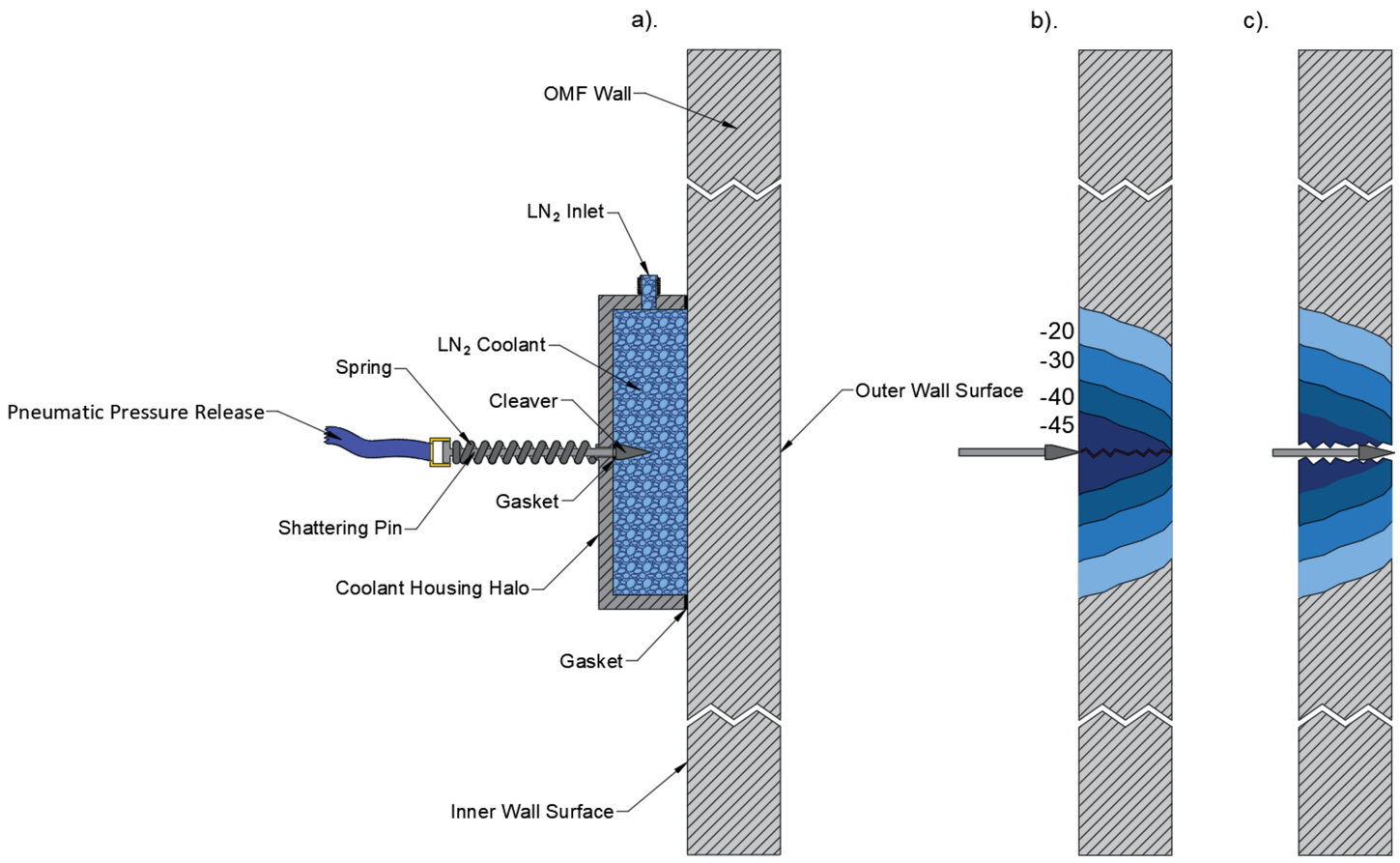

Figure 5 - a) Cross Section View of the CCT applied on the inside of an OMF Wall
b) Cooling area of the OMF Wall and Fracture Line
c) Full Fracture of the OMF Wall

Figure 6 - Cutting time of EN 1.0577 (S355J2), applying Abrasive Water Jet (AWJ) 6000 bar, 4000 bar, Oxy Arc Torch (OA) and the Cooling Cutting Technique (CCT)

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