

WHAT is the Heat Affected Zone (HAZ) ?

It's the area of the base metal that's been affected by the heat input during welding — but without melting: The metal didn't melt, but its microstructure changed due to the heat exposure.

“HAZ - The most feared Danger Zone in Welding Technology”

WHY is the HAZ important and potentially dangerous ?

Because microstructure changes may lead to :

- Lost of mechanical properties
- Crack susceptibility
- Loss of toughness and low ductility
- Formation of delayed cracks

This is especially critical in materials like :

- Medium and high carbon steels
- Heat-treated metals
- Heat-sensitive alloys

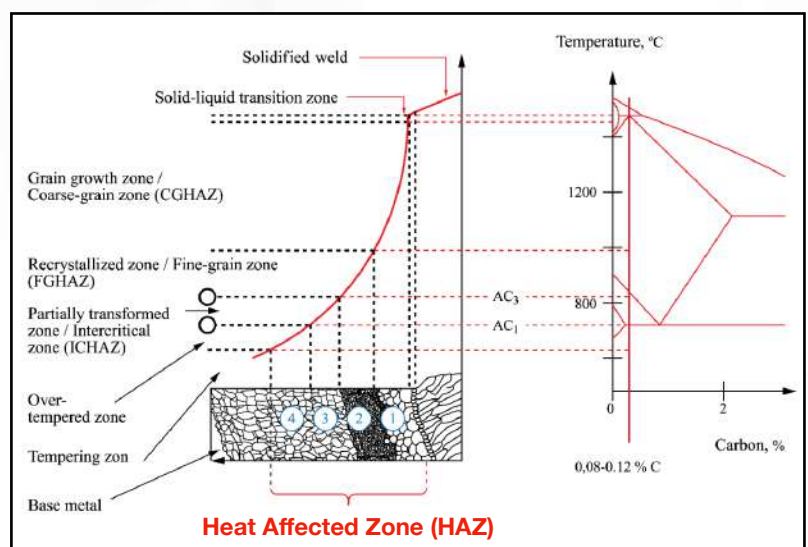
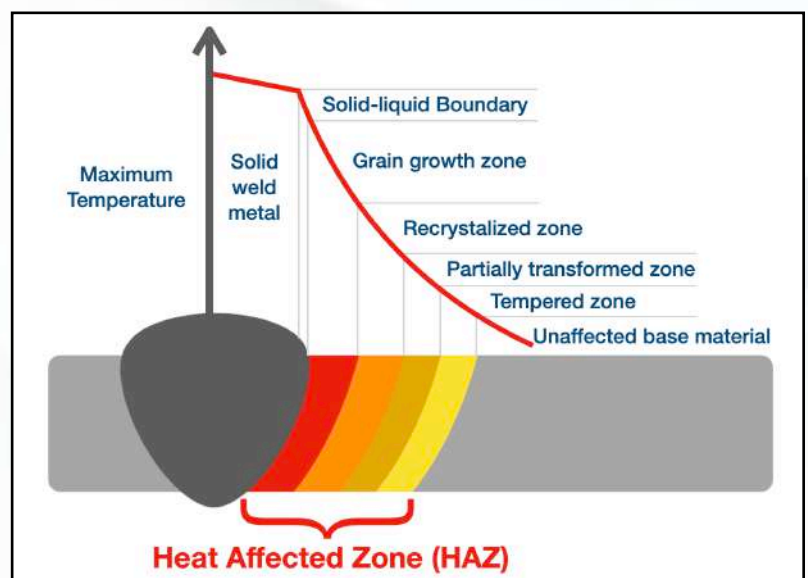
HOW do we detect problems in the HAZ ?

By applying following inspection techniques:

- Visual Testing (VT)
- Ultrasonic Testing (UT)
- Liquid Penetrant Testing (PT)
- Magnetic Particle Testing (MT)
- Radiographic Testing (RT)
- Hardness Testing
- Bending Testing
- Metallographic Examination

WHICH factors affect the HAZ ?

- Welding temperature and heat input
- Welding Process
- Cooling rate
- Type of base metal
- Welding method
- Thickness and size of base metal
- Pre- or Post-Weld Heat Treatment (PWHT)



Conclusion & Technological Solution :

- The wider the HAZ, the higher the risk of weakened metal.
- Pulse Laser Welding Technology provides a premium HAZ property because of its very low heat input (about only 30 Joule / AL-1200F)

HAZ – The most feared “**Danger Zone**” in welding technology

A transnational investigation project :

This project was carried out by *DSI-Thailand-Academy* together with *German Welding Society DVS SLV Hannover* and *Thai German Institute (TGI)*. The target was to investigate the width of the HAZ by comparing three different welding methods: two classical arc-methods, SMAW (111) and MAGW (135), with Pulse Laser Welding (521). The latter use photons as energy source, i.e. bundled, rectified, pulsating light particles and their speed – melting metal and welding at 300,000 km/s !

Base material, welding specimen :

- Base material : S355J2+N structural steel (DIN EN 10025-2).
- Quantity : Six samples (12 × 100 × 100 mm)
- Method : two by manual arc, two by metal active gas, and two by pulsed laser welding
- Condition : single-layer weld and three-layer weld

Case study 1 : Shield Metal Arc Welding (SMAW / 111)

- Welding filler material : EN ISO 2560-A E 38 2 RB 12/AWS A5.1: E6013
- Electrode diameter : 4 mm/rutile-basic coated,
- Type of welding machine : FRONIUS “TransPocket 180”/amperage: 160A.

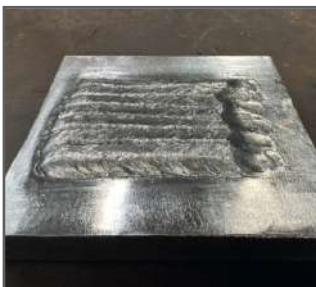


Fig. 1: Single-layer
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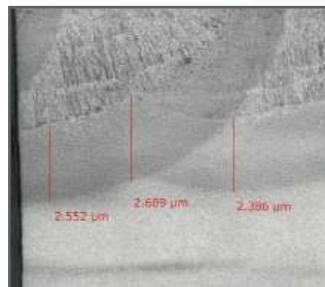


Fig. 2: Single-layer
(HAZ 2.4 mm-2.7 mm)
(© DSI-Thailand)



Fig. 3: Three-layer
(© DSI-Thailand)

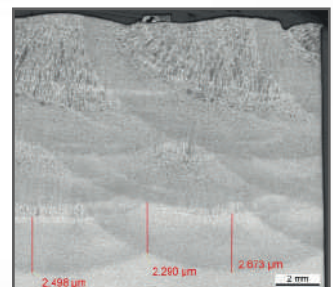


Fig. 4: Three-layer
(HAZ 2.2 mm-2.7 mm)
(© DSI-Thailand)

Case study 2 : Metal Active Gas Welding (MAGW / 135)

- Welding filler material : AWS A5.18: ER70S-6 / solid wire / dia. 1.2 mm
- Shielding gas mixture : M21 (argon 82 %/CO2 18 %)
- Type of welding machine : FRONIUS “TPS 4000”/current: 170 A



Fig. 5: Single-layer
(© DSI-Thailand)

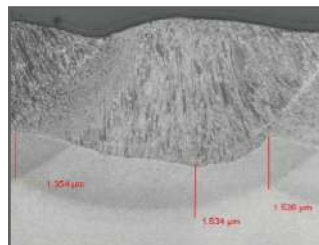


Fig. 6: Single-layer
(HAZ 1.4 mm-1.7 mm)
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Fig. 7: Three-layer
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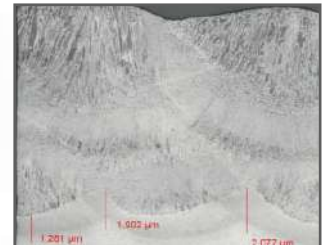


Fig. 8: Three-layer
(HAZ 1.3 mm-2.1 mm)
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Case study 3 : Pulsed Laser Welding (PLW / 52)

- Welding filler material : DSI M90 / 1.5424 / 10MnMo4-5
- Welding machine : "ALPHA LASER / AL Flak 1200 F" (Type : Fiber Laser 1070 nm)
- Welding parameters : Pulse laser power 1200 W / beam diameter 2.4 mm / pulse duration 2.8 ms
pulse frequency 34.0 Hz / shielding gas 12l/min / Argon 4.6.

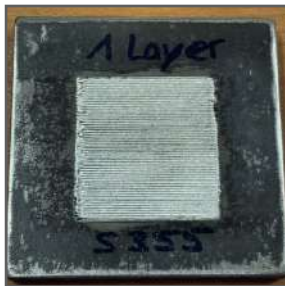


Fig. 9: Single-layer
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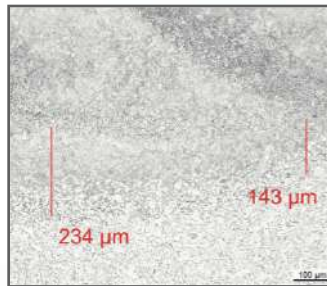


Fig. 10: Single-layer
(HAZ 0.14 mm-0.23 mm)
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Fig. 11: Three-layer
(© DSI-Thailand)

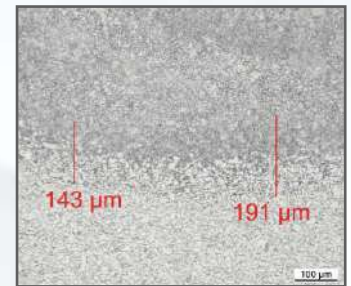


Fig. 12: Three-layer
(HAZ 0.14 mm-0.19 mm)
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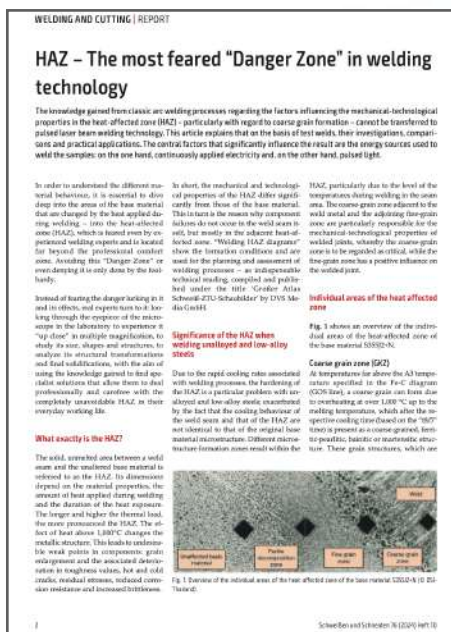
Conclusion:

The technology "**Welding with Pulsed Light and its Speed**" is able to reduce the originally high risk potential of the "danger zone" in classic welding processes using electric current as an energy source to a minimum and to harmonize between the base material and the weld metal.

The Premium Quality of Pulse Laser Welding : Investigated. Proved. Published.

The successful refurbishment of this Structural steel was published in the Magazine of German Welding Society *Welding and Cutting* (issue 2/2024)

„HAZ – The most feared “Danger Zone” in welding technology “



HAZ investigation
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