BESST
Breakthrough in European Ship and Shipbuilding Technologies

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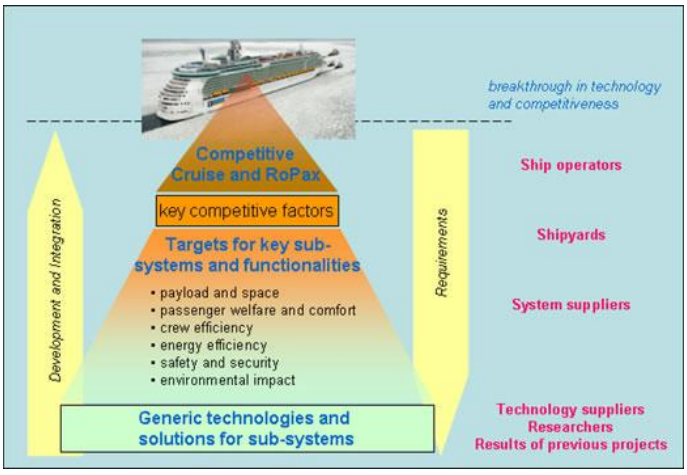
WE HAVE THREE DIVISIONS
AND ONE PASSION:
SHIFTING THE LIMITS.

EU Project BESST

Project acronym: BESST
Project full title: Breakthrough in European Ship and Shipbuilding Technologies
Grant agreement no.: 233980
Call ID: FP7-SST-2008-RTD-1
Start date: 01.09.2009
End date: 28.02.2013
Duration of project: 42 months
Activity code: Sustainable Surface Transport (SST) Strengthening Competitiveness
Funding Scheme: CP-IP - Large-scale integrating project

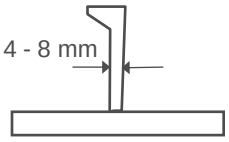
The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013)

EU Project BESST



Partners

1. Introduction



/ In shipbuilding, bulb bar profiles are regularly used to increase stiffness of subassembly and sectional parts

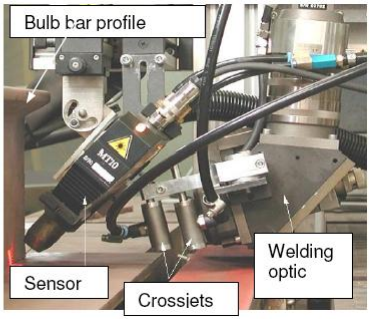
/ As yet, the most widely used joining process is SAW + FCAW
→ high heat input and low or moderate welding speed
→ warpage and distortion

2. CO_2 Laser-GMA Hybrid Welding with MEYER SHIPYARD PAPENBURG

Panel line at MEYER SHIPYARD:
/ 4 x 12 kW CO_2 Laser-GMA-Hybrid
/ One of the most impressive instances for successful field application (approx. 400 km/year)

The applied system proves beneficial due to:
/ High welding speed, shorter lead time
/ Fewer welding systems per section
/ Less rework
/ Increased amount of prefabrication
/ Excellent automation capabilities
/ Fewer on-board installation joints
/ Covering various sheet thickness- and material ranges (“tailored blanks”)

3. Laser-GMA Hybrid Welding Heads – Review and State of the Art: Docklaser and BESST

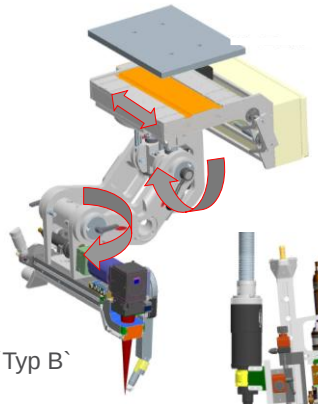


/ Tractor-guided Laser-GMA Hybrid Welding system and welding head
/ Moveable base station connected the tractor
/ 4 kW Nd:YAG and 10 kW fibre laser
/ Full penetration is required (crevice corrosion)

Laser-GMA Hybrid Welding Heads – Review and State of the Art: Welding heads developed by FRONIUS

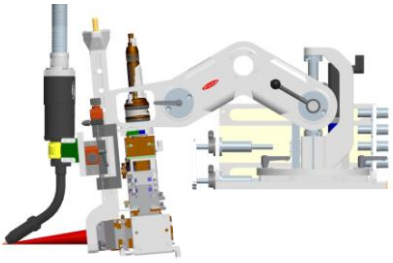
A	B	C
		

Laser-GMA Hybrid 90 10KW



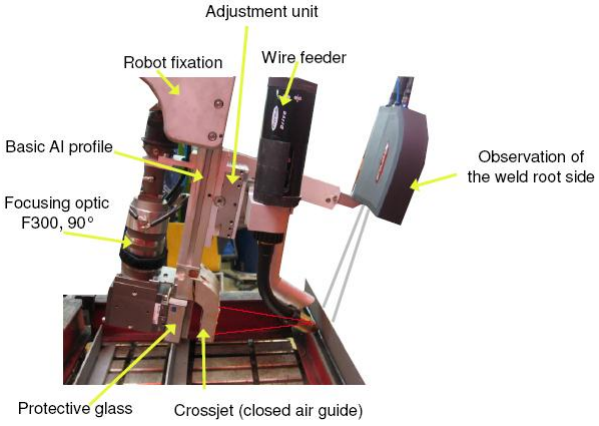
´Typ B`

Focal length: 300mm
Current load: 350A 100%
Laser power: 10 KW
Focal diameter: 0,45 - 0,9 mm
Wire diameter: 1,0 / 1,2 mm
Optic: Trumpf



´Typ C`

4. Applicability Test – Experimental Setup

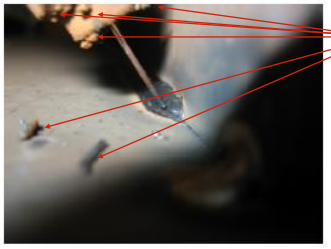


/ Laboratory set-up of Laser-GMA Hybrid Welding for single-sided full penetration of bulb bar profiles

Spatter on the Base Metal and the Torch After the Welding Tests with Primer on Both Sides

~15 µm

Primer: CERABOND (heat resistant shop primer up to 800°C)



spatter

Problems with Primer:

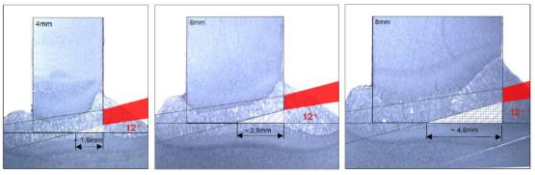
/ Shielding gas flow disturbed (porosity)

/ Lower welding speed

/ To clean the gas nozzle and to change frequently the protective glass needs time

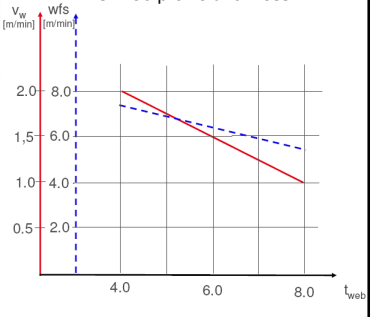
/ Due to the big and hot spatter Fronius faced the danger of destroying the gas nozzle (Risk of cooling water loss in serial production)

5. Web Plate Thickness Variation – Measurable Effects

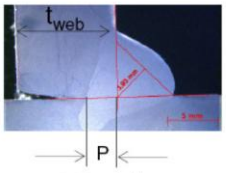
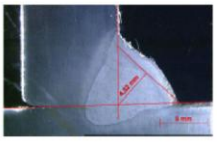
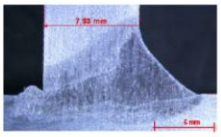


Thickness [mm]	4 / 12	6 / 12	8 / 12
Welding speed [m/min]	2.0	1,5	1.0
Wire feed speed [m/min]	7,5	6,5	5,5
Current [A]	220	200	180
Voltage [V]	19.0	19.0	20.0
Laser power [kW]	7.0	8.0	8.0
Laser incidence [°]	12	12	12
Shielding gas	96 Ar / O_2	96 Ar / 4 O_2	96 Ar / 4 O_2
Gas flow rate [l/min]	20	20	20

Relation of welding- and wire feed speed vs. web profile thickness

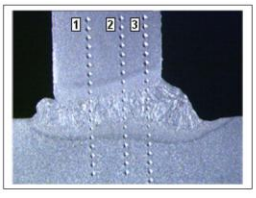


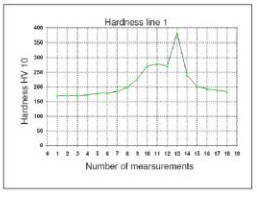
6. Comparing Laser-GMA Hybrid- to Conventional Welding Processes

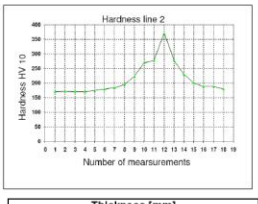
	GMA	GMA-Tandem	Laser-GMA Hybrid
			
v_w:	0.6 m/min	1.2 m/min	1.0 m/min
Q:	1.04 kJ/mm	0.84 kJ/mm	0.74 kJ/mm

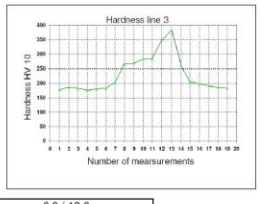
Fillet weld penetration ratio applying to different welding processes

7. Hardness Lines for Single-sided Fillet Weld



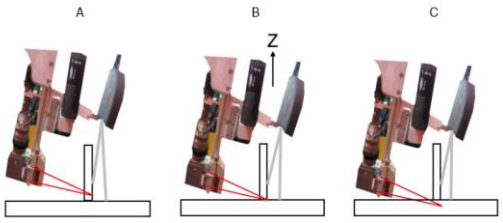






Thickness [mm]	6.0 / 12.0
Welding speed [m/min]	1.5
Wire feed speed [m/min]	6.5
Welding current [A]	200
Arc voltage [V]	19.0
Laser power [kW]	8
Shielding gas (EN 439)	96 Ar / 4 O_2
Filler wire (EN 14341)	G3 Si 1
Preheating temperature [°C]	-
Parent material grade (ASTM A 131M)	AH 36

8. Weld Pool Observation Applying ‘Q-Eye’



/ A / C: Deviation in z-axis direction

/ According to EN 60825 (part 1-5), it is not permitted remaining in the welding cell throughout processing

/ Allowing the operator to currently correct these deviations just manually, it is future planned to implement these corrections automatically connecting adaptive control to mechanical means.

Summary

/ A specific shipyard welding application, i.e. joining bulb bars as stiffener profiles to web plates, was described.
/ The usually employed SAW and FCAW partial penetration welding often leads to undesirable drawbacks.
/ An approach for both reducing cost and improving quality is to use solid state Laser-GMA Hybrid Welding.
/ International research activities such as the ‘*DockLaser and BESST*’ projects were carried out.
/ Three commercially available welding heads were reviewed and discussed.
/ Practical welding trials implementing original structural shipbuilding steel grades and parts, could prove the solid state Laser-GMA Hybrid Welding process able to supply both highly reproducible results and high quality output.
/ Solid state Laser-GMA Hybrid Welding employing highly advanced hybrid welding heads is considered cost reducing and an efficient and quality improving alternative to SAW + FCAW.


Fronius
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