15 months Post-Doctoral Offer

Effect of gravity on weld pool and thermal field during GTA welding and its consequences on the residual stresses of welded 316L part.

Host Laboratory : Laboratoire de Mécanique et Génie Civil, Univ. Montpellier, France.
Host research Group: équipe Assemblages Soudés (https://lmgc.umontpellier.fr/assemblages-soudes/)
Location of the research activities: IUT de Nimes, Département GMP.
Contract duration : 15 months (Gross salary: 2485€/month, net salary before tax income: 1997€/month)
Partners: CEA (LTA and LIST groups), LMA, IUSTI & LMGC
Associated Project : ANR MINA3D « 3D modeling of the crystalline structure of thick multi-pass austenitic welds made in position by GTAW process. Application to ultrasonic Non-Destructive Testing. »
Preferred starting date: 1st October 2024 or 1st November 2024
Supervisors : Frédéric DESCHAUX-BEAUME (Full Professor), Sébastien ROUQUETTE (Associate Professor, sebastien.rouquette@umontpellier.fr)

Scientific skills: solid mechanics, welding, thermal measurement, stress measurement with laboratory x-ray or neutron diffraction techniques, data processing with python,

CONTEXT

Highly localized heat input in fusion welding processes (e.g., arc welding) generates considerable residual stresses and deformations (distortion, shrinkage) during and after the welding operation [1]. It affects strongly structural and mechanical integrity of the welded joint. Welding residual stresses increase the potential risk of brittle fractures in welded joints as tensile residual stresses reduce fatigue strength and corrosion resistance. Multi-pass welding enhances the level of residual stresses and deformations in the welded parts. The microstructure is also impacted with the multiple thermal loadings: large grains are observed in the fused zone (FZ) as well as its interface in the heat affected zone (HAZ). In addition, the heterogeneous and anisotropic nature of the microstructure of the multi-pass welds induces strong perturbations in the propagation of acoustic beam during ultrasonic testing while researching the presence of flaws in the weld. The distortion of acoustic beam is undertaken by the LMA, Aix-Marseille University. The LMGC will focus on the elaboration of multi pass welds made with Gas Tungsten Arc (GTA) process at various welding positions. Indeed, the gravity modifies the flow of molten metal in the weld pool what affects the weld pool shape and temperature distribution within and closer to it. Previous works on GTA welding at various welding positions pointed out that the gravity affected the weld pool shape [2]. As a consequence, the thermal field is modified inside and in the vicinity of the weld pool what may affect the solidification kinetics and so on the microstructure, residual stresses and deformations.

PROPOSED RESEARCH WORK

The Post-doctoral research work will set up the GTA process for carrying out multi-pass weld on a 316L part with a U-shape chamfer. Then she/he will characterize the welded specimen both in-situ: recordings of electric signals, temperature measurements and ex-situ: microstructure analysis (EBSD) and residual stresses. She/he will explore different welding positions in order to show the effect of the gravity during welding.

The material under consideration is stainless steel 316L with a thickness of 30 mm. The metallic specimen of size 250 x 200 x 30 mm will be machined with a U chamfer. Up to 6 weld beads will be deposited. During the welding operation, the electrics signals, local temperature and deformations will be recorded as well as the weld pool behaviour. The microstructure of the weld will be analysed using Electron BackScatter Diffraction (EBSD). Additionally, a x-ray diffractometer (Xstress 3000) will be used for measuring the residual stresses at the surface of the specimens. A proposal will be submitted to a large facility such as ILL (Grenoble, France), SINQ (Villigen, Switzerland), ... to measure the stress field inside the specimen with neutron diffraction technique [3]. The effect of welding process parameters and positions on residual stresses will be investigated through 3 welding positions: flat, horizontal and vertical. Furthermore, some welded specimens will be post weld heat treated to study the effect of residual stresses on ultrasound propagation (ultrasound work carried out by the LMA, Aix-Marseille university).

Objectives:

- Effect of welding positions on weld pool shape and thermal field;
- Effect of welding position on residual stress field;
- Effect of welding position on microstructure in FZ and HAZ;
- Residual stress measurements with X-ray and neutron diffraction techniques;
- Effect of post weld heat treatment (stress relief effect);

Application procedure (deadline 1st September 2024) :

- PhD in the field of experimental solid mechanics and metal metallurgy;
- send your CV + academic transcript + copy of diplomas + motivation letter + contact details of PhD's supervisor and master's thesis supervisor :

sebastien.rouquette@umontpellier.fr , tél : +33 (0)466220839 (leave a message please)

REFERENCES

[1] Sindo KOU. Welding metallurgy, 2nd ed. A Wiley-Interscience publication. (2002) ISBN 0-471-43491-4

[2] Théo BOUTIN. Détection de dérives en temps-réel lors de la mise en œuvre de procédés de soudage par analyse expérimentale et apprentissage automatique. Thèse de Doctorat de l'Université de Montpellier, 21 Avril 2023. **https://www.theses.fr/s242625**

[3] Camille Cambon, Issam Bendaoud, Sébastien Rouquette, Fabien Soulié. A WAAM benchmark: From process parameters to thermal effects on weld pool shape, microstructure and residual stresses. *Materials Today Communications*, 2022, 33, **⟨10.1016/j.mtcomm.2022.104235⟩**. **⟨hal-03778192⟩**