Technical University of Czestochowa, Faculty of Production Engineering and Materials Technology, Institute Metal Forming and Safety Engineering

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„Analysis of bimetallic plate rolling after explosive welding”

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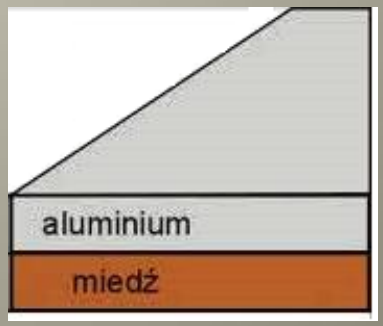
Introduction

In recent years, double layer sheets are increasingly used in various industries and manufacturing, which until now were reserved only for homogeneous plates. Bimetallic plates are widely used in chemical, petrochemical, energy, aerospace, automotive components, etc.

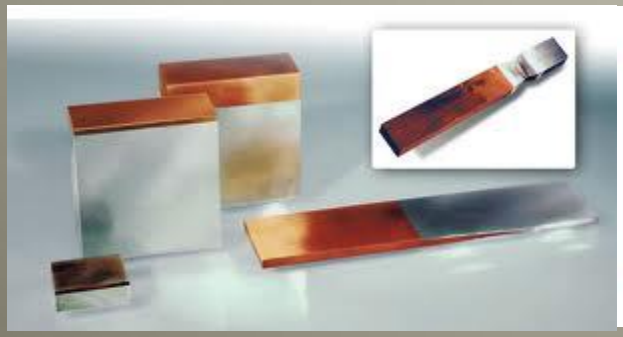
Current solutions rely on the production technology of multi-layer, through the initial connection layers, then subjecting them to plastic working processes (eg. rolling), and sometimes the heat treatment of the finished products. For joining two plates and multi-layer is used, among others, methods: welding, casting or welding explosion.

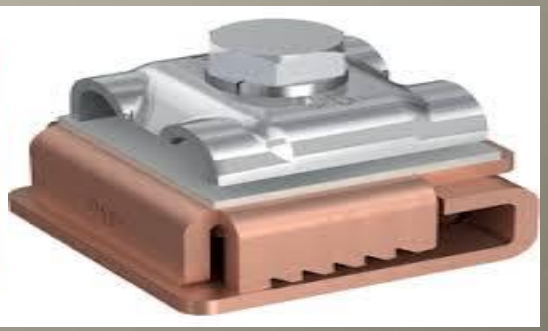


Chemical composition and the use of

Tabel 1. Chemical composition M1E- PN-87/H-82120, A199,8 - PN-79/H-82160

Type of material		Chemical composition [%]									
		Cu	Al	Zn	Sn	Pb	Fe	Sb	Si	Ni	S
M1E (Cu)	min	99.90	-	-	-	-	-	-	-	-	-
	max	Rest	-	0.003	0.002	0.005	0.005	0.002	0.001	0.002	0.004
A199,8 (Al)	min	-	99.8	-	-	-	-	-	-	-	-
	max	0.02	Rest	0.05	-	-	0.15	-	0.13	-	-

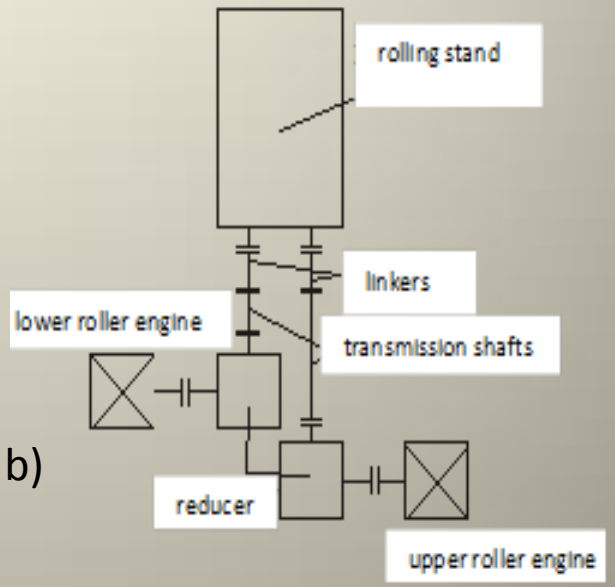




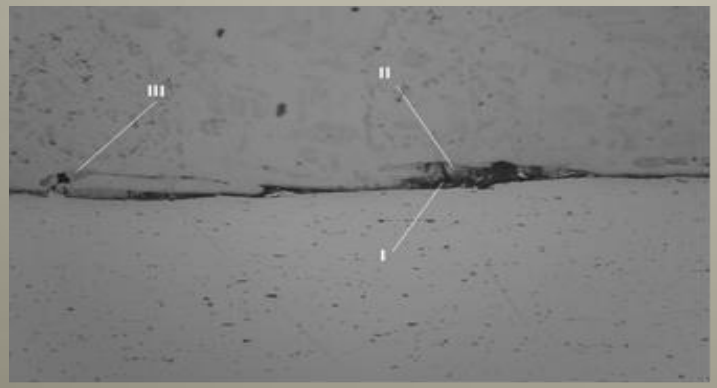
a), b) Scheme of the laboratory duo 150 rolling mill
c) Sample after direct connection – not etched, mag. 200x

a)

b)

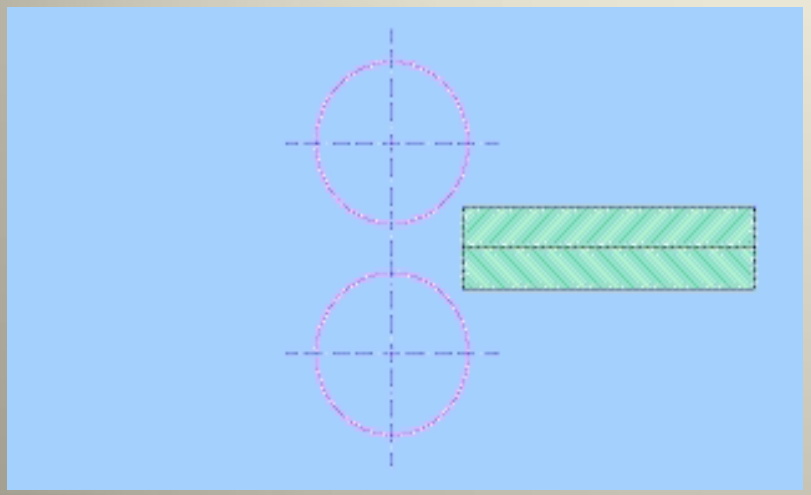


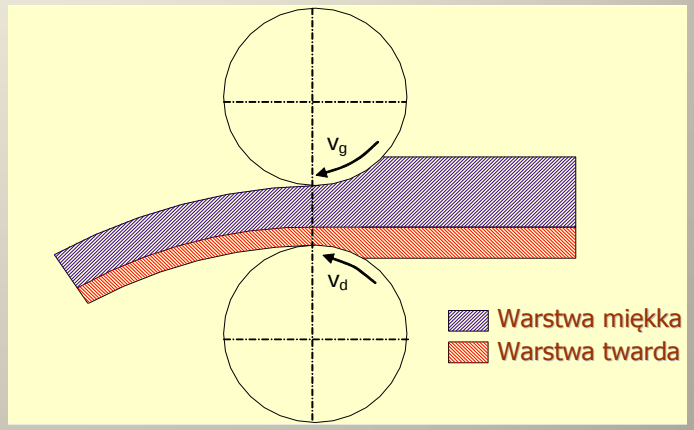
c)

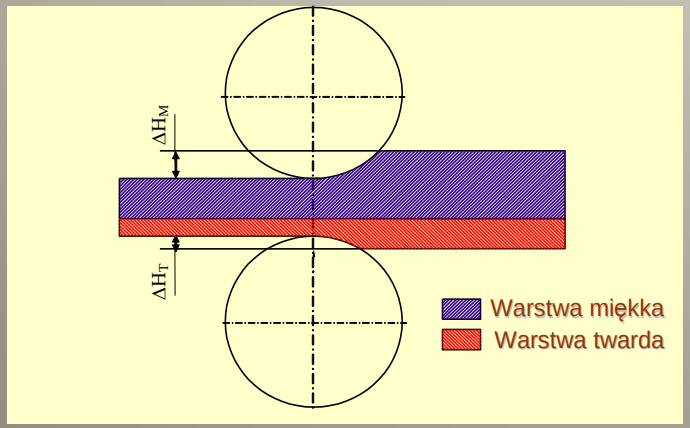


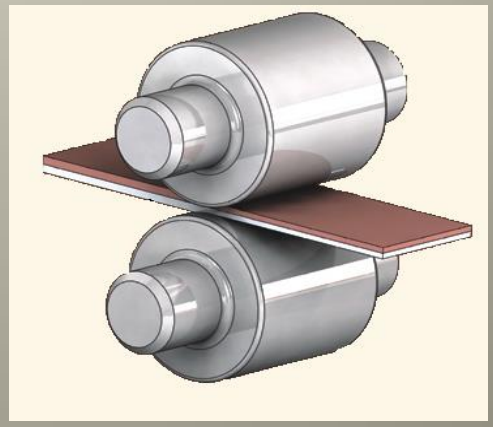
Intermetallic phases:
I - θ (Al_2Cu),
II - η_1 (CuAl),
III - η_1 (CuAl).

Scheme an exemplary process of bimetallic rolling sheets

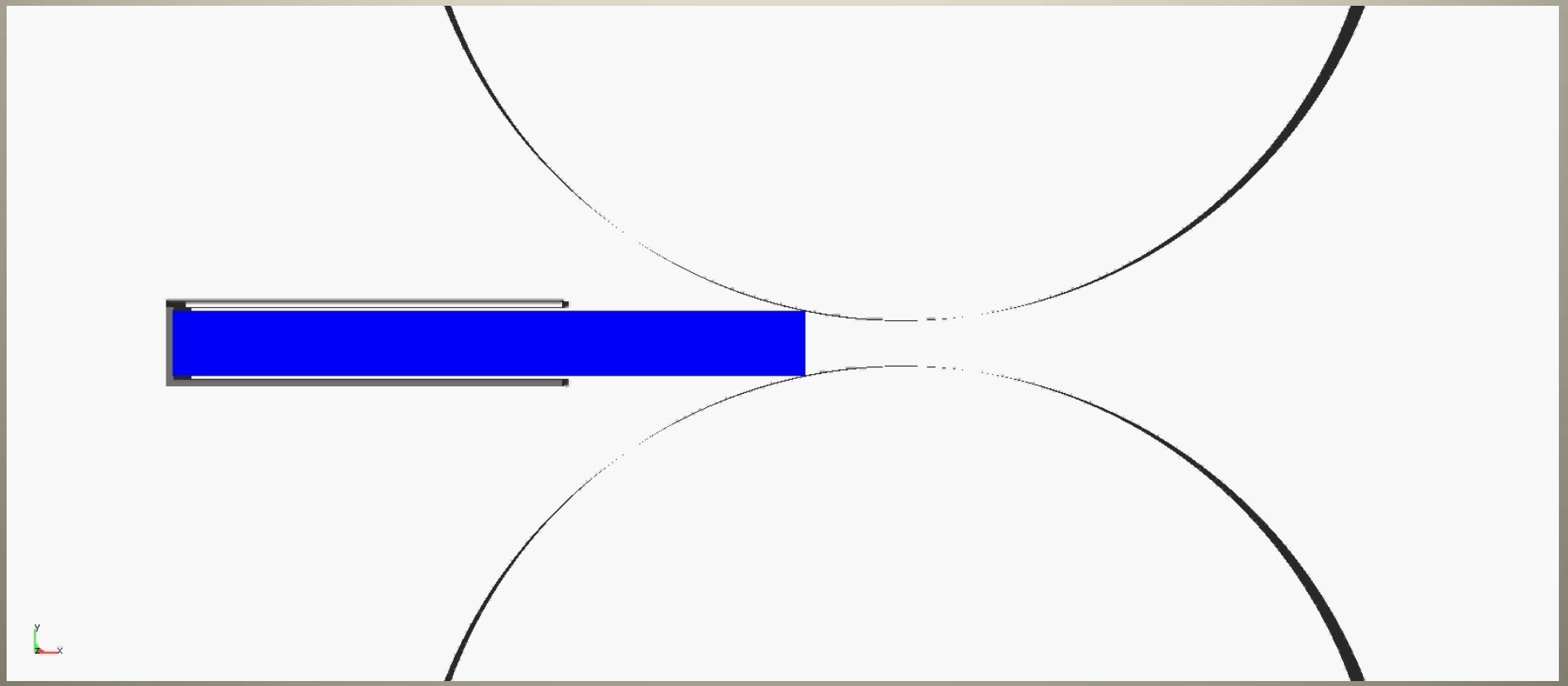








Exemplary scheme of rolling technology - computer simulation

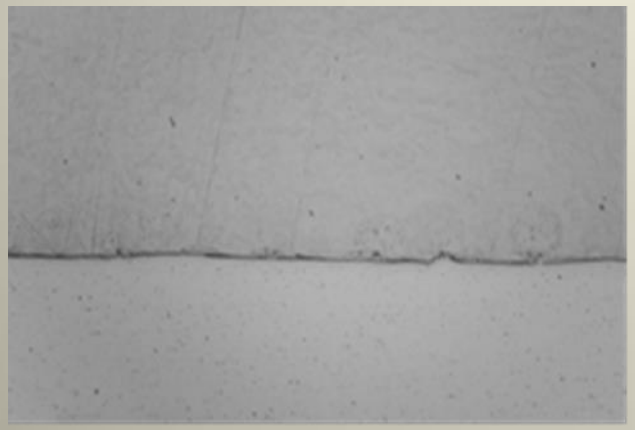


Variants of rolling

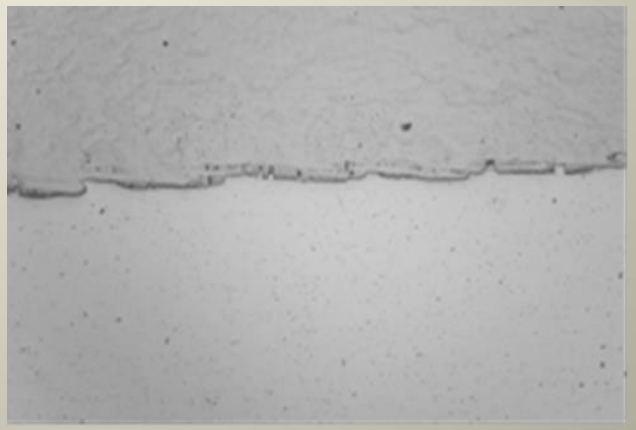
Passage no	Wariant I		Wariant II		Wariant III	
	Initial thickness mm	Final thickness mm	Initial thickness mm	Final thickness mm	Initial thickness mm	Final thickness mm
1	12	10.8	12	10.8	12	10.8
2	10.8	9.7	10.8	9.7	10.8	9.7
3	9.7	8.7	9.7	8.7		
4	8.7	7.7	8.7	7.7		
5	7.7	6.5				
6	6.5	5.5				
7	5.5	4.7				
8	4.7	4.0				

Not etched samples observed at magnification 200x:
a) rolled after 8 pass according to variant I,
b) after 4 pass rolling according to variant II,
c) after 2 pass rolling according to variant III

a)



b)

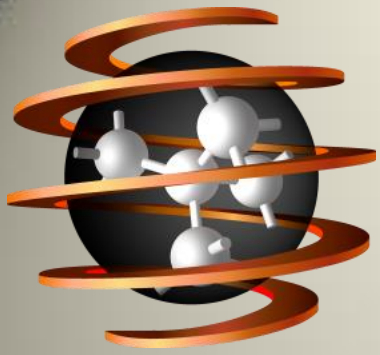


c)

Summary and conclusions

On the basis of research made for the area of Al99.8 + M1E plates connection area the following conclusions can be drawn:

- The rolling process of bimetallic samples after direct connection for variant I do not cause break of consistency of welded area. However it can be considered that rolling of annealed samples according to variant II and III decrease joint durability with an increase of annealing temperature. For samples rolled according to the variant II delamination appeared after pass no 4 while in the case of the variant III rolling delamination was observed after the second pass.
- Intermediate layer did not undergo plastic deformation. It cracks as a result of forces occurring in the rolling process. The reason for this phenomenon is the presence of Al2Cu and Cu-Al intermetallic phases in the welded area. Those phases are hard and brittle, and taking into account fact that in the rolling process forces act strongly on the bonding area of the bimetallic plate most often brittle cracking of those phases takes place.



Thanks for your attention