RESEARCH CENTRE IN SHEET METAL FORMING-CERTETA

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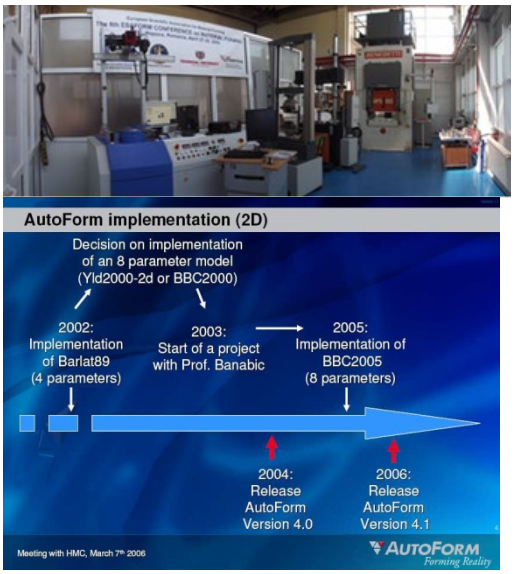

Areas of expertise

The main areas of our scientific interest and activity are:
Modelling of the material behavior
Formability of metallic materials
Simulation of the sheet and tube metal forming processes
Virtual fabrication in metal forming

Team

Prof. Dr. Eng. Dorel Banabic, Assoc. Prof. Dr. Eng. Dan-Sorin Comșa, Assoc. Prof. Dr. Eng. Lucian Lăzărescu

Representative projects

Analysis of formability and mechanical behavior of metallic materials – research contract with FONTANA Pietro SPA Italy (2018)
"From micro to macro - continuum scale modelling of advanced materials in virtual fabrication", PNII, (2009-2013)
"Holistic, extensible, scalable and standard Virtual Factory Framework", European FP7 Project, (2009-2013)
"Sheet metal formability for special metal forming processes", Humboldt Foundation (Joint Research Project), (2005-2008)
"Improvement of performances of formability models for sheet metals using new constitutive laws", Swiss National Science Foundation (Joint Research Project), (2005-2008)
VIRFAB, **"Integrated platform for the simulation of forming processes in virtual manufacturing"**, CEEX, (2006-2008)
VIF, **"Virtual Intelligent Forging"**, European FP6 Project, (2004-2008)

Significant results

Books and contribution to books:

1. Lăzărescu L., Comşa D.S., Banabic D., Analiza cu elemente finite a proceselor de prelucrare prin deformare plastică, Casa Cărţii de Ştiinţă, Cluj Napoca, 2018
2. Lăzărescu L., Comşa D.S., Banabic D., Proiectarea tehnologiilor si a matritelor pentru prelucrarea tablelor metalice, Casa Cărţii de Ştiinţă, Cluj Napoca, 2018.
3. Banabic D., Balan T., Comsa D.S., Anisotropic Yield Criteria for Aluminum Alloy Sheets, In: Encyclopedia of Aluminium and its Alloys (ed. Totten G.E.), CRC Press, New York, 2019.
4. Banabic D., Comsa D.S., "BBC2005 yield criterion used in the numerical simulation of sheet metal forming processes", In: (Ed.:Tekkaya E.A.), 60 Excellent Inventions in Metal Forming), *Springer, Heidelberg Berlin*, 2015
5. Banabic D., Lazarescu L., Comsa D.S., "An innovative procedure for the experimental determination of the Forming Limit Curves", In: (Ed.:Tekkaya E.A.), 60 Excellent Inventions in Metal Forming), *Springer, Heidelberg Berlin*, 2015
6. D. Banabic, "Sheet Metal Forming Processes", in *Science Press*, Beijing, 2015.
7. Banabic D., Multiscale modelling in sheet metal forming, Springer, Heidelberg, 2016, (425 pag) (ISBN 978-3-319-44070-5)

The most representative publications of the past 5 years:

1. Y. Ma, Y. Xu, S. Zhang, D. Banabic, A.El-Aty, D. Chen, M. Cheng, H. Song, A.I. Pokrovsky, G. Chen, Investigation on formability enhancement of 5A06 aluminium sheet by impact hydroforming, Annales of CIRP, 67(2018), 281-284.
2. Alharthi H., Hazra S., Banabic D., Dashwood R., Determination of the yield loci of four sheet materials (AA6111-T4, AC600, DX54D+Z, and H220BD+Z) by using uniaxial tensile and hydraulic bulge tests, International Journal of Advanced Manufacturing Technology, 98(2018), 1307–1319.

3. Banabic D., Barlat F., Cazacu O., Kuwabara T., Advances in Anisotropy of Plastic Behaviour and Formability of Sheet Metals, International Journal of Materials Forming, 13(2020), 749-787.
4. Banabic D., Kami A., Comsa D.S., Eyckens P., Developments of the Marciniak-Kuczynski Model for Sheet Metal Formability: a Review, Journal of Materials Processing Technology, 287(2021) 116446.
5. Da-Yong Chen, Yong Xu, Shi-Hong Zhang, Yan Ma, Ali Abd El-Aty, Dorel Banabic, Artur I. Pokrovsky, Alina A. Bakinovskaya, A novel method to evaluate high strain rate formability of sheet metals under impact hydroforming, Journal of Materials Processing Technology, 287(2021), 116553.
6. Lucasz Madej, Dorel Banabic, Professor Zdzisław Marciniak—A life dedicated to metal forming, Journal of Materials Processing Technology, 287(2021), 1168762.
7. W Jiang, W Xie, H.W. Song, L. Lazarescu, S.H. Zhang, D. Banabic, A modified thin-wall tube push-bending process with polyurethane mandrel, International Journal of Advanced Manufacturing Technology, 106(2021), 2509–2521
8. W. Chen, H.W. Song, L. Lazarescu, Y. Xu, S.H. Zhang, D. Banabic, Formability analysis of hot-rolled dual-phase steel during the multistage stamping process of wheel disc, International Journal of Advanced Manufacturing Technology, 110(2020)1563–1573.
9. Johan Pilthammar, Dorel Banabic, Mats Sigvant, BBC05 with Non-Integer Exponent and Ambiguities in Nakajima Yield Surface Calibration, International Journal of Materials Forming, 14(2021), 577-593.
10. H.-W Song, W. Xie, S-H. Zhang, W. Jiang, L. Lazarescu, D. Banabic, Granular media filler assisted push bending method of thin-walled tubes, International Journal of Mechanical Sciences, 198(2021) 106365.
11. W. Xie, W. Jiang, Y. Wu, H. Song, S. Deng, L. Lăzărescu, S.H. Zhang, D. Banabic, Process parameter optimization for thin-walled tube push-bending using response surface methodology, International Journal of Advanced Manufacturing Technology, 118(2022), 3833 – 3847, 10.1007/s00170-021-08196-8
12. H.L. Zhu, Y. Xu, W.J. Chen, S.H. Zhang, D. Banabic, L. Lăzărescu, A. I. Pokrovsky, Research on hydroforming through combination of internal and external pressures for manufacturing the structure of double-layer tube with gap, International Journal of Materials Forming, 15 (2022) Article number: 55, DOI 10.1007/s12289-022-01699-z
13. J. Yanagimoto, D. Banabic, M. Banu, L. Madej, Simulation of metal forming – Visualization of invisible phenomena in the digital era, CIRP Annals Manufacturing Technology, CIRP Annals Manufacturing Technology, 71(2022), Vol 2, DOI: 10.1016/j.cirp.2022.05.007
14. Han-wei LI, Hong-wu SONG, Shi-hong ZHANG, WAN Li, Chun-li JIA, Xue-ting CHAI, Guo-wei ZHANG, Lucian LĂZĂRESCU, Dorel BANABIC, Operating effect of filler on filling roll bending of integral panel, Transactions of Nonferrous Metals Society of China, 33(2023), 2314-2327 (DOI: 10.1016/S1003-6326(23)66261-2)
15. Cazacu O., Banabic D., Developments in modelling and simulation of material forming, a focus on Japan, South Korea and China, Special Issue of the International Journal of Material Forming, (2023) Dec. (Guest Editor)

Significant solutions:

The members of the CERTETA Centre developed a yield criterion for anisotropic metallic materials called BBC2005. Its mathematical formulation has been implemented in the commercial finite element code AutoForm in order to simulate the sheet metal forming processes. One may notice the fact that the AutoForm program is used by 95% of the world's leading manufacturers of automobiles and airplanes, which assures a global scale application of the model BBC2005. This means that the model is applicable at the global scale and CERTETA Centre is visible in automotive and airplane production industries (according to the AutoForm official site www.AutoForm.com, over 2500 users from 500 companies located in 40 countries). The Material Modelling Committee of the Japan Association for Nonlinear CAE (JANCAE) has recently developed a unified user-subroutine (called UMMDp, Unified Material Model Driver for Plasticity), which couple different hardening rules and yield functions, including BBC 2005 and BBC2008 models developed by the CERTETA team. This subroutine can be used within any commercial FE software (Abaqus, LsDyna, ANSYS, MSC Marc, Radioss) by using the unified interface routine.

Other remarkable results consist in the fact that CERTETA developed a program for the calculation the forming limit curves, called FORM-CERT. This program is used by several automotive companies (Daimler, Audi, etc.).

The third major achievement consists in the development of a model for the prediction of Forming Limit Bands. In this research field, CERTETA is a pioneering laboratory at international level.

Products and technologies:

The yield criteria developed in order to describe the plastic anisotropic behavior of the metallic sheets. The BBC2005 yield criterion has been implemented in the AutoForm FE commercial code and in the UMMPd user subroutine.

Hierarchical Multi-Scale (HMS) model coupled with BBC2008 yield criterion.

FORM-CERT commercial program for the determination the forming limit curves.

Technology and expertise to determine the mechanical parameters of the metallic sheets

The offer addressed to the economic environment

Research & development	CERTETA currently develops constitutive models for anisotropic metallic materials, with special emphasis on cold-rolled sheet metals. The theoretical prediction of the forming limits is also an important domain of research. The models are developed with the aim of being implemented in the programmes used for the numerical simulation of the forming processes and computer-aided design of the forming tools. The members of the CERTETA are also involved in the development of experimental methods for the determination of the mechanical parameters and limit strains of metallic sheets.
Consulting	The research centre provides consulting services in the field of materials testing, numerical simulation of the sheet metal forming processes, and computer-aided design of forming tools.
Training	The research centre offers training courses in the field of numerical simulation of the metal forming processes using finite element programmes. The members of team have also a sound expertise in the field of metal forming procedures and their implementation in industry.

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