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Paper Title: Advancing Hydroforming Efficiency: Benchmarking ML Models with Feature based Insight

Authors: Dwaipayan De, Aparajita Mukherjee, Soumya Banerjee, Aurko Mukherjee, Shreyasri Porel, Tamajit Nayek

Presenter: Soumya-Banerjee

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By

Prof. Amitabha Ghosh

Emeritus Scientist

Indian National Science Academy

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Advancing Hydroforming Efficiency: Benchmarking ML Models with Feature based Insight

Dwaipayan De[1], Aparajita Mukherjee[2], Soumya Banerjee[3], Aurko Mukherjee[4],
Shreyasri Porel[5], Tamajit Nayek[6]
[1,2,3,4,5,6] Mechanical Engineering Department, Institute of Engineering & Management (IEM),
School of University of Engineering and Management (UEM), Kolkata, India
E-mail IDs: dwaipayan.de@iem.edu.in, aurko.mukerji@gmail.com, aparajita.mukherjee@iem.edu.in,
porelshreyasi02@gmail.com, soumyaimperial@gmail.com, tamanayek59@gmail.com

Abstract: Hydroforming is widely recognized as an efficient and high-quality technique for producing complex metal components that is further used in automobile, aerospace, and several other sectors. In this study, a data-driven approach is presented to elevate this process by using feature engineering and machine learning to predict certain parameters - internal pressure and axial force. The prognosis is based on core inputs, including energy consumption and geometric changes during forming. By comparing several machine learning models, an approach is being provided that delivers comparative result forecasts with certain accuracy, while also highlighting the factors that have the greatest impact on the process. These outcomes clarify our understanding of the relationship between process variables and shaping results, and they pave the way towards intelligent process control. When combined with optimization techniques, the predictive framework can support improved performance, higher reliability, and reduced trial-and-error in production. This work demonstrates the potential of integrating explainable Artificial Intelligence with hydroforming technology to optimize manufacturing through insightful choices.

Keywords: Hydroforming, Machine Learning, Feature Engineering, Internal Pressure, Axial Force, Process, Optimization, Explainable AI, Manufacturing

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Investigation of Hole Characteristics in the Drilling of Novel Al-nanocomposite

Pihu Saharan, Pushpam Kunal, Mithilesh K. Dikshit*
Department of Mechanical and Aerospace Engineering,
Institute of Infrastructure Technology Research and Management, Ahmedabad, India
E-mail IDs: Pihu.Saharan.22m@iitram.ac.in, Pushpam.Kunal.22m@iitram.ac.in, mithileshdikshit@iitram.ac.in

Abstract: In this study, drilling operations were performed on h-BNNS-reinforced Al-6082 nanocomposites to investigate the influence of key drilling parameters rotational speed (RS), feed rate (f), and reinforcement content of h-BNNS (Rein) on hole quality characteristics, including circularity error (CE), cylindricity (Cy), and conicity (Ct). The nanocomposites were fabricated using the stir casting method, and a total of 20 experiments were designed and executed using a Rotatable Central Composite Design (RCCD). A full quadratic model was developed, and Analysis of Variance (ANOVA) was employed to evaluate model adequacy. The results showed that CE initially decreased with increasing RS and feed rate up to mid-levels, followed by an increase, with feed having a more pronounced effect. Cylindricity increased with all parameters up to a point, then decreased to a minimum. Ct exhibited a trend similar to CE, indicating a strong correlation between these two responses. Overall, the study demonstrates the significant influence of drilling parameters on hole quality in h-BNNS-reinforced Al-MMNCs.

Keywords: Nanocomposite, Metal matrix, h-BNNS, Stir casting