Review on Process Parameter Analysis of Three Roll Plate Bending Machine.

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Abstract:

Plate bending is a general process followed by any shell manufacturing industries. Three roll plate bending machine is used in shell bending. Generally, operators follow trial and error method to control the shape of shell. The present work report on the review of various paper on process control of three roll plate bending machine used in plate bending. If process parameters are set properly the need for trial and error can be reduced and process becomes more effective. Scope of control the geometry is very wide and it is useful for industries.

Keywords: *Three roll plate bending, process parameters and circularity*

1.INTRODUCTION:

Three Roll Plate bending: The process used for bending plate use three rollers arranged in a triangular fashion. The motion of top roller is allowed in vertical direction, while that of bottom rollers in the horizontal direction. The shape of shell is controlled by adjustment of top and bottom rollers. During shell bending a template is used to check countor of shell and re-rolling continuous untill final shape is obtained. The process is purely based on trial and error method. It depends mostly on operator skill.

Process parameters: Process parameters are factors that are to be control for better output from the machine. Process parameters in three roll plate bending machine are displacement of bottom rollers, displacement of top roller, speed of rollers and no of passes of the shell. If these parameters are such that machine can give optimal output and hence the productivity can be increased.

Circularity: It is geometrical characteristic of shell, significant for function and assembly. The control of circularity is vital for economically manufacturing the shells as well as subsequent process.

2.LITERATURE REVIEW:

1) **Ahmed Ktari et all**: [1] carried out modelling and computation of the three-roller bending process of steel sheets. FE simulation is carried out which may leads the better design and quality assurance of sheet metal products. FE modelling done reveals that, the distribution of the curvature was asymmetric at about the top contact point, this can be explained by asymmetrical deformation about maximum bending moment point. Residual stress and plastic strain distribution shows that as distance from neutral axis increases, residual stress continuously decreases until it becomes minimum at surface. Rolling map study shows that Higher diameter is obtained as lowering top roller, longer distance between bottom roller results in bigger ferrule diameter as top lower position is constant. The results are validated with results of Gandhi and Raval. Relation is developed for spring back action between initial Curvature radius R_o and obtained radius R_f keeping thickness of sheet as constant.

2). Zhengkun Feng et all: [2] studied modelling and simulation of asymmetrical three roll bending process. Their analysis deals with prediction of lateral position of roller in cylindrical roll bending. Analysis is carried out in well-known ANSYS/LS-DYNA environment with explicit time integration. Results are validated with

experiments. After checking elasto plastic behaviour of material three-dimensional model is established based on FE analysis. Their modelling is based on determining elastic modulus, yield stress and tangent modulus of bilinear material model. Report state that distance between centre of top roller and lateral rolls was effected by properties of material, dimension of plate and dimension of cylinder required. Model develop to predict the position of lateral roll, error between simulation and experiment validation of model is found to be around 6%.

3). Zemin et all: [3]Reported work in analytical modelling and numerical simulation for three roll bending forming of sheet metal. During study, accurate relationship is developed between inner roller displacement and unloaded radius of curvature, Relation is modelled analytically and FE modelling and validated by experiment. Work piece dimension is 3105 mm X 714 mm X 545mm.One dimensional beam theory is adopted in analytical method and two-dimensional FE analysis is done with plane strain condition. Optimum tool and process parameters are considered in his work.

Here, relationship is developed for displacement of inner roller with horizontal displacement zero (x =0) and loaded radius of curvature neglecting spring back of sheet This model further analysed in ABAQUA in commercial FE software and results are compared, due to plain straining condition results are matched and validated with experiments. Work is further concluded that method of rollers parameters optimization and numerical simulation for three-roll bend forming of sheet metal are reasonable and effective

4). Ming Yang et all: [4] Reported work in pyramid type three-roll bending process, Deformation of U-shaped cross section in three roll bending operation. Study includes the displacement of top roller with rotation of roller to check distribution of radius of curvature and bending moments. Simulation is validated with experiments, results shows relationship between position of roller and radius of loaded curvature. Material consider for analysis purpose is an aluminium alloy bar with U- cross section (10mm x 10mm x 1mm thickness).In analysis number of elements are 40, simulation reveals that relationship between centre roller displacement and final radius of curvature is steady state in nature. Study conclude with statement that by correcting each incremental displacement of top roller, incremental variable of curvature, bending moment and angle of deflection calculated. This simulation results were compared with experiments results and accuracy of simulation is confirmed

5). A H Gandhi et all: [5] Modelled analytically and empirically top roller position in three roll plate bending machine as function of loaded radius of curvature to obtain desired radius. Here contacts shift of bottom roller plate interface is consider, effect of initial strain and change of material properties during deformation is neglected. set of data is taken into consideration for centre distance between bottom roller and bottom roller radius

6). Mahesh Chudasama et all: [6] Reported work in development of analytical model for dynamic bending force during single pass 3-roller cone frustum bending technique. Objective of work is to predict force during various stage of dynamic loading. Effect of various material parameters is considered on dynamic bending force. Analytical model is developed by considering two condition 1). External bending moment during dynamic roll bending process 2). Internal bending considering shear stress along with normal stresses. Reported work concludes that:

* Effect of plate thickness co-efficient of friction on dynamic bending force:

As thickness of plate increases for constant value of bottom roller inclination and dynamic bending force increases with constant value of co-efficient of friction. Results also show that dynamic force reduces as co-efficient of friction increases for constant bottom roller inclination and thickness remains constant

The study tells that static bending increases and dynamic bending decreases with friction co-efficient.

*Effect of Strain Hardening Exponents on dynamic bending force:

For constant plate thickness and bottom roller inclination, strain hardening co-efficient increases and bending force reduces.

It is also noted, as thickness of plate decreases curve of bending force vs strain hardening co-efficient decrease and almost becomes linear at 6 mm. Conclusion also makes statement about stress in plastic and elastic region, in plastic region stress is non-linear while in elastic it follows linear curvature. As thickness becomes more and more plastic region increases as compare to elastic, hence force variation is highly non-linear.

7)Ozgur kisi et all: [7] In their reported work comparison of three back propagation training algorithms for two case studies performed, *ANN algorithm taken into consideration are Levenberg Marquardt, conjugate gradient and resilient back propagation*. Convergence velocities during training testing and validation are compared. The case study is performed on hydrology sample, as we know Artificial neural networks have proven to be efficient alternative to other method when direct modelling is not possible. This study is performed because 90% of study generally uses feed forward algorithms. Levenberg-Marquardt algorithm was used for second order training

speed without computing Hessian matrix. While back propagation conjugate gradient adjust weight in the steepest descent direction. If we talk about resilient back propagation algorithm is multi-layer networks typically use sigmoid transfer function in the hidden layer called as squashing function. It transfers infinite input to finite output value. It approach such that slop of curve becomes zero. Study finally concluded that Levenberg algorithm converges faster and performance is better as compare to resilient back propagation and Conjugate gradient ANN algorithms. While also concludes that RB and CGF algorithm are most robust in lateral stress estimation.

8) M. Philipp et all: [8]Reported work on front end bending in plate rolling influenced due to circumferential speed mismatch and geometry. Research mention that operators in rolling mills are still struggling with problem of front end bending of plate during rolling. FE Modelling is developed to simulate front end bending phenomenon bases on geometrical relations. It is a common problem encountered during rolling that due to mismatch of circumferential speed of two rollers plate bend upward or downward. This Papers shows influence of mismatch of circumferential speed between plate roll, thickness and draft per pass with shape factor (l/h) and reduction per pass (r).
Reported work conclude that thickness influence both rolled stock curvature and neutral point. Shape factor and reduction per pass is most important reference for predicting bending intensity and bending direction. As plate thickness increases drift of neutral point occurs to higher value.

9). R.Royl: [9]He has reported in his work for neural network application for assessment of sheet metalworks. did modelling of spring back action in sheet metalworks which is highly unpracticable in nature. Spring back action is dependent on properties of metal and bending conditions. This nonlinear relation between spring back angle, tooling and bending force is modelled in ANN. ANN is used to predict bending force for zero spring back.
Algorithm used: Multilayer feedforward back propagation. Training data is based on experiment in a laboratory environment. Hidden layer: 3. Function: hyperbolic tangent. Three different model with three different degree 0, 45 and 90 to rolling direction. Input nodes are 7 they are: n, C, sheet thickness, punch radius, die radius, die width and spring back. 9 Randomly selected sample are used for validation. Validation experiments shows that NN network can predict value of force with accepted level of spring back angle around -1 degree

10). Ozgu Senol et all: [10]They mentioned study on spring back analysis in air bending process through experiment based on artificial neural networks. This Research cover bending parameter and spring back action phenomenon of stainless steel in air bending process. FE modelling is prepared for air bending process and spring back amount is computed for different sheet thickness and bend angle. Experiment is also performed to validate FE model and results are used to develop ANN Model
In ANN modelling Multi-layer feedforward backpropagation network is used. Training function is chosen as levenberg Marquardt with transfer function as log-sigmoid function. In FE modelling plain strain condition is adopted. Friction contact is provided with value 0.05. Here in presented work two different sheets 1 and 1.5 are consider. Bend angle for 1 mm sheet:93.6,101.4,112.3,128.0 .Bend angle for 1.5mm sheet: 92.3,118.5,121.0,134.0 Study concludes that ANN can be used to determine spring back action accurately and quickly, ANN results can be improve by training data

3.CONCLUSION:

Review of above papers show that various analytical relations are developed and simulations are been performed to validate that results. This relation between top roller positioning and bottom roller displacement are highly non-linear in nature, Literature have given relation between top roller position and bottom. Roller motion to obtain desired radius in loading condition. ANN is also used to get relation between various process parameters. ANN is helpful as it develops relation by training various amount of data. Direct relation can be built by experimental results.

REFERENCES

[1] A. Ktari, Z. Antar, N. Haddar and K. Elleuch, “Modeling and computation of three roll bending process of steel sheet,” *Journal of Mechanical Science and Technology,* pp. 123-128, 2012.

[2] Z. Feng and H. Champliaud, “Modeling and Simulation off a Symmetric thre-roll bending process,”

ELSERVIER, pp. 1913-1917, 2011.

[3] Z. fu, X. Tian, W. chen and X. Y. Bingkun hu, "Analytical modeling and numerical simulation for three-roll," *Int J Adv Manuf Technol,* 2013.

[4] MING YANG and SUSUMU SHIMA, "SIMULATION OF PYRAMID TYPE THREE-ROLL BENDING PROCESS," *Int J Mech Sci ,* vol. 30, pp. 877-886, 1988.

[5] A.H. Gandhi and H.K. Raval, "Analytical and empirical modeling of top roller position for three-roller cylindrical bending of plates and its experimental verification," *Journal of Material Processing Technology,* pp. 268-278, 2008.

[6] M. Chudasma and H. Raval, "Developement of analytical model for dynamic bending force during single pass 3 roll cone frustum bending techquenic," *Universal Journal of Mechanical Engineering,* pp. 148-154, 2014.

[7] O. k. &. E. uncuoglu, "Comparision of Three back propogation training algorithm for two case studies," *Indian Journal of Engineering & Material Science,* vol. 12, pp. 434-442, 2005.

[8] M. Philipp, W.Schwenzferier, F. D. Fischer, R. Wodlinger and C. Fischer, "Front end Bending in plate rolling influenced by circumferencial speed mismatched and geometry," *Journal of material processing technology,* pp. 224-232, 2007.

[9] R. Roy, "Assesment of steel metal bending requirement using neural network," *Springer,* pp. 35-43, 1996.

[10] O. Senol, V. Esat, Darendelier and Haluk, "Spring back analysis in air bending process through experimental based artificial neurak network," *ELSEVIER,* 2014.