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# Numerical and experimental study on two roller vertical forward flow forming process

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## Introduction

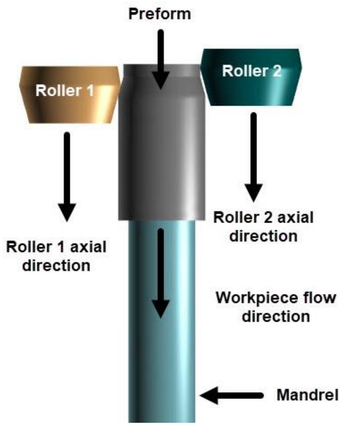


Figure 1 Designation of two roller staggered vertical forward tube flow forming process

## Finite Element Model

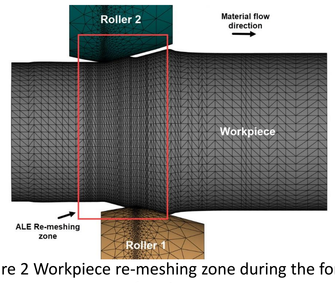


Figure 2 Workpiece re-meshing zone during the forward flow forming process

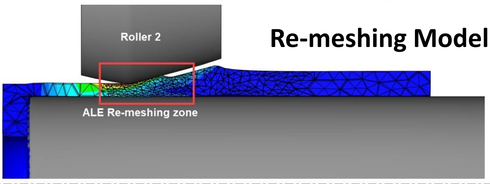


Figure 3 Cross-section of structured ALE re-meshing under the roller

## Equations

Law Limited Tresca friciton model

$$\tau = \mu\sigma_n \begin{cases} If & \mu\sigma_{n<\bar{m}}\frac{\sigma_0}{\sqrt{3}} \quad then \quad \tau = \mu\sigma_n \\ If & \mu\sigma_{n\geq\bar{m}}\frac{\sigma_0}{\sqrt{3}} \quad then \quad \tau = \bar{m}\frac{\sigma_0}{\sqrt{3}} \end{cases}$$

$$C_{CR} = \int_0^{\bar{\varepsilon}_f} \left(\frac{\sigma_{max}}{\bar{\sigma}}\right) d\bar{\varepsilon}$$

Von Mises Stress

$$\sigma_{eq} = \frac{1}{\sqrt{2}}[(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_1-\sigma_3)^2]^{\frac{1}{2}}$$

$$\tau = \mu(\Delta, v\sigma_n)\Delta v$$

$$m = m_0 + m_1 T$$

$$\varphi_c = h(T - T_0)$$

$$\dot{W} = \eta c_{ij}\dot{\varepsilon_{ij}} = \eta K\sqrt{3}\dot{\bar{\varepsilon}}^{m+1}$$

## FEA Method

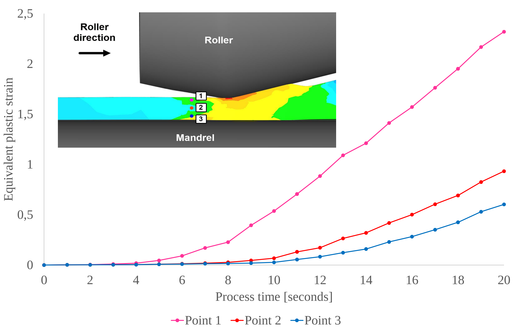


Figure 4 Strain distribution through the wall thickness from outside (Point 1) to inside surface (Point 3)

## Experimental Results

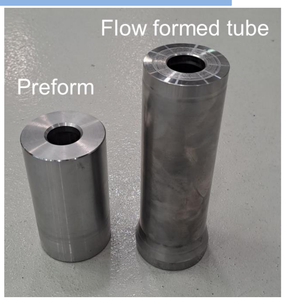


Figure 5 Preform and flow formed tube pictures after the flow forming process

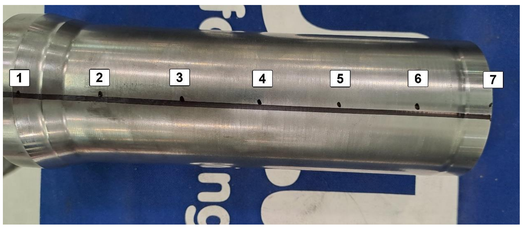


Figure 6 Twist measurement points of flow formed tube with 30 mm intervals

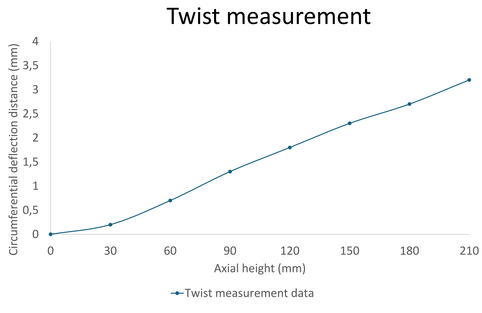


Figure 7 Twist results of each point after the flow forming

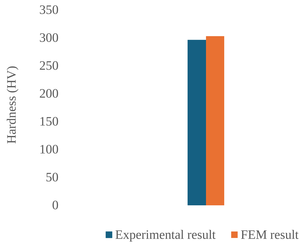


Figure 8 Comparison of average hardness between the simulation and experiment

## Conclusions

- The FEA results have demonstrated good agreement with the experiments regarding stress, strain, and damage results. It was verified that the outside surface of the workpiece exhibited a greater strain value, gradually diminishing towards the inner diameter of the workpiece
- The present research indicates that the ALE formulation is very proficient in simulating the flow forming process, yielding highly precise predictions of the workpiece hardness.
- The twist indicates a consistent effect of the flow-forming process along the tube's length, with each segment gradually undergoing increased deformation.

## References

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## Contacts

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