Study of Modeled Residual Stress in a Cold Wire Draw

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Abstract

Modeled residual stress was used to study the affect area has on residual stress. The modeled stress used was a distribution of residual stress calculated by FEM. From then a Matlab function was written so that the stress could be averaged over area of any given point in the circle circle. The findings were as the area gets larger the percent error gets larger. In the tangential stress case, when the area is 9 rows wide the error is approximately 65 [MPa] lower than the original data.

1 Introduction

Residual stress is the stress present in an object in the absence of any external load or force. These stresses are present in all metal manufactured but they can be fabricated to assist with the load or force the material is subject to. An example of residual stress by design is a flat bed beam trailer that is pre-bent so when a load is placed on the trailer, the beam is straightened.

Cold wire drawing is a metal working process which pulls a larger wire though a series of dies until the desired thickness is reached. This process causes the wire to have residual stress that was not designed or desired. Studying these stresses could help the manufactures produce a better quality product. The goal of this project is to analyze residual stress over different areas and different number of elements.

1.1 Background

A material science and engineering paper was used for this study. Residual stress determination in a cold drawn steel wire by FEM simulation and X-ray diffraction written by S. He was a study on residual stress in a cold wire draw of low carbon steel using finite-element method simulated data and X-ray diffraction. [2]

This study used modeled data based on calculated residual stresses over the cross section of the wire after it has been drawn based on the isotropic and anisotropic FE models. Tangential, axial, and radial stresses, in MPa, are plotted vs relative position, as seen in the three graphs, Figure 1. At the surface the wire is in tension in the axial and tangential direction where radial is almost zero. Near the center of the wire, all three stresses are in a compressive state

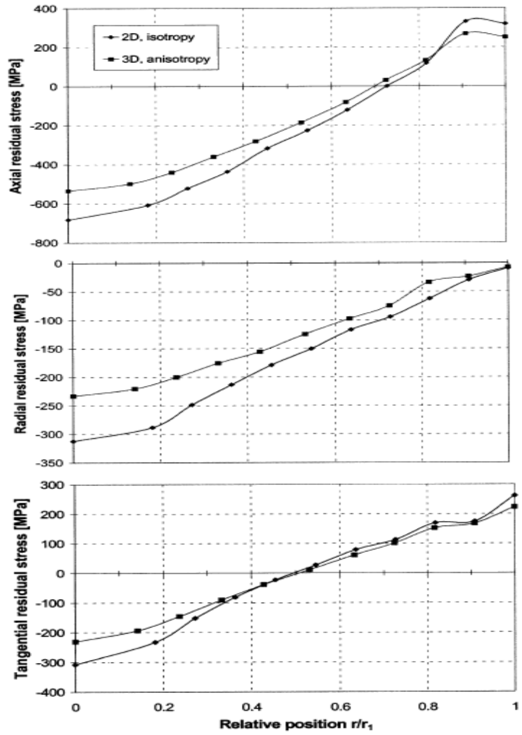


Figure 1: . Distribution of residual stress calculated by FEM. [2]

These three stresses were then used and in the circle mesh analysis.

2 Circle Mesh Analysis

Using Matlab, a function was created that output square mesh was created for the cross section of the wire. From there each element was numbered and had a stress associated with it. This stress was the tangential, radial, and axial stress that was modeled by S.He.

This study was performed looking at the area size and how it effects the average stress over different areas. The area was changed by 16 elements for each measurements. This was changed by adding 2 rows starting form 1 row and moving to 9 rows of elements. The change between rows and area is shown in Figure 3. The rows were not carried all the way out to the edge because the elements start to get distorted and less square.

Once all 5 measurements were completed, 1,3,5,7 and 9, the data from each area was plotted with the original tangential, radial, and axial stress to show the difference area makes in a measurement. These plots are seen in Figure 3.

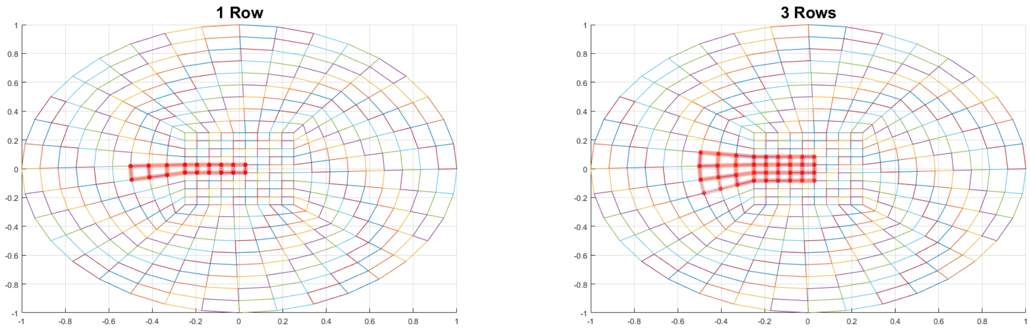
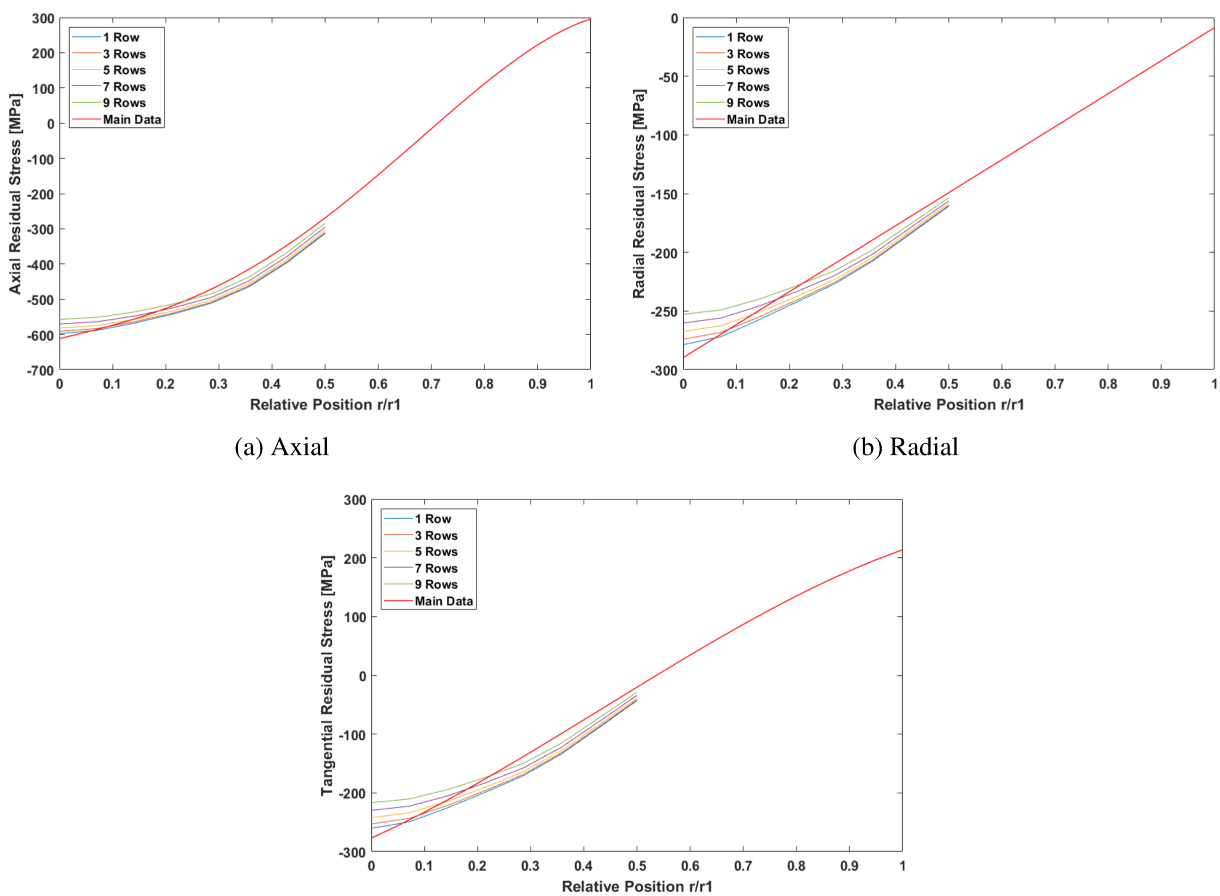


Figure 2: Showing the elements and test area for 1 row and 3 rows.



(a) Axial

(b) Radial

(c) Tangential

Figure 3: The three stresses and the study with a larger area compared to original data.

3 Conclusion

As the number of rows increased and the area grew larger, the less accurate the measurement became. For example, the radial stress when measured at the center with 3 rows had a 6% error, whereas with 9 rows it had a 13% error.

Taking measurements 3 elements wide would be three times as fast as a measurement only 1 element wide but does result in 6% error in the radial stress case. This process could reduce beam time by taking measurements over larger areas and knowing what error to expect. With the larger area the x-ray beams have more crystal structures to hid and diffract off.

4 Acknowledgments

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References

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