[Local Stress Prediction] User Manual

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1. Introduction

The process of calculating the local stress at the nozzle junction of a pressure vessel using the finite element method is highly complex. To alleviate the difficulty of analysis, a predictive software based on ABAQUS and ML has been developed. This software can quickly predict the local stress at the nozzle junction of a pressure vessel, with an accuracy level exceeding 0.999 and a mean square error of only 1.639. This method contrasts with traditional finite element analysis design methods as it bypasses many complex analysis steps. Furthermore, we provide the methods and tools needed for software development, which will assist users in developing predictive software for specific operating conditions and material parameters. It provides a reliable and convenient platform for rapid evaluation and optimization of pressure vessel design, while also serving as a reference for stress prediction under different operating conditions and materials.

2. Product Overview

The Local Stress Prediction package comprises an ABAQUS script and a corresponding plugin (Generate Dataset) for generating datasets, Python code for machine learning and model generation, and a comprehensive stress prediction software (Stress Prediction-ML). This means that users can refer to these publicly available files to create stress prediction software tailored to specific working conditions and materials.

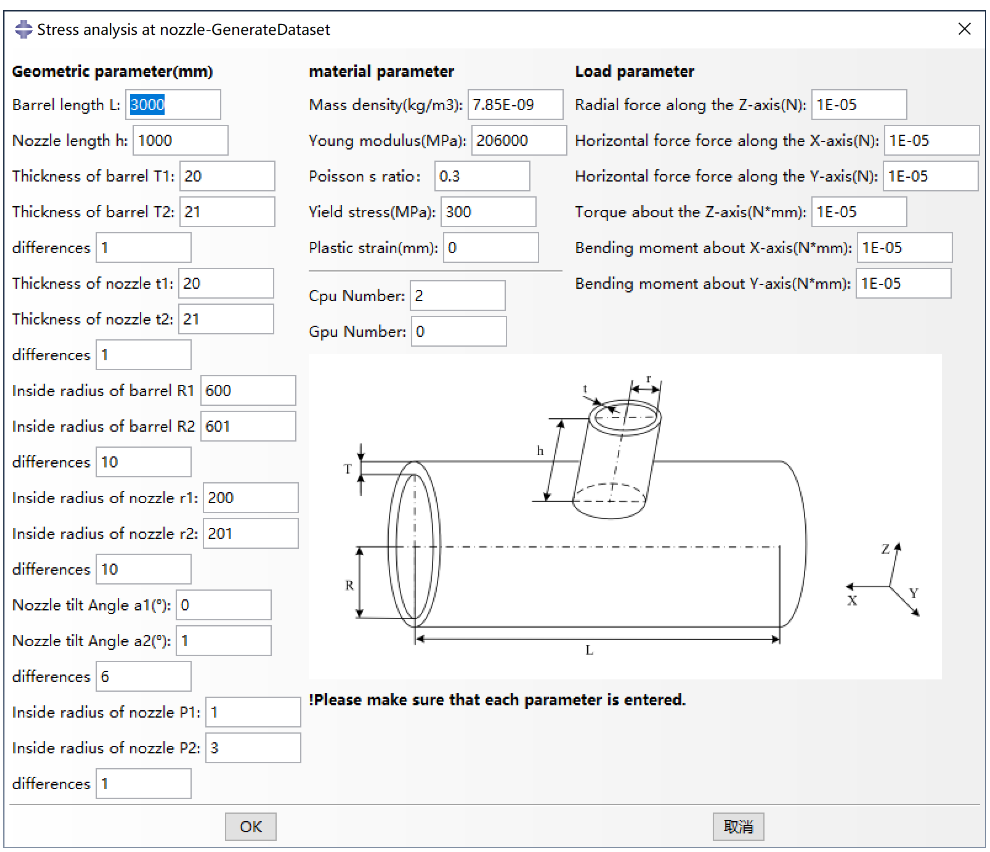
One ABAQUS script and one plugin are publicly available and serve the purpose of generating datasets. This script or plugin can create nozzle models in batches based on user-provided parameters and subsequently calculating the stress within them. All the calculated data is saved in a .txt file, which can be transformed into datasets in various formats as per requirements. Modifying the script or plugin allows users to obtain datasets for different materials and working conditions, although it is recommended to limit modifications to material parameters and avoid altering other parameters. An example of the dataset is also provided here, which has 2860 samples (date-1.scv).

After generating the dataset, machine learning can be performed using Python code to create personalized predictive models. This enables the generation of stress prediction models for any working conditions and materials. These models are designed to carry out predictive tasks, and users have the option to develop graphical user interfaces (GUIs) to provide fully-fledged software that can be used by non-technical individuals.
The complete stress prediction software is an illustrative example that can be directly utilized. It employs Q345 as the material and assumes normal temperature as the working condition. On top of this, it uses parameters such as pressure and geometry as features for machine learning to derive the software's predictions.

3. Installation/Setup Instructions

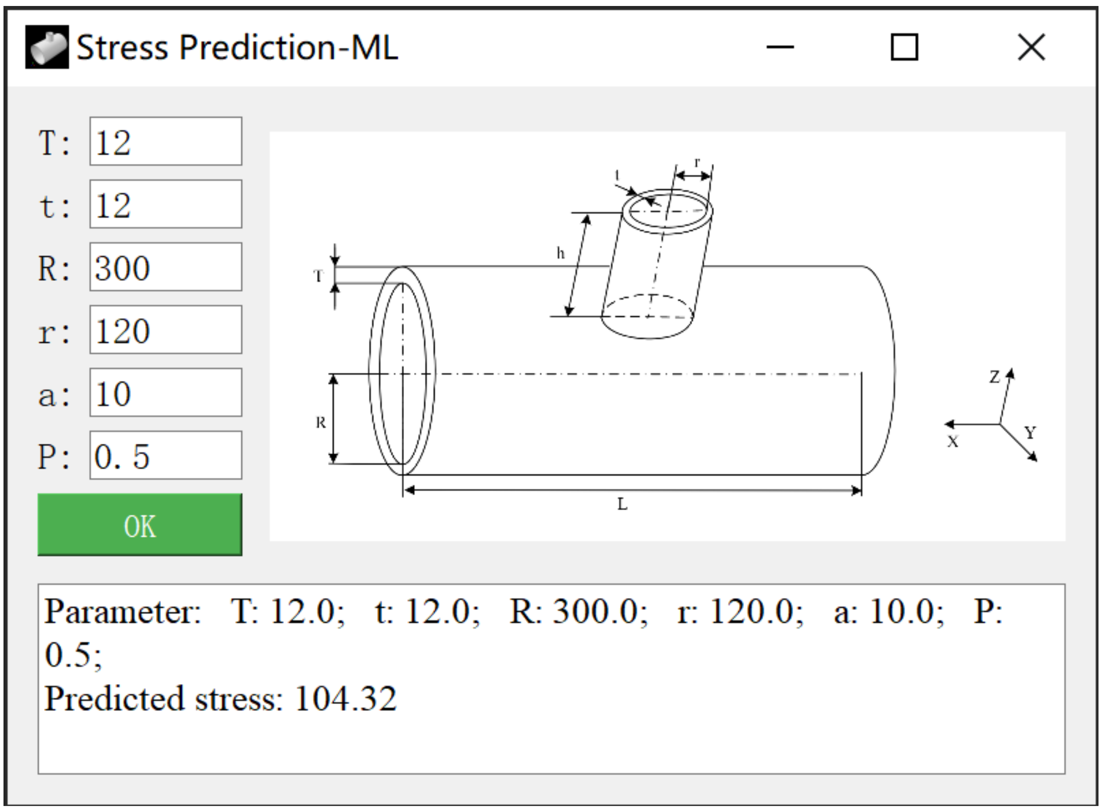
GenerateDataset

1. Copy the "GenerateDataset" folder to 'C:\Users\Username\abaqus_plugins'.
2. Open ABAQUS, and you will find "GenerateDataset" under the "Plug-ins" menu.
3. Open "GenerateDataset" and enter the parameters. Click "OK" to complete the batch analysis.
4. In the folder "C:\temp\Local_pipe_analysis", you will find the "MaxMises.txt" file.
5. Copy or convert the data into the desired format for your dataset.



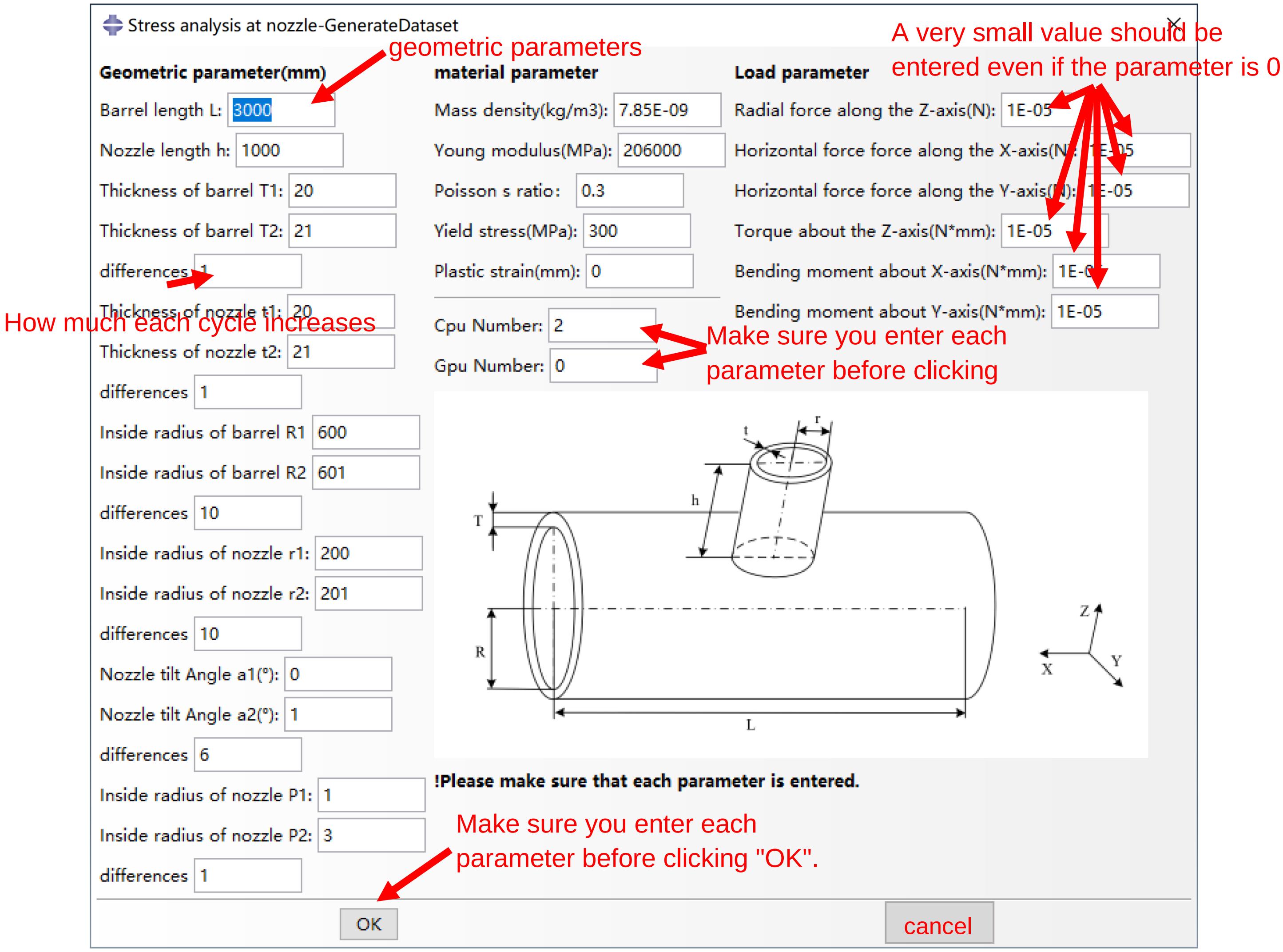
Stress_Prediction-ML

1. Press Win+R to open the Run dialog box, then type "cmd" and press Enter. This will open the Command Prompt window.
2. In the Command Prompt window, enter the following commands (install one after another once the previous one is installed): pip install pyqt5 pip install pandas pip install scikit-learn pip install matplotlib pip install seaborn
3. Double-click on "Stress_Prediction-ML.exe" to run the program. Enter the corresponding geometric parameters and click OK to obtain the predicted values.
4. You can copy and save the results for each set of input parameters for further analysis.

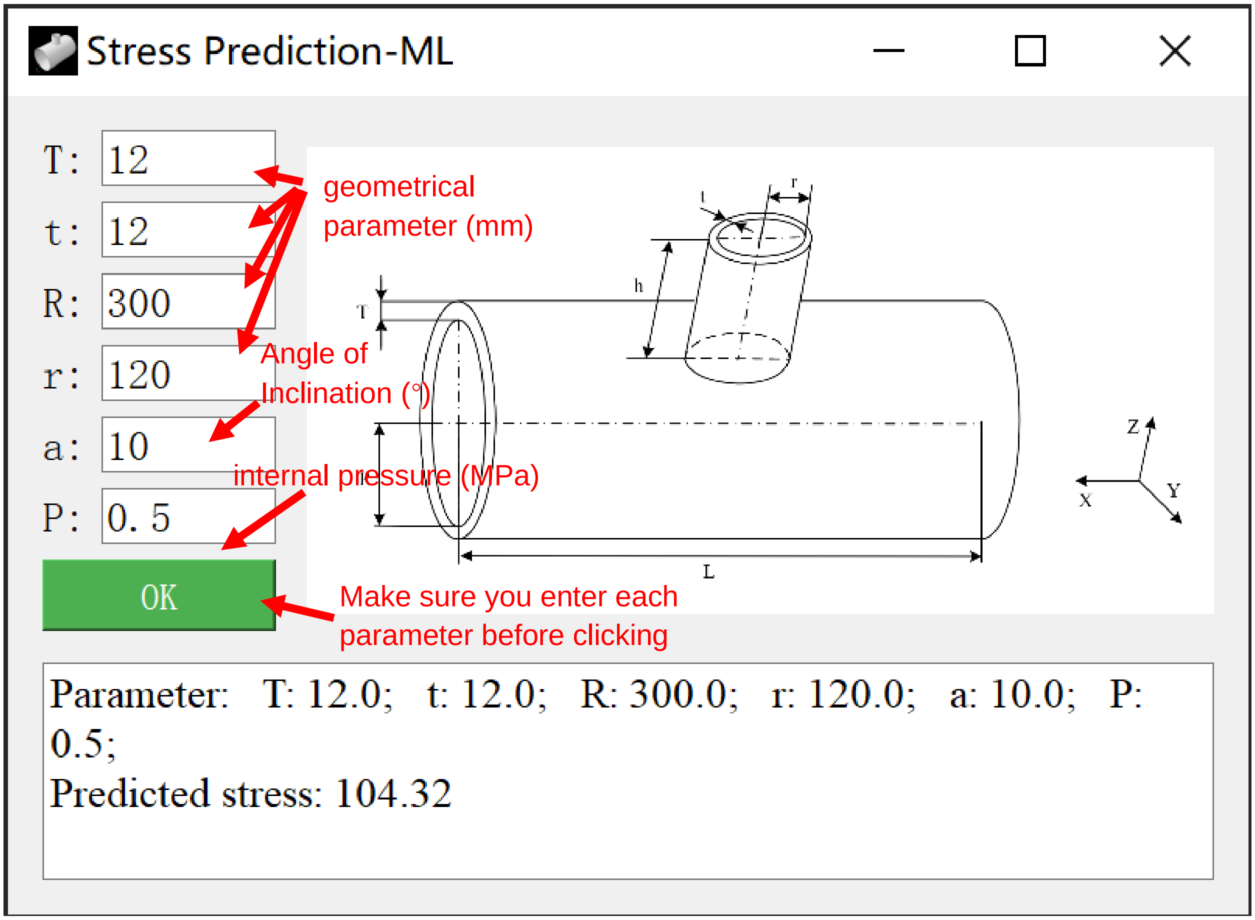


4. Operating Instructions

GenerateDataset



Stress_Prediction-ML



5. Troubleshooting

If you have any questions, please leave a message, or email Fanhangchao@163.com.

6. Disclosures

Refer to license.txt for details.