

Tension Reel Fault Diagnosis Steel Industry

Problem: Unexplained tension variations in the steel sheet as it is coiled on its exit from a cold rolling mill were causing quality problems known as tension digs and sticker breaks. Furthermore, the related motion of the tension reel assembly was leading to failures in its support structure.

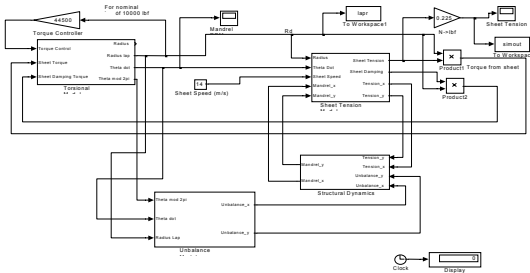
Experimental

The tension reel assembly structure is very complex. It has been in place for over 30 years, during which time it has been modified many times and its exact configuration is not known. Due to this complexity and uncertainty, experimental methods were used to model the structure. An impact test was performed on the structure involving measuring the response of the structure due to forces applied at various locations. This data was used to develop a mathematical model of the structure. Additional torsional dynamics measurements of the system were made while it operated.



Evaluation

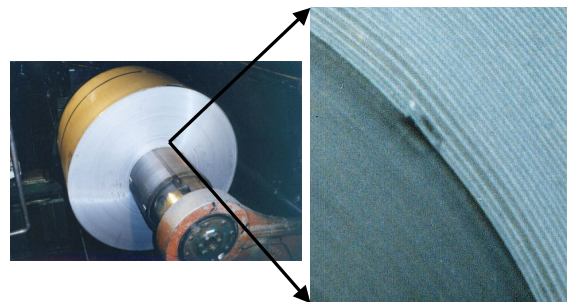
The integrated system model enabled us to explore the effects of phenomena that are not directly measurable. An example of this was our ability to quantify the effects of the lap. The lap occurs where the beginning of the sheet is covered by the next wrap of steel. This results in a step change in the radius of the steel coil. Due to the large inertia of the steel coil and the fixed sheet speed exiting the last mill roll stand, this step change causes an abrupt increase in tension in the sheet.



Simulink Tension Reel Model

Analytical

Once an accurate model of the structure was obtained the rest of the system was modeled. This model included the effects of torsional dynamics, sheet tension, structural dynamics, and unbalance of the mandrel and coil. The system model was then validated by comparing sheet tension variation predicted by the model to the tension variation measured while the mill was operating. The predicted and measured tension variation closely matched.



Lap at beginning of roll

Solution: We were able to provide an understanding of the root cause of the observed tension variation. Furthermore, potential system modifications were evaluated in the computer model prior to implementation. Based on these simulations our customer avoided an expensive attempt at a fix that would have made the tension variations worse. Other potential fixes are currently being evaluated.

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