Advanced Tension Control in Steel Rolling Mills

Traditional tension control systems for steel bars/billets (so-called “long products”) involve using loopers between stands to avoid bar tension. Loopers deviate the hot steel trajectory, creating a “buffer” of material between stands to compensate for unanticipated speed fluctuations.

Loopers take valuable space and may cause cobbles; that is, sudden blocking of the hot steel flow leading to loss of production, safety issues, and possibly equipment damage.

HiTension is an innovative and effective architecture for accurately controlling the tension of the steel bar between the stands based on HiSection eddy-current section sensors. Accurate interstand section measurement paves the way to tension control, thus avoiding the need for loopers in rolling mills. Furthermore, improved section tolerances and increased yield are attained.

Enabling Sensing Technologies

- Key to bar/billet tension control is the availability of accurate interstand section measurements.
- Usually only the final downstream section is measured. With eddy-current section sensors, each intermediate section can be measured online.
- Section measurements on each stand allow for identification of an accurate mathematical model of the rolling process.
- This way, the bar/billet section fluctuations can be actively corrected by a model-based multiple-input, multiple-output advanced control system.

Inventions and Innovations

- First looperless multivariable feedback controller for steel bar/billet tension in hot rolling mills worldwide
- Direct feedback of interstand section measurements with eddy-current section sensors

Contributors: Thomas Parisini, Imperial College London, U.K. & University of Trieste, Italy; Lorenzo Ciani and Riccardo M. G. Ferrari, Danieli Automation, Italy
Control Architecture

- Each interstand section is measured in real time and compared to reference value. The error variables are fed to the controller that regulates the stand speed.
- Controller parameters are tuned online at the beginning of production based on the identified process model.

Operational Results

- The HiTension architecture is now running during regular production at a steel plant in northeastern Italy.
- Use of the tension control leads to
  - Tighter tolerances on final section: <0.5% of nominal value;
  - 50% reduction of section error variance on the whole bar/billet.

Benefits

The HiTension bar/billet rolling mill control system has resulted in several very significant benefits:

- Major improvement in rolling quality
- More stable rolling conditions
- Major reduction in cobbles frequency
- Increased productivity through reduction of out-of-tolerance production
- Solution toward looperless rolling mills for long steel products