TATA STEEL

TATA INNOVISTA
Celebrating Innovation

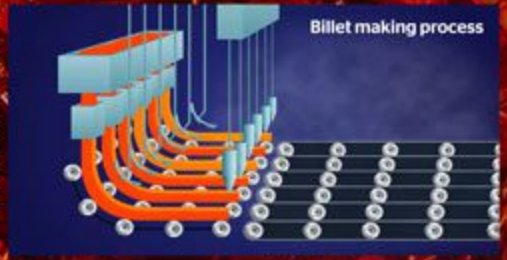
In-Situ Online Measurement of Rhombic Distortion

By Tata Steel | Category: Implemented Innovations

Liquid steel is converted into long square billets at LD1. The shape of the square changes to a rhombus due to non-uniform cooling of the billets. The difference in the diagonal is called rhombodity. Rhombodity leads to twisting of the billet, resulting in the product being rejected downstream. It is measured manually after every four hours, and result of any change done in the process parameter gets reflected after another four hours. In case of high rhombodity, all the billets are kept on hold. Sorting and inspecting such huge volumes of billets on the rhombodity is unsafe. Measuring the billets online will reduce holding time to improve safety and quality. An in-house imaging solution to measure rhombodity was thus developed.

The Context

It takes four hours for the billets to cool down to a temperature where a measurement can be taken. Late correction and inspection is done after another 4 hours to get the effect of the correction. In this process, heat of 8 hours (1200 tonnes or 960 billets) gets held up. Handling of such billets in order to sort and inspect them is a huge task. To reduce this rejection and the unsafe condition of handling billets, an online measurement system was required that would reduce time of inspection and reduce heat hold for inspection.



Overcoming Challenges

Due to the temperature of the freshly-cast billet (around 900 degrees centigrade) the outer surface of the billet gets oxidised fast, and converts it into iron, which deposits on the surface as black flakes, commonly known as scales. Presence of scales occludes the face of the billet partially, and therefore makes the contour detection extremely difficult, and measurements thus obtained would not be useful for any decision making purposes. It was decided to use especially designed air nozzles to blow off scales deposited on the billet face, before the billet reaches in the field of view of the camera for measurements.

Impact of the Innovation

revenue impact

₹60 mn

The Innovation

DD (Diagonal Difference) is considered to be the measure of rhomboidity, which is a shape-related defect in the square cross section billet. The billet rhomboidity starts with non-uniform shell solidification in the mould, which is due to inconsistent mould cooling, causing irregular heat transfer. The higher diagonal-difference greatly impacts the quality of the billets to be rolled at various mills. Rhomboidity at or over 4% leads to the billet twisting in the roughing stands of the rolling mill. Currently, billet rhomboidity is measured manually at the end of the casting operation. Essentially, it is a Machine Vision System installed adjacent to the first V-shaped notch of the transfer bed.

The imaging system consists of a high resolution industrial camera fitted with a high precision lens and optical filters. It captures the face of each billet as it moves. A combination of PLC signals, viz., Lift, Hold, Push and Move are programmed in a manner to associate the billet face being observed by the camera with its strand number. Using this innovative identification mechanism, the billets of all 6 strands of the caster can be measured for rhombic distortions, using a single system only, which would have otherwise required 6 different installations. Protecting the optoelectronic devices from heat irradiant from freshly cast hot the billets was a challenge on its own.

Once the billet rest signal is received, the system captures the image of the billet face and using Hough transform determines all possible lines in image, and an exhaustive search is performed on all possible combinations of 4 lines (NC4) to find its suitability for fitting a quadrilateral face. Once the fitting contour is obtained, it is further fine-tuned to define the true billet face boundaries, and from there all the measurements including DD are obtained.