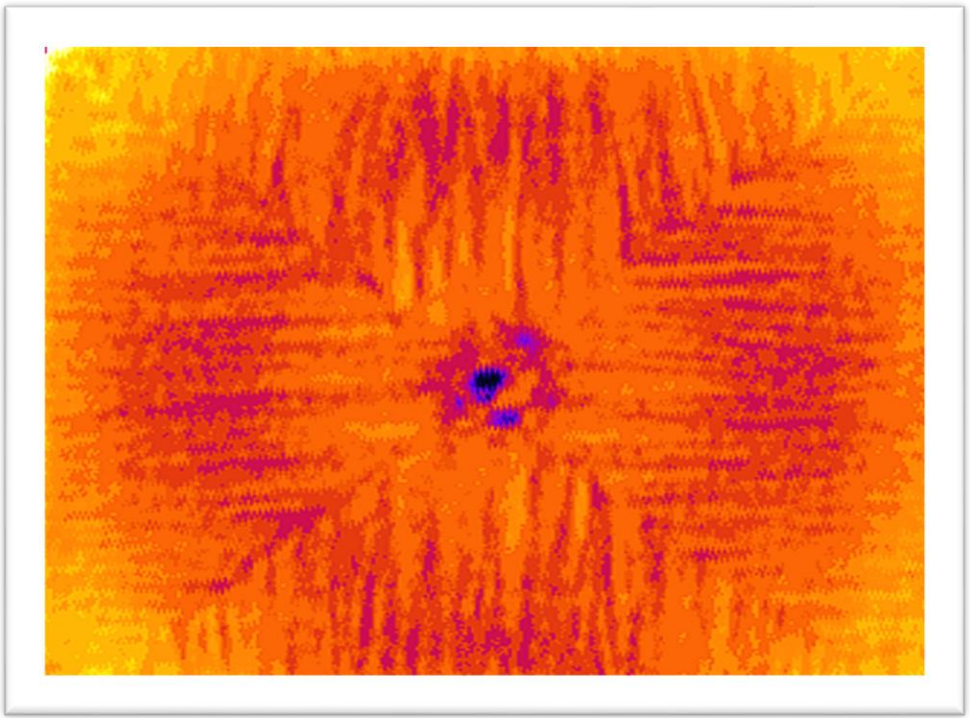

PERFORMANCE EVALUATION OF ELECTROMAGNETIC STIRRER

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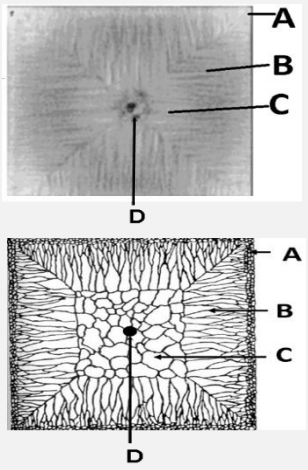
The effect of electromagnetic stirring on the soundness of continuously cast billets and slabs can be assessed by many methods like visual inspection of macro-etch & Sulphur print evaluation. The ultrasonic assessment provides through-thickness information of the test samples, whereas, macro-etching and Sulphur print methods provide information in one plane only. An attempt has been made to evaluate the effect of electromagnetic stirring on soundness (in homogeneities /flaws as well as the effect columnar/equiaxedaxed grains) of continuously cast low carbon and high carbon continuously cast steel billets by ultrasonic attenuation as well as high gain pulse-echo technique in transverse cut slices. With the increasing demand for steels for drawing at higher speeds, the quality, in terms of internal defects and macro-structural features (central porosity, equiaxed zone, etc.), of billets has become of paramount importance. By optimizing the Electro-Magnetic Stirrer (EMS) parameters viz., EMS current and frequency the severity of defects, area of the columnar zone as well as central porosity, in continuously cast billet can be effectively minimized. The result would be an increase in equiaxed zone area and improved internal soundness. Billet samples were collected for macro structural evaluation. The samples were scanned using **SHRUTI®** an immersion ultrasonic C-scanner to get images of samples. Macro structural features revealed by ultrasonic C-Scan were analyzed for determining the best combination of EMS parameters.

SHRUTI® (Scanning High-Resolution Ultrasonic Testing and Imaging) is a DHVANI RESEARCH developed customizable, automated, multi-axis robotic scanner. Along with an air-coupled ultrasonic inspection instrument, advanced data analysis (***extut®***) and image analysis package

(***imagine®***), SHRUTI provides for the easy inspection of samples and components. Owing to the very less transmission coefficient of ultrasound in the air when compared to the water the preference is always given for the immersion scanning, however, if the interaction with water causes a change in the material property of the sample there is no choice but to avoid water and to go for other techniques. Other techniques include contact inspection which involves human intervention which contributes a huge tolerance factor and involves a lot of time and effort. Moreover, most likely a report involving manual intervention is always looked upon with the least interest as the probability of getting it wrong is very high. This points out a feasible solution which is a non-contact inspection without involving water as a couple, completely automated with automatic defect report generation and Histogram analysis of Defect data.

C SCAN IMAGES OF EVALUATED SAMPLES

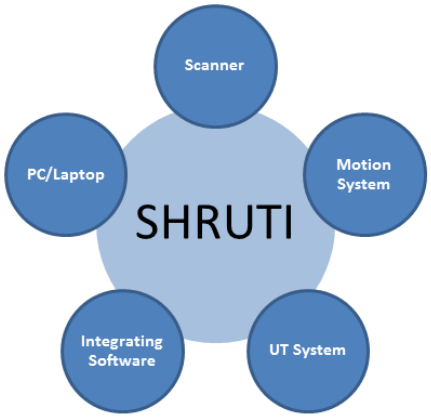
A Greyscale was used to evaluate and analyze the results obtained from the gated area. Referring to ultrasonic C-scan images, and based on a greyscale that depicts attenuated signals darker, one may see clear identification of different macrostructures by the darker areas. Every one of the areas is reproduced with a certain degree of dimensional accuracy. Top and bottom surfaces as well as three intermediate layers of each billet sample were scanned at an interval of around 7 mm in the ultrasonic C-scanner. The two-dimensional image obtained from the C-scanner distinguished different macro-structural regions such as equiaxed, columnar, and cultural, hilled zones, and casting defects, if any. Shown is a C Scan image VS a Schematic diagram



COURTESY

We thank R&D and SS Division, Tata Steel, Jamshedpur for the data.

Manish Raj, E Z Chacko, Sanjay Chandra, Isaac Anto, Krishnan Balasubramanian, Development of an Immersion-based Ultrasonic C-Scan Technique to Evaluate the Performance of the Electro-Magnetic Stirrer for Improving Internal Quality of Continuously Cast High Carbon Steel Billets, ISNT NDE journal -duty 2013.



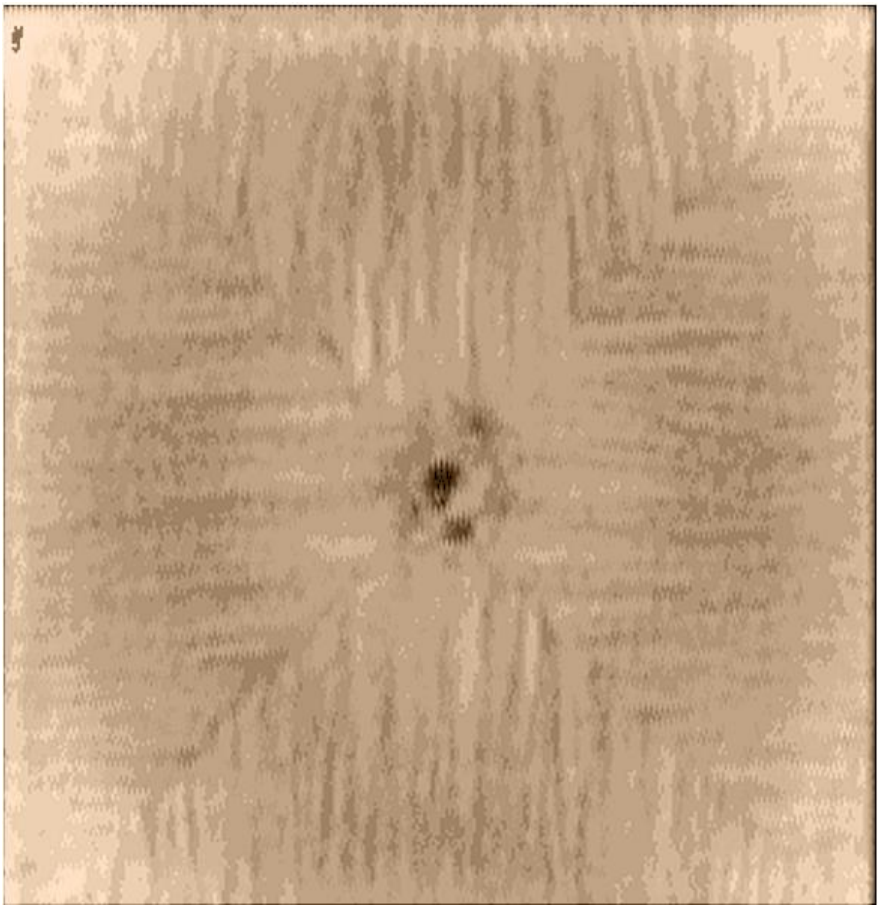
Robust Hardware

SHRUTI® (Scanning High-Resolution Ultrasonic testing and Imaging) offers a very high-resolution June image of the test coupon with very high scanning speeds. The complete instrument control is through the software. Skelton of the system is being built from lightweight aluminum extrusions which are upgraded to Stainless Steel for heavy applications. All the electrical connections are rugged and properly routed following industrial standards offering very durable and reliable running. Components of flat, cylindrical, and complex shapes can be imaged.

Performance Evaluation of Electromagnetic Stirrer- Application Note

A Dhvani Research Application Note

Chennai, INDIA



Typical Water-Coupled Ultrasonic Image obtained on a billet sample revealing grain structure

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