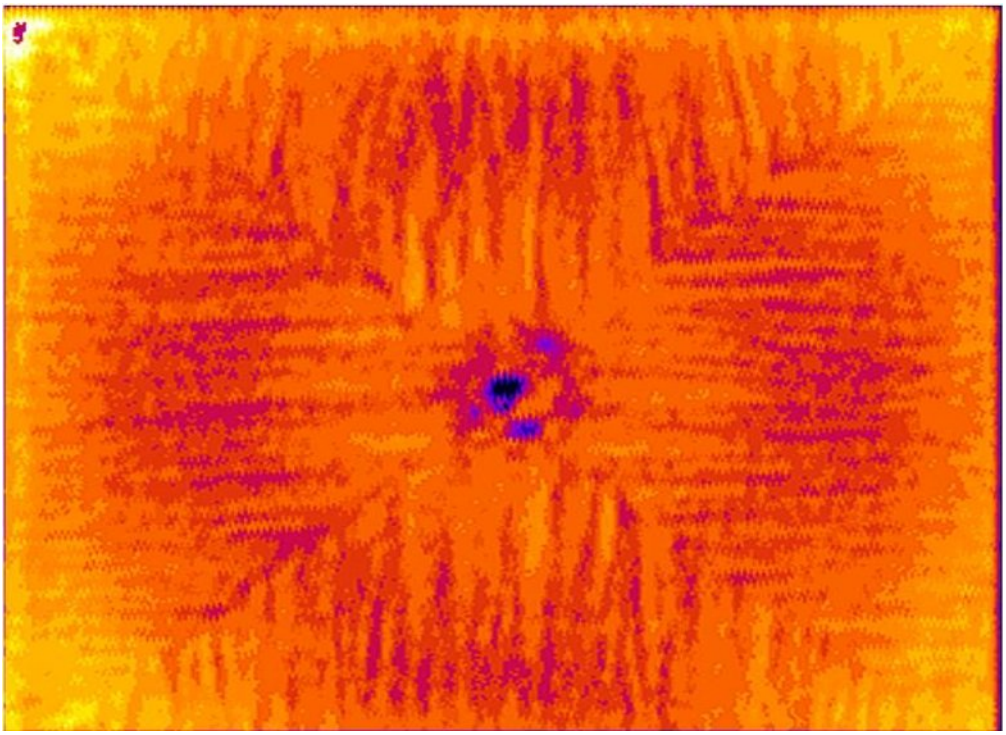

Performance Evaluation of Electromagnetic Stirrer A Dhvani Research Application Note

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25 September 2013

NDT FOR MANUFACTURING COMPONENTS

NON-CONTACT WATER COUPLED ULTRASOUND NDT SOLUTION

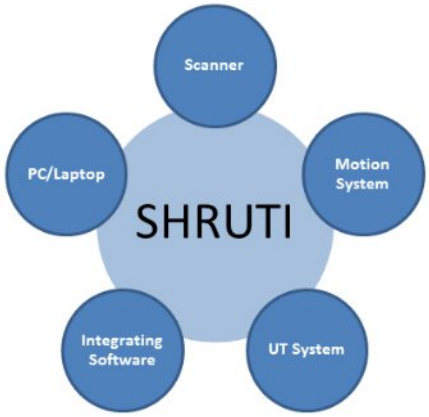
Effect of electro-magnetic stirring on soundness of continuously cast billets and slabs can be assessed by many methods like visual inspection of macro-etch & sulphur print evaluation. Ultrasonic assessment provides through thickness information of the test samples, whereas, macro-etching and sulphur print methods provide information in one plane only. An attempt has been made to evaluate the effect of electro-magnetic stirring on soundness (inhomogeneities / flaws as well as effect of columnar / equiaxed 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 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 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 analysed for determining the best combination of EMS parameters.

IN THIS ISSUE

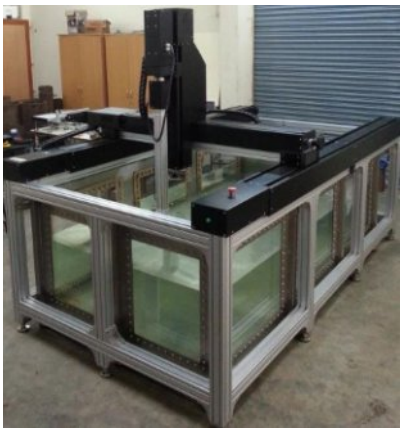
SHRUTI® (Scanning High Resolution Ultrasonic Testing and Imaging) is a DHVANI RESEARCH developed customizable, automated, multi-axis robotic scanner. Along with an air coupled ultrasonic inspection instrument, advanced data analysis (*extut*®)) and image analysis package (*imagine*®), SHRUTI provides for the easy inspection of samples and components. Owing to the very

less transmission coefficient of ultrasound in 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 least interest as the probability of getting it wrong is very high. This points out to a feasible solution which is a non-contact inspection without involving water as a couplant, completely automated with automatic defect report generation and Histogram analysis of Defect data.

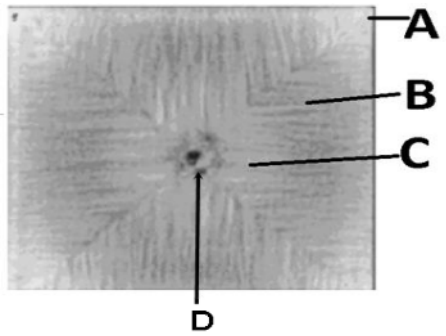
SHRUTI® (Scanning High Resolution Ultrasonic Testing and Imaging) offers very high resolution image of the test coupon with very high scanning speeds. The complete instrument control is through the software. Skeleton of the system is being built from lightweight aluminum extrusions which are upgraded to Stainless Steel for heavy duty 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.

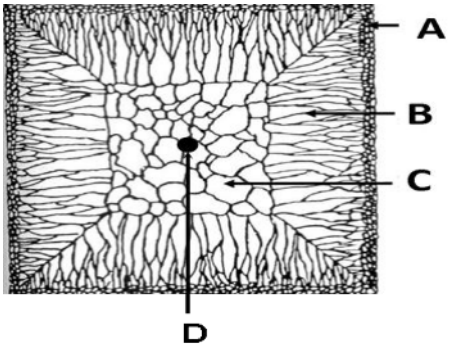


Robust Hardware



A typical scanning system is shown Above for Industrial Scanning





C SCAN IMAGES OF EVALUATED SAMPLES

Grey scale was used to evaluate and analyze the results obtained from the gated area. Referring to ultrasonic C-scan images, and based on a grey scale that depicts attenuated signals darker, one may see clear identification of different macro structures by the darker areas. Each and 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 chilled 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, Issac 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 June 2013.

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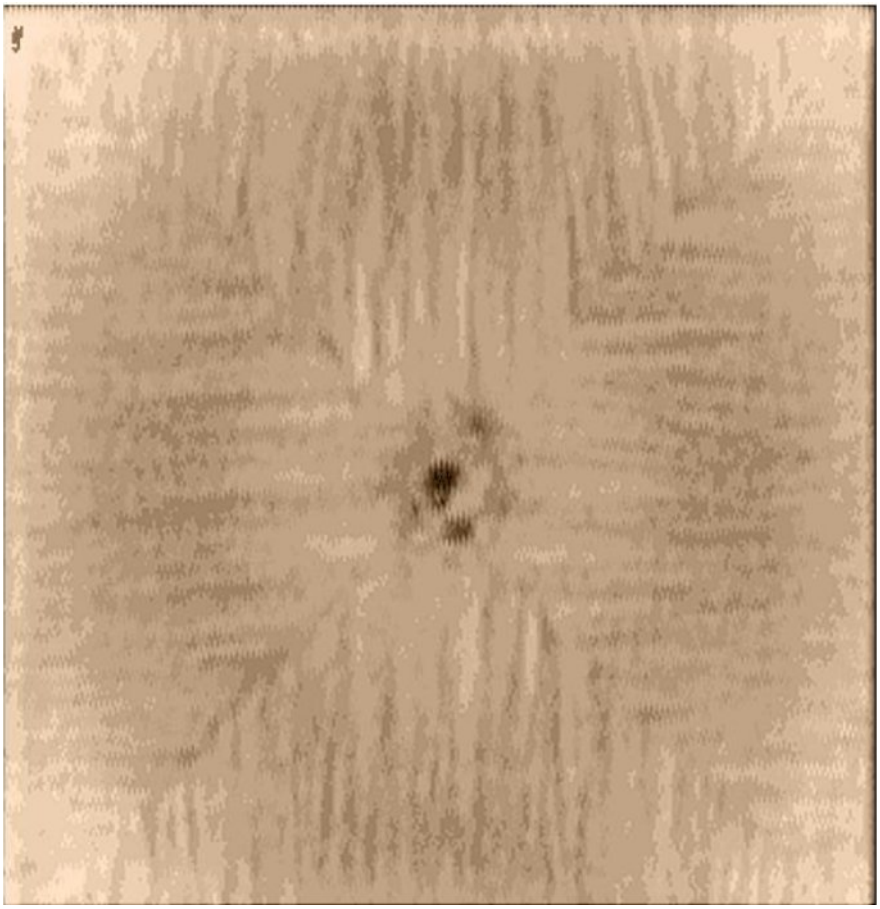
Chennai, INDIA



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

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