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# Grain Size Determinations in 1%C-13%Mn Steels for Railway Crossings. Detection of Anomalies during its Processing.

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Railway crossings and turnouts (Fig. 1) for the XXI Century are called to an expansion in its production because of the permanent attention paid in recent times to the railway transportation systems. The reasons behind are normally attributed to energy savings appealing to the scarcity of fuel resources, to the more efficient use of the energy and finally to less polluting transports and other environmental concerns such as landscape conservation, etc. However for an efficient shift of the transportation of people and goods from road to railway transportation, the intervention of the governments is must. Incentives to the use of public transportation have become a regular policy across Europe, sometimes by the imposition of heavy taxes for the use of cars and trucks, and others by a new improved image of the public transportation system based on higher comfort and recognition of timesavings. For the policy to work a good deal of the pressure must go into the railway companies, i.e.: the new generation of high speed trains shall operate safely and within time-schedule penalties in case of delays. Under this scenario the high speed trains of the 2000's, shall operate safely and comfortably at forecasts speeds of 200 kilometres per hour, with the possibility of reaching up to 350 kilometres per hour in what is called direct way. Higher durability based on reduced wear and the development of railway crossings and turnouts providing more stability become a crucial issue in this respect. Yet there are newer requirements related with safety and durability, such as fatigue behaviour of these components because of the vertical deflection of the beams over which cyclic loads operate (17 T/wheel-axle).

The usual metallurgical control of these Hadfield Steels in the past focused on the following: Chemical Analysis (Table 1), Metallographic Inspection to asses the ASTM grain size by Chart Comparisons and the presence of second phase (carbides, oxides, etc…) and Mechanical Testing, namely Impact Test on side test bar coupons and the determination of the surface hardness. Measurement, Inspection and Testing Equipment at Metallographic Labs., complying with ISO 9000 standards, require the statistical estimation of the uncertainty of the measures making it compatible with the requested capacity of the measurement. For this reason the application of digital imaging techniques to the determination of the ASTM grain size [1], must replace the subjective assessment of the grain size based on Chart comparisons.

In the work developed it is presented a comparison of the 95% confidence limit, for various techniques: Manual Area Analysis, Manual Linear Analysis, Semiautomatic Analysis and a Fully Automatic Processes based on the application of a image filtering sequence (Fig 2) for a better definition of grain boundaries against to the Wall Chart Method. Also it is made clear the importance of the preparation and etching techniques [2] as well as the total area of capture per image.

## References

[1] G. F. Vander Voort, Grain Size Measurement, ASTM STP839, Philadelphia (1984) 85.
[2] G. F. Vander Voort, Metallography: Principles and Practice (1984).

**FIG. 1 Railway crossings and turnouts at F-Melt**

**TABLE 1. Chemical Analysis of Hadfield Steels for railway applications (% -weight)**

| C | Mn | Si | Cr | Ni | Al | Cu | S | P | N ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 14 | 0.27 | 0.07 | 0.02 | 0.04 | 0.030 | 0.004 | 0.027 | 150-250 |

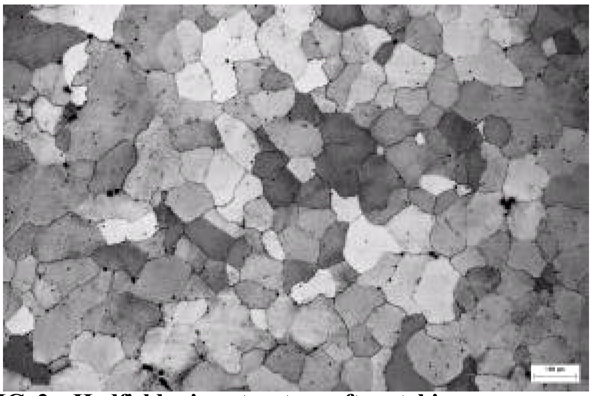

**FIG. 2a. Hadfield microstructure after etching**

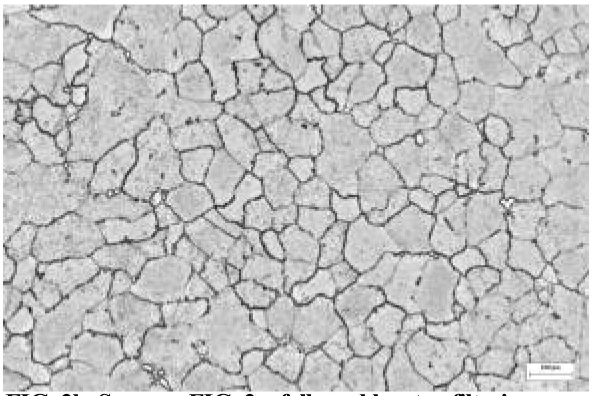

**FIG. 2b. Same as FIG. 2a. followed by step filtering process.**

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