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STUDIES AND RESEARCH ON DETERMINING THE CAUSE OF THE CRACKING OF X60 PIPELINE IN THE EXPANDING OPERATION

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ABSTRACT

In this paper was followed the determination of the cause of pipe cracking in the expansion operation. The metallographic analysis of a sample taken from the X60 pipeline was performed to determine the cause of pipe cracking. The structure of the material presents the following defects: linear macro-inclusions type silicates fragile, which layer the material and affect virtually all the thickness of the board; linear segregations in carbon, thickness 0.4-1.5 mm; segregations area in sulphur, and linear segregation in sulphur at the half thickness of the board; in the area of the fissure, the presence of hard particles, with the hardening structure, which influenced the normal flow of steel to deformation. The presence of hard particles, with the hardening structure, in the rift area influenced the normal flow of steel to deformation. The presence of the overlay formed in hot lamination on the surface of the board indicates the existence of a material defect, which changed the normal flow of the material during deformation. At the expansion operation, in the area of overlap of the material, due to these structural inhomogeneities, the limit of breaking resistance was exceeded, and the material was cracked on about 90% of the thickness of the table.

KEYWORDS: segregation in sulphur, macroscopic inclusions, fragile silicates, purity of steel

1. Introduction

In this paper was followed the determination of the cause of the pipe cracking in the expansion operation. The metallographic analysis of a sample taken from the X60 pipeline was performed to determine the cause of the pipe cracking. The presence of hard particles, with the hardening structure, in the rift area influenced the normal flow of steel to deformation. At the expansion operation, in the area of overlap of the material, due to these structural inhomogeneities, the limit of breaking resistance was exceeded, and the material was cracked on about 90% of the thickness of the tablet. This primary segregation in sulphur and phosphorus print a strong character in the strings, the structure of the X60 steel. It was found that at app. 5 mm the outer surface of the board (in the outer overlay area), on the transverse rift, the normal flow of the material to the hot deformation was prevented by the presence of stain particles. These particles still retain the hardening structure, unremoved by hot lamination of the board, due to its characteristics different from those of steel. At the half of the thickness of the board were emphasized segregations area in sulphur, and linear segregation in sulphur. The appearance, nature, location and dimensions of the structural inhomogeneities indicate the faulty leadership of the elaboration-casting stage.

2. Experiments. Analyses carried out

The analysis was carried out on a sample of the well-determined dimensions shown in Figure 1, the sample that comprises the defective area, was taken from a X60 fissured pipe to the expanding operation.

On the surface of the sample and in the section of the table according to Figure 1, the following analyses were performed: 1 - macroscopic analysis on the surface and in the cross section of the sample (section "T " – Figure 1, 2 - The segregation-sulphur footprint, 3 - analysis microscopic (purity of steel in section "L " and structure in section "T " – Figure 1).

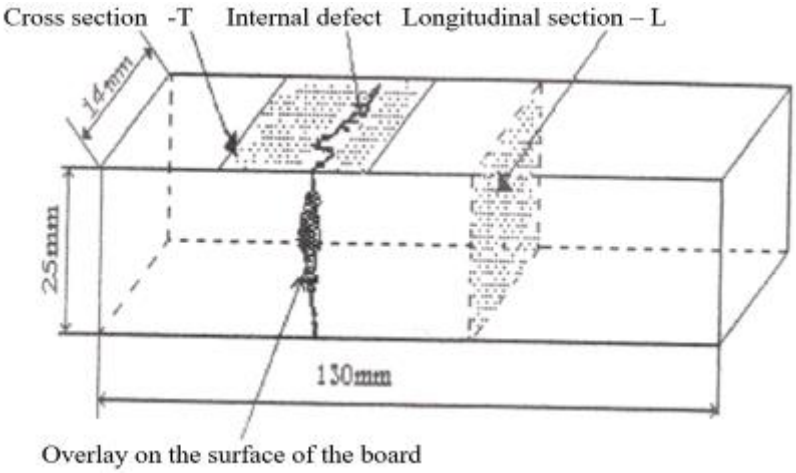


Fig. 1. *Location of the faulty area on the surface of the board and sections "T" and "L" analysed*

3. Results and discussion

3.1. Macroscopic appearance

On the outer surface there is a longitudinal overlap of the material on the entire length of the sample (Figure 2).

The cross section shows, starting from the longitudinal overlay, the zigzag fissure developed, in the analysed plan, on approx. 90% of the thickness of the board. The macroscopic attack with hydrochloric acid indicates linear chemical segregations of different lengths (in the centre of the thickness of the linear segregation table occupying virtually all the length of the sample). The dark aspect of linear segregations indicates the existence of higher carbon content in these areas (Figure 3).

Fig. 2. *Macroscopic issues. Surface of the board-presence of the overlap of material x1,4*

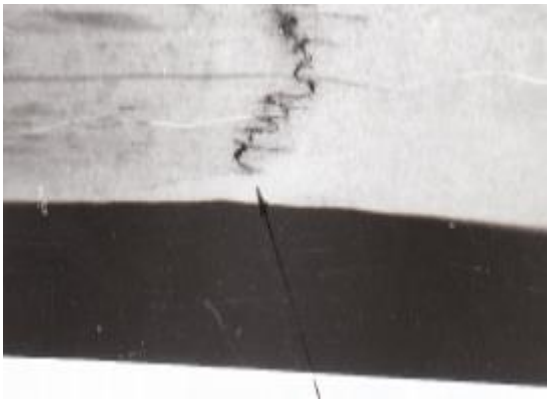


Fig. 3. *Macroscopic issues. Cross section "T" – Fissure area x 1.4*

3.2. Segregation in Sulphur

The Baumann footprint performed in the cross section of the board indicates a non-uniform distribution of sulphur. There is a higher concentration in sulphur on half a sample, which also comprises an area with an abnormal flow of material. In the central area of the thickness of the board is observed a linear segregation in sulphur, on almost the entire length of the cross section (Figure 4).

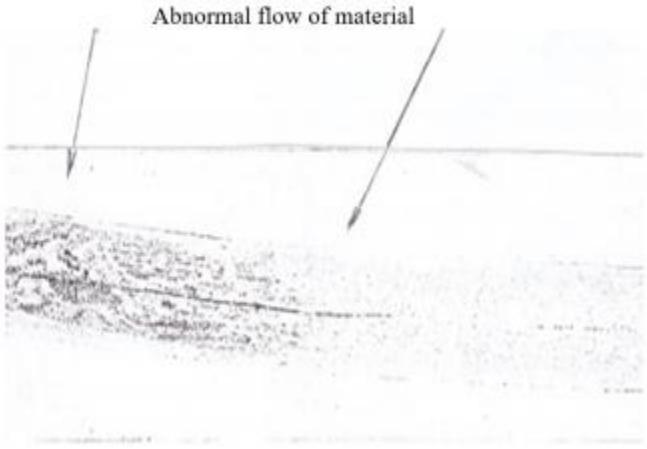
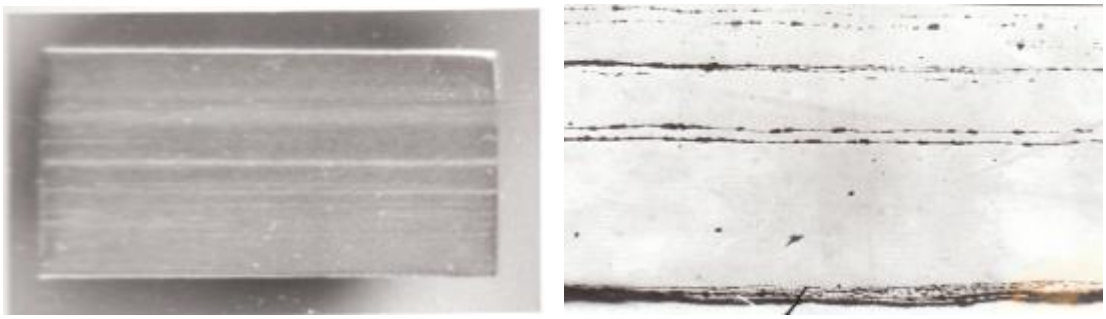


Fig. 4. *Macroscopic issues. Segregation in sulphur – the footprint of Baumann*

3.3. Microscopic analysis

3.3.1. Purity of Steel

The aspects of purity steel were made in macroscopic and microscopic evidence in the longitudinal section "L ". It has been found to have macroscopic inclusions that affect virtually all the thickness of the tablet, in the analysed plan. Recorded macroscopic inclusions are of silicates fragile type (Figure 5).



a) aspect macroscopic x3 b) Microscopic appearance x100

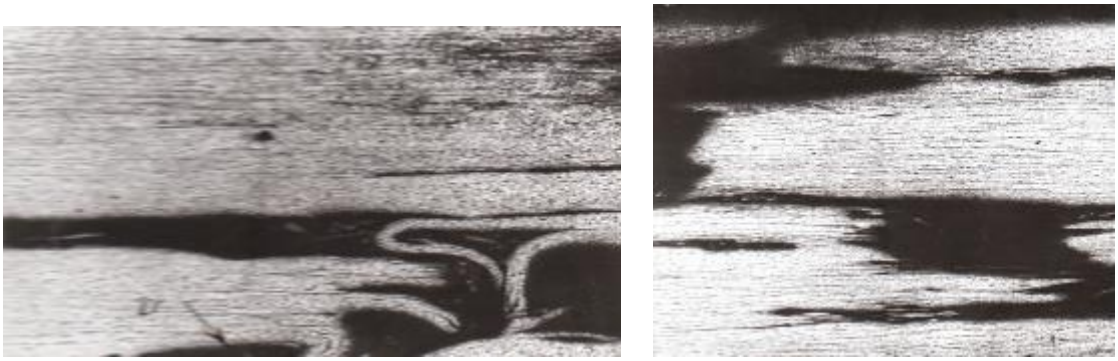
Fig. 5. *Aspects of steel purity. Longitudinal section "L"*

3.3.2. Steel structure in defective area

The steel structure in the defective area has been analysed in the cross section "T".

It was found that at approx. 5 mm of the outer surface of the Board (in the outer overlay area), on the transverse rift, the normal flow of the material to the hot deformation was prevented by the presence of foreign particles. These particles still retain the hardening structure, not removed by hot lamination of the board, due to its characteristics different from those of steel. (Figure 6 - detail D).

The steel structure has a strong character in the strings due to the primary segregation in Sulphur and phosphorus, accompanied by the presence of non-metallic inclusions. There were also registered as structural defects, bands having the width of 0.4-1.5 mm in which the larger quantity of Perlite indicated a higher carbon content (segregation area in carbon).



a) macroscopic structure x32 b) microscopic structure x320 (detail in area D)

Fig. 6. *Structural aspects of the section of the board. Cross section "T"*

3. Conclusions

The presence of the overlay formed in hot lamination on the surface of the Board indicates the existence of a material defect, which changed the normal flow of the material during deformation.

The structure of the material shows the following defects:

- fragile macro-inclusions linear silicates types, which layer the material and practically affect all the thickness of the board;
- linear segregations in carbon, with thickness of 0.4-1.5 mm.
- segregations area in sulphur, and linear segregation in sulphur at half thickness of the board.
- in the area of the fissure, the presence of hard particles, with the hardening structure, which influenced the normal flow of steel to deformation.

At the expansion operation, in the area of overlap of the material, due to these structural inhomogeneities, the limit of breaking resistance was exceeded, and the material was cracked on about 90% of the thickness of the table.

The appearance, nature, location and dimensions of these structural inhomogeneities indicate the faulty leadership of the elaboration-casting stage.

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