REDUCTION OF STRIP BREAKS IN TERNIUM PLTCM PLANT*

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Abstract

The Pickling Line Tandem Cold Mill (PLTCM) from Ternium Pesquería started in 2013. It is a line with 5 stands, 6 high; focused mainly on the exposed automotive market, with a wide spread of products with high quality requirements. In addition the operational continuity is very important, for this, one of the greatest challenges is to ensure operational discipline, the order of production, the quality of the input (hot band), operational interruptions, equipment failure, breakage of strip in the mill, among others. In relation to this, it has a strong impact on productivity, customer compliance, damage to equipment, rolls, safety, quality, reprocessing among others. Here is present the results obtained in the project "decrease of strip breaks" which focused on several fronts, discipline in the order of production, previous review of raw material in surface and dimensional defects with automatic inspection equipment in the hot mill, as well as in PLTCM, generation of logic in the redundant systems of alerts and prevention to avoid or minimize strip breaks that were high impact in the past. All these multidisciplinary actions led as a whole to a significant improvement in the performance indicators of the PLTCM, in productivity, compliance, reprocessing and quality in the cold rolled mill.

Keywords: Strip breaks; Tandem Cold Mill (PLTCM;

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1 INTRODUCTION

This project arises from the need to reduce the number of strip breaks in the PLTCM, within the Tandem Mill.
From own experience, strip breaks that happen at maximum speed or acceleration ramps turn out to be the most damaging. Typically they occur when thin material is processed as a hot band less than <2.6mm. A second type of breakages also catastrophic, happen at the entrance of the mill rolling in the first two stands high strength steels (DP590, DP780 or DP980).

The causes can be multifactorial, among the most common are:
a) Due to poor programming practice.
b) Defective welding.
c) Delays by electrical or mechanical equipment.
d) Substrate defects, close to the weld also frictions, scales, overlaps, cut edges, etc.

Figure 1 shows schematically the Tandem configuration (PLTCM).

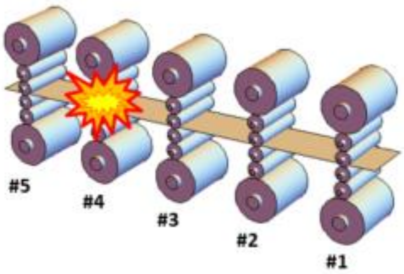


Figure 1. General scheme of the PLTCM.

It is important to have a characterization of all breakage events, in this way we can find patterns that can be avoided, or take some actions to prevent breakages.

The causes of strip breaks can be grouped into the following

1.1 Hot surface defect.

Slivers typically generate breakage in the last three stands. And Overlaps in the first stands.

The thickness variations, together with cold zones can cause breakages in the first stands due to a sudden drop in tension strip (usually are very serious). Slip, which can be caused by leveling, camber or wavy edges, typically occurs at the entrance or exit of the mill

The camber in most of the cases seen later, this is an event already happened with the automatic surface inspection equipment, located in the pickling section.

1.2 Programming practice.

Sequencing of non-compatible steel grades, difference of setup force between adjacent coils (> 400t), leading to sudden changes in tension, welding violations practices in very dissimilar hot band thicknesses, very different widths or steel grades, etc.

1.3. Failure of Electrical or Mechanical Equipment.

Tension failures or Hyrop problems, as well as work roll breaks is the principal problems.

1.4. Operational failures

Strip breaks, when the mill stop, bite in the gap of the mill, due to failures in the coiling section, in which the strip still with tension, due to fails in bridle brakes. Skidding, if the rolling condition changes suddenly due to loss of roughness in the work rolls.
Welding defects. Poor cutting, edge problems or damage due to material.

Lubricity failure in thicknesses less than 0.55mm, in table 1, the strip breaks in percentage is shows.

Causa	Demora	Causa	Número de eventos
Material Defectuoso	40.31 %	Material Defectuoso	47.26 %
Desconche de WR	19.98 %	Soldadora	19.86 %
Servicios	14.02 %	Transición	6.85 %
Soldadora	8.57 %	Programación	3.42 %
Equipo Eléctrico	4.68 %	Desconche de WR	3.42 %
Desconche de IMR	3.18 %	Equipo Eléctrico	2.74 %

Table 1. Percentage of breaks in the PLTCM

2 MATERIAL AND METHODS

Based on the previous description and the knowledge acquired of the main sources of strip breaks that were identified, namely, substrate defects, programming, equipment and operational failures, a series of actions were taken in order to reducing the incidence of strip breaks.

2.1. Defects of substrate hot band.

An interdisciplinary team was created between hot and cold rolling mills, for this purpose the review of thin thickness campaigns was established under the premise of a hot band thickness <2.6mm and a yield value of less than 350MPa.

The parameters that are reviewed are, previous discard material with a download of the production databases of the hot rolling mills and other lines, thickness, surface defects, among others.
Additionally, information on surface defects detected in hot rolling mills by automatic inspection equipment.
With this information, the final comments are downloaded to a production program and from there to the operation.

2.2 Structure of production programs.

These are elaborated and fed to a predefined structure where it is simulated.
The rolling order is structured in such a way that it is possible to identify violations of the program such as thickness step, force, width, grades of steel non-compatible. Out of capacity products, estimation of forces, and stresses between stands among others. Figure 2

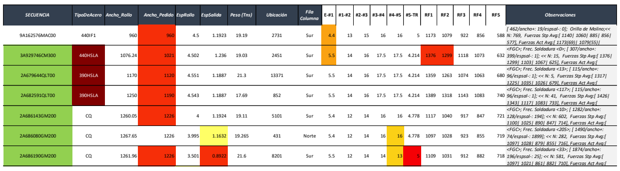


Figure 2. Example of off-line simulation production program.

2.3. Equipment failures

In this part of the project, the focus was to assure the availability of inspection equipment assuring refacionary, was generated a critical parts list of the equipment, these were registered in the maintenance structure through Middleware.

150005421	GABINETE PRINCIPAL COGNEX			
71704720	TARJETA COGNEX 560-119485	L	4	PZA
71662369	TARJETA COGNEX 560-117564.1	L	4	PZA
71656889	ASSY, PCB, SV, I/O CONTROL BRD 2 COGNEX	L	1	PZA
71635159	FUENTE VOLTAJE SOLA 24VDC SDP2-24-100T	L	1	PZA
71703707	MODULO DE ENTRADA C4IDC	L	6	PZA
71703724	MODULO DE SALIDA C4OACA	L	15	PZA
71703721	CABLE CAT6 ETHERNET 555-115969-100	L	8	PZA
71703734	SV PCIE BACKPLANE 560-115753	L	1	PZA
71703738	TARJETA COGNEX 560-112098-10	L	1	PZA
71704720	TARJETA COGNEX 560-119485	L	4	PZA

Table 2. Example of critical equipment ensures the operation of the automatic inspection.

2.4. Operational failures.

On the operational side, was focused on generating knowledge by disseminating the causes and origin of breakages through a detailed analysis of each of them with special focus on those generated by operating itself and those related to hot substrate defects.

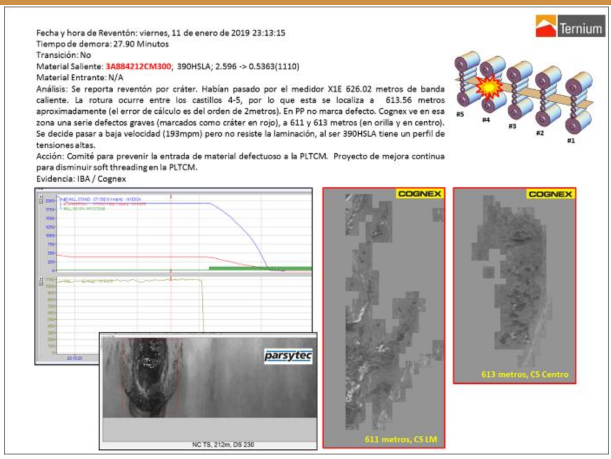


Figure 3. Example of detailed analysis of a substrate default break.

The procedure established before the event of a break was structured as follows. We proceed to collect the sample from the area where it occurs, the variables that are reviewed in a preliminary way are:

Exact position of the break with an estimated error of 2m. Sample are send to the laboratory if is necessary.

A database of take actions we have with signals in MICA or IBA also (speeds, differential force, tension, differential tension, Hyrop position, thickness deviation, bending, etc.) reference and real.
In case of suspicion that the break is due to a superficial defect, the sample is sent to the laboratory for analysis and the results obtained are fed back to the hot or cold rolling mills according to the origin of the defect.

The register of the personnel of the shift is complemented. Tool to determine exact break point. In case of strip breaks that has been generated by a surface defect it is extremely important to locate the exact point where the strip break occurs. By identifying the distance in which it occurred.

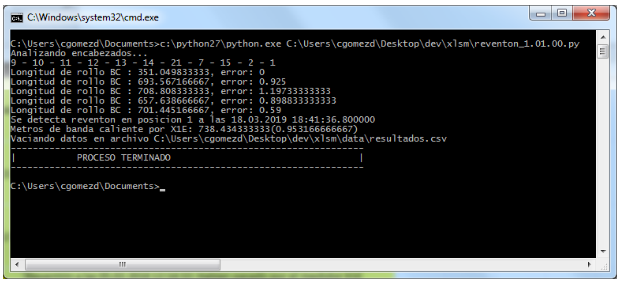
The breakage can be precisely located in the automatic inspection equipment. To obtain the position, the length in hot band must be calculated from the passage of the weld bit by where the break occurs, the thickness deviation is extracted by the meter X1E and the speed of the bridle 7 by means of the formula (rule of the trapeze) can calculate the length).

$$L = \int_{t_{bit X1E}}^{t_{rotura}} v_{7BR}(t)dt \approx \sum_{i=0}^{N-1} \frac{\Delta t}{2}(v_i + v_{i+1})$$

where _t in Mica Trace is 1 = 50s. Once the distance is reached, the position P of the defect is located in,

$$P = L - 4 - 6\sum_{i=0}^{M} \frac{h_i}{H}$$

Where M is the stand where the break is generated, hi is the thickness at the exit of the stand i and H is the thickness of the hot band. The reduction profile is obtained from the model, If the defect is seen in the automatic inspection equipment, then the distance reported must match the P value.


```
C:\Windows\system32\cmd.exe
C:\Users\cgomezd\Documents>c:\python27\python.exe C:\Users\cgomezd\Desktop\dev\xlsm\reventon_1.01.00.py
Analizando encabezados...
9 - 10 - 11 - 12 - 13 - 14 - 21 - 7 - 15 - 2 - 1
Longitud de rollo BC : 351.049833333, error: 0
Longitud de rollo BC : 693.567166667, error: 0.925
Longitud de rollo BC : 708.808333333, error: 1.19733333333
Longitud de rollo BC : 657.638666667, error: 0.898833333333
Longitud de rollo BC : 701.445166667, error: 0.59
Se detecta reventon en posicion 1 a las 18.03.2019 18:41:36.800000
Metros de banda caliente por X1E: 738.434333333(0.953166666667)
Vaciando datos en archivo C:\Users\cgomezd\Desktop\dev\xlsm\data\resultados.csv
---------------------------------------------------------------
|           PROCESO TERMINADO                                 |
---------------------------------------------------------------

C:\Users\cgomezd\Documents>_
```

Table 3. Calculation for the exact detection of the breakage

3 RESULTS AND DISCUSSION.

As mentioned, in the Project for the reduction of breakages in the PLTCM, it was structured with a multifunctional team, in which several areas where involved, the operation of hot and cold rolling mills, programming and maintenance, and additional tools were developed, analysis and prevention. Offline models to simulate the program and revision of the coils before processing and a database, with the origins of breakages. In the histogram of figure 2, the evolutionary breakage is shown from January 2016 to December 2018.

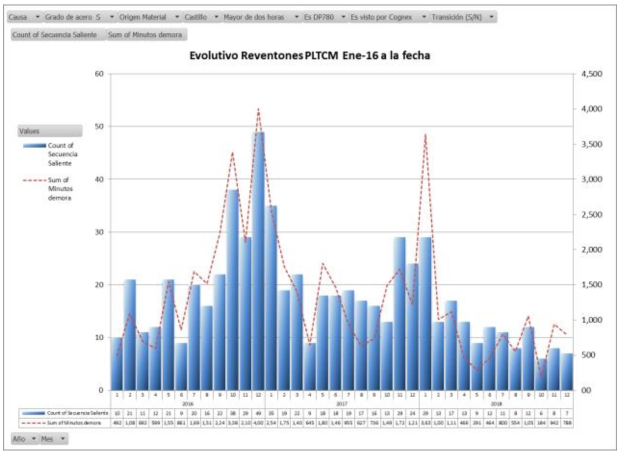


Figure 3. Evolution of strip breaks all causes.

Of the greater benefits obtained whose participation is close to 49% (table1), it was the breakages due to defective material that had a significant decrease and were consolidated with the actions in the last year as shown in figure 4.

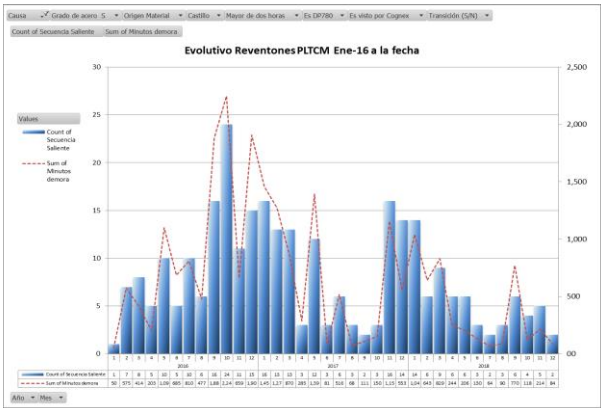


Figure 4. Evolution of breaks due to defective material.

Another catastrophic breaks caused by the welding, had an important decrease, when making improvements in equipment, as Well as compliance in the programming, as shown in figure 5.

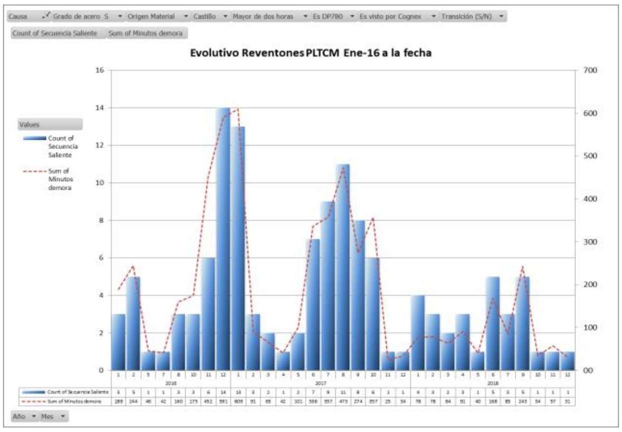


Figure 5. Breakages evolution by welding problems.

In general, the evolution of breaks is shown in figure 6.

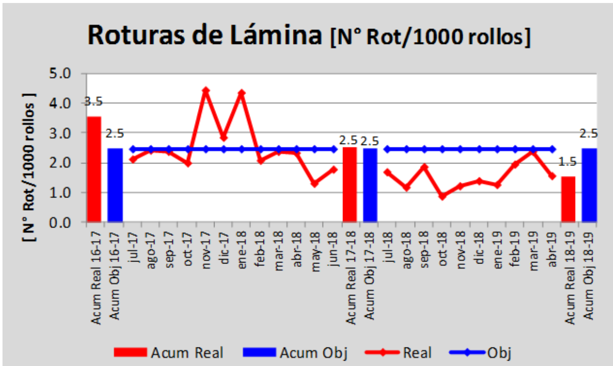


Figure 6. Evolution of strip breaks

4 CONCLUSION.

As mentioned, strip breaks are a critical part in the operation of a mill, having this type of events leads to the possibility of accidents, reduce productivity, and damage to equipment.

With the tools implemented, review of material off line, in terms of surface defects, and dimensional. The design of programming guidelines compliance (off

line simulation). Spear parts that supports the detection of surface defects.
Weekly meetings and information exchange between supplier of coils, hot mills and cold rolling. Disclosure of events and historical records that help generate knowledge and avoid recurring failures.
All the above has led to an improvement in the performance of the mill to reduce delays in strip breaks from 2.3 to 1% of the global, and a decrease in the impact of production from 37 to 16 (mt / year).

Acknowledgments

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2. Technical design information is Mitsubishi-Hitachi equipment.