# PRELIMINARY STUDIES REGARDING THE FOUNDATION PARTICULARITIES OF THE PEELING PROCESS OF HEAVY STEEL BARS

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**Rezumat.** *Cojirea este o operație unică şi economică de prelucrare pentru producerea de suprafețe cilindrice pe barele grele, cu finisaje de înaltă calitate şi precizie dimensională. După ce semifabricatul de tip bară trece prin această operație, toate erorire şi impuritățile de suprafață sunt eliminate. Acest lucru implică, în general, o rotație a unui cap de cojit multi-cuțit, instrument ce permite o rată ridicată de alimentare. Această lucrare prezintă un studiu preliminar privind particularitățile de proces la cojirea barelor grele.*

**Abstract.** *Peeling is a unique and economical processing operation for the production of cylindrical surfaces on heavy bars with high quality finishes and dimensional accuracy. After the work piece undergoes this operation, all the errors and surface impurities are removed. Generally this involves a rotation of a peeling head with multiple tools that allows a high feed rate. This paper presents a preliminary study of the particularities of the peeling process of heavy steel bars.*

**Keywords:** *peeling, heavy steel bars, peeling head, process.*

## 1. Introduction

Bar peeling (Fig. 1) is preferably applied to manufacture bright bars, a product with a blank, relatively smooth surface finish and high dimensional accuracy. Blank bar material is used in modern mass production (e.g., automotive industry and its sub-suppliers).

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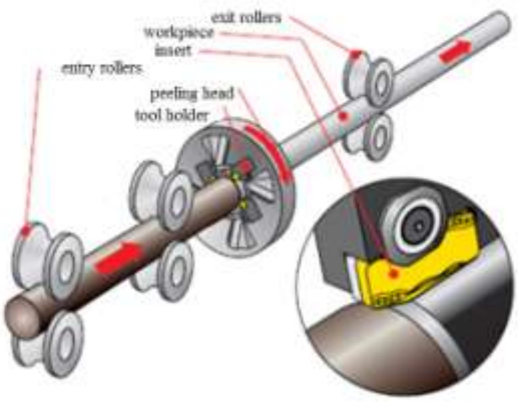


Fig. 1. Bar peeling principle [3]

Due to the development of appropriate high-performance machines, bar peeling provides an increased awareness for steel producers, as well as for the intermediate machining of round products produced by spring and pipe manufacturers. On wrought, forged, or injection-moulded round blocks, round bars, or rods, operations such as blasting, flaming, and grinding can be eliminated and replaced by bar peeling. This process is not only more economical, it is also helpful to make the workplace run more efficiently.

The cutting process is a set of dynamic and thermal phenomena present in different areas of contact tool / chip / work piece. Carrying the cutting process is mainly influenced by the properties of the work piece, cutting tool geometry, cutting data, cooling and lubrication conditions [4].

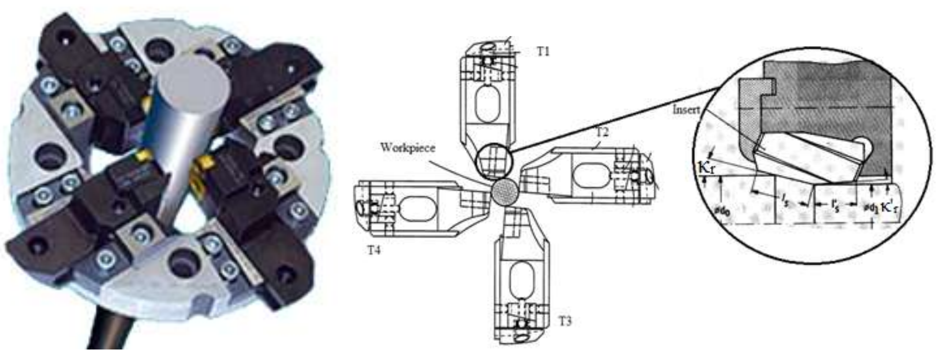


Fig. 2. Peeling head with 4 holders [3]

The peeling head (Fig. 2) is the essential device that is equipped on a peeling machine. This device is often equipped with 3, 4 or 6 tool holders and from the construction angle the peeling head can be adjustable or not, depending on the destination of the peeling machine.

Hard turning is performed on materials with hardness within the 45–68 Rockwell range using a variety of tipped or solid cutting inserts, preferably CBN.

Although grinding is known to produce good surface finish at relatively high feed rates, hard turning can produce as good or better surface finish at significantly higher material removal rates [5].

The peeling process requires special tools that have increased durability, specific geometry and holders (Fig. 3).

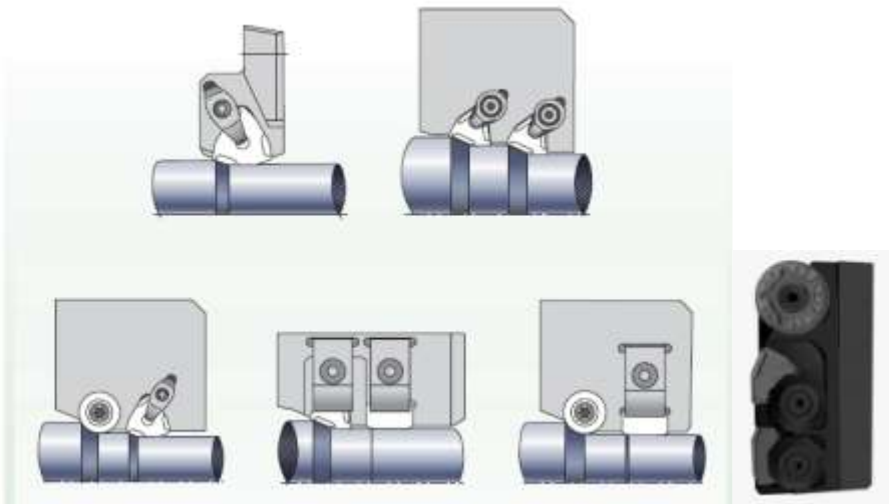

Fig. 3. Examples of tool holders [3]

## 2. Experimental Work

This research deals with peeling machines in the heavy industry branch. For a deeper knowledge of the process of peeling it undertakes a detailed study from the experimental point of view in order to remove the phenomena that occur during the process. For a better understanding of the plan that is guiding this subject, a sketch was created (Fig. 5).

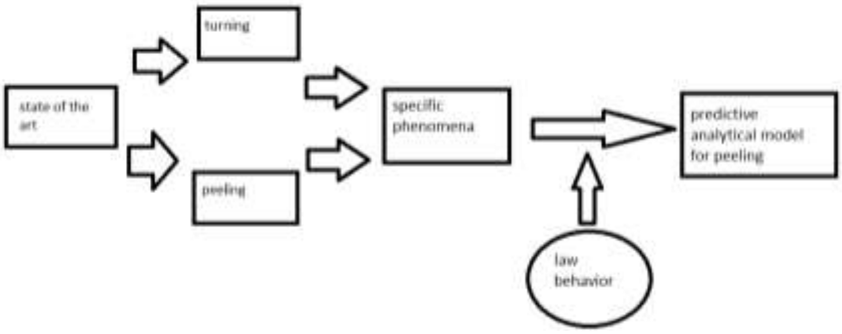


Fig. 4. Design of experiment sketch [6]

An experimental device was built that allows reproducing specific conditions from peeling in a case of cutting by turning. For technical reasons and dynamic study the experiment was done using a specific tool from a peeling machine that was adapted on a frontal lathe, so the forces and vibrations can be measured in a static benchmark. To study the behaviour of the tool in the cutting process, mechanically and dynamically speaking, a series of tests in normal turning configuration were performed. Thus was built the second experimental stand for the measurement of cutting forces and highlighting the dynamic parameters.

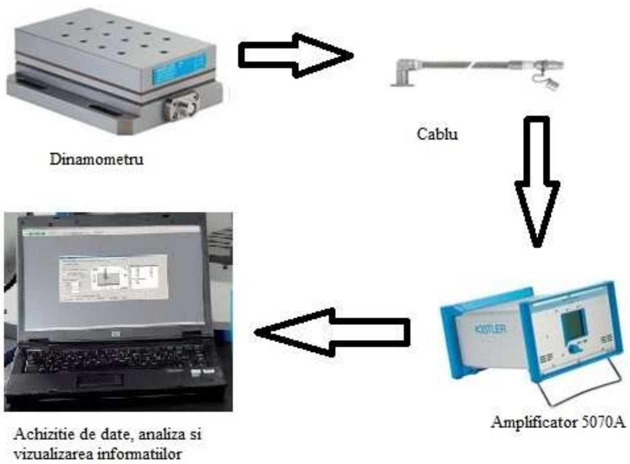


Fig. 5. Measurement chain.

Experimental measurements were performed to determine the forces, vibrations and temperatures that occur during the peeling process. This experiment was done by mounting a peeling head from a peeling machine on a frontal lathe. The material used in the experiment was 41Cr4, chosen for its high hardness, which is around 50 HRC. The measurement of forces was done with the measuring chain made up of (Fig. 5): dynamometer Kistler 9257B, Kistler 5015 amplifier and DynoWare signal processing software. Kistler is a multi-component dynamometer that provides a dynamic and quasi-static measurement of the 3 orthogonal components of a force ($F_x$, $F_y$, $F_z$) acting from any direction onto the top plate. With the aid of optional evaluation devices the 3 moments $M_x$, $M_y$ and $M_z$ can be measured as well. The dynamometer measures the active cutting force regardless of its application point and both the average value of the force and the dynamic force increase may be measured [6].

Highlighting the dynamic phenomena could be achieved through triaxial accelerometer with a sensitivity of 100mV/g National Instrument acquisition board USB4432 and software acquisition and signal processing Fastview.

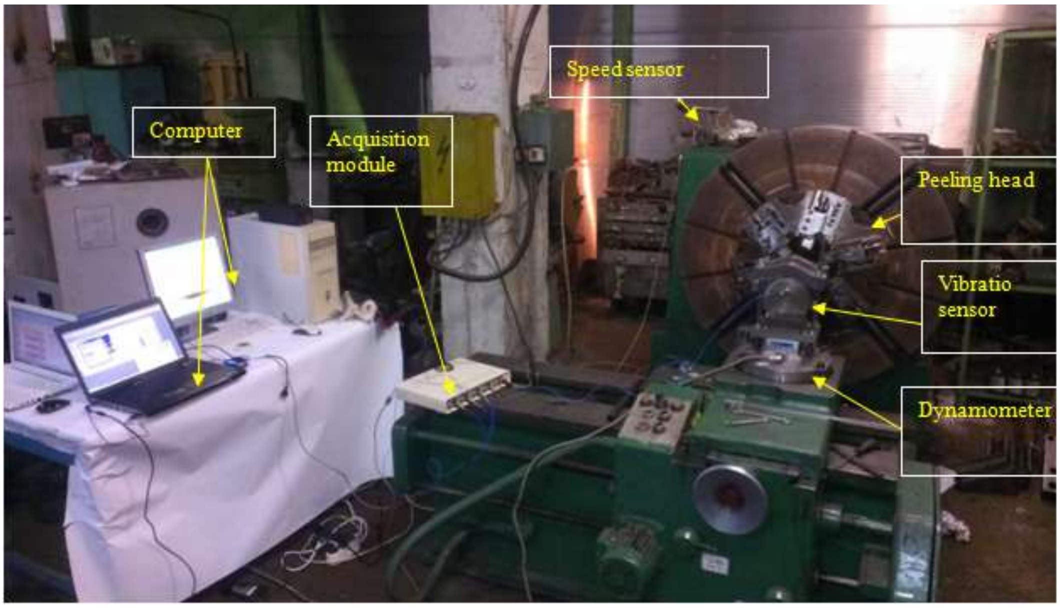


Fig. 6. Detailed view of the experimental stand.

The signal was processed using the DynoWare 2825A software, which is a general-purpose data acquisition and display software package suitable for cutting force and general dynamometer applications. It is designed to combine the performance of the proven line of Kistler quartz dynamometers with modern computer technology.

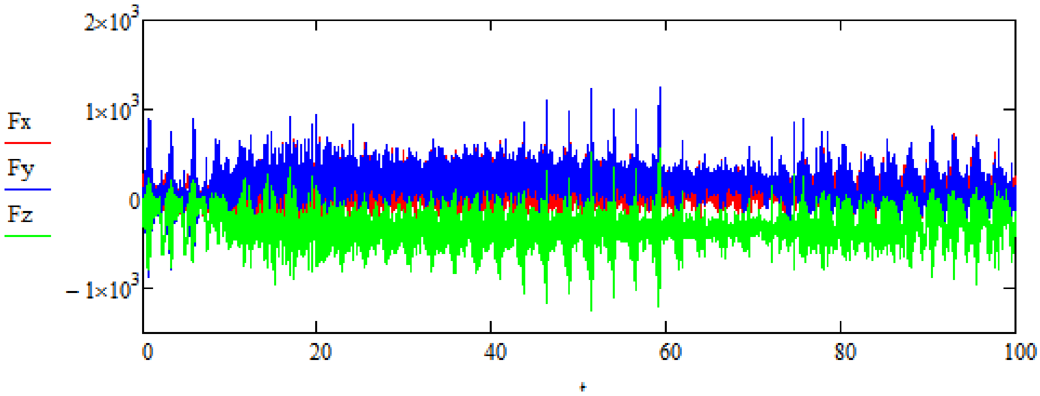


Fig. 7. Analysis of data using MathCAD.

To better understand the data collected, MathCAD was used to create a graphical interpretation. For the example bellow, the acquisition time was of 100 s with a rate of 1000 measuring points in 1 second, for each direction.

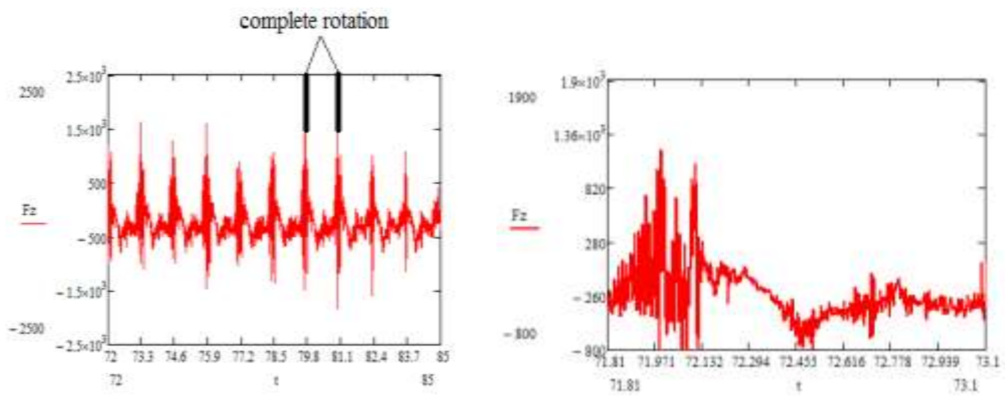


Fig 8. Particular view of the advance direction force.

The work piece used to perform the experimental measurement is DIN 41Cr4, with a weight of 23 kg, with initial diameter of Ø = 122 mm. To achieve a more accurate measurement, the work piece was processed before being centred on the experimental stand. The bar was processed in steps 3, to ensure the depth established in the experimental plan (0.5 mm, 1 mm, 2 mm). Examples of cutting parameters and values are exhibited in the table below.

**Table 1)** Cutting parameters

| No. | ap mm | f mm/rot | N rot/min | Temperature increase C° | Acquisition time s |
|---|---|---|---|---|---|
| 1 | 0.5 | 0.25 | 22 | 5.5-6.5 | 100 |
| 2 | 0.5 | 0.355 | | 6.5-7 | |
| 3 | 0.5 | 0.5 | | 7-7.3 | |
| 4 | 0.5 | 0.71 | | 7.3-7.5 | |
| 5 | 0.5 | 1 | | 7.5-8.5 | |
| 6 | 1 | 0.5 | | 8-8.1 | 50 |
| 7 | 1 | 0.5 | | 8.1-8.3 | |
| 8 | 1 | 0.71 | | 8.3-9.2 | |
| 9 | 1 | 1 | | 9.2-9.6 | |
| 10 | 1 | 1.4 | | 9.5-10 | |
| 11 | 2 | 0.5 | | 10-10.3 | |
| 12 | 2 | 0.71 | | 10.3-11 | |
| 13 | 2 | 1 | | 11-12 | |
| 14 | 2 | 1.4 | | 12-13 | |

**Conclusions and Future Work**

For completing these preliminary stages of experimental measurements the following steps were required:

• lathe preparation for mounting equipment

• design and implementation of the intermediate piece to ensure the necessary peeling kinematics

• create a plan for experimental measurements

• choosing the work piece material

• prepare the work piece by processing it in 3 steps

• calculating the cutting parameters

Using the data obtained, graphs were made that help examine the process, namely: determining forces average on three directions, time in which the peeling head performs a full rotation.

As for future work, tests will be performed on a peeling machine using tools and materials specific to peeling; a predictive analytic model to optimize cutting peeling conditions will be created.

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## R E F E R E N C E S

[1] Degner, W. et al, *Spanende Formung. Theorie, Berechnung, Richtwerte*. 16, aktualisierte Auflage. Carl Hanser Verlag, München, Wien (2008).

[2] Perović, B., *Handbuch Werkzeugmaschinen. Berechnung, Auslegung und Konstruktion.* Carl Hanser Verlag, München, Wien (2006).

[3] *Tools and Inserts for Bar Peeling*. CERATIZIT (2014).

[4] Toulouse, *D., Contribution à la modélisation et à la métrologie de la coupe dans le cas d'un usinage tridimensionnel*. Thèse de Doctorat de Mécanique, Université Bordeaux 1 - France, 1998.

[5] Xiao, M. el al, *Analysis of Chatter Suppression in Vibration Cutting*, International Journal of Machine Tools and Manufacture, Volume 42, Issue 15, pp. 1677-1685, 2002.

[6] Toma A.I. et al, Study of experimental tests regarding forces analysis during the peeling process, *Conference Proceedings of the Academy of Romanian Scientists*, Vol. 7, pp 295-302, 2015.