THE INFLUENCE OF CUTTING PARAMETERS ON THE DYNAMIC STABILITY PERFORMANCE OF FINISHING CNC MACHINES

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ABSTRACT

The paper describes the influence of the cutting regime parameters on the dynamic stability reserve of CNC finishing machines. For this purpose it is used an experimental stand comprised of transducers for measuring tool and workpiece rotation speeds, as well as a measuring device for the dynamic components of the cutting force (Ft, Fx). The processed materials are steel, bronze and cast iron. Finally there is presented the variation pattern of these parameters and their influence on the finishing process productivity.

1. INTRODUCTION

CNC finishing machines are one of the most significant cases for the treatment of vibration problems. This is due to the fact that surface finishing operations are usually solved by finishing [1].

Compared to conventional machining (with defined tools) where by choosing appropriately depending on the type of machine tool and the given operation, the cutting regimes, the process remains stable for a long time, when finishing, the process becomes unstable in a relatively short time. This causes the process to be interrupted in order to straighten the abrasive tool.

Among the rectification operations, the finishing process occupies an important place due to the special conditions in which it takes place [2].

In order to study the action of the parameters of the cutting regime on the dynamic stability reserve of the CNC finishing machine, we further reproduce the structure and connection schemes that are established between the main components in the technological process of finishing (fig. 1).

The experimental stand used for this purpose consists of transducers for measuring tool and workpiece speeds, as well as a sensor for measuring the dynamic components of the cutting force (Ft, Fx). Using for each measuring channel adequate connection schemes, at the level of the central computer, the variation of the two components Ft, Fx is obtained according to the other parameters of the cutting regime, with the help of an interface for which special

programs have been built such as: control of the acquisition board, processing of the measured signals, writing to files on the hard disk and displaying the signals on the screen.
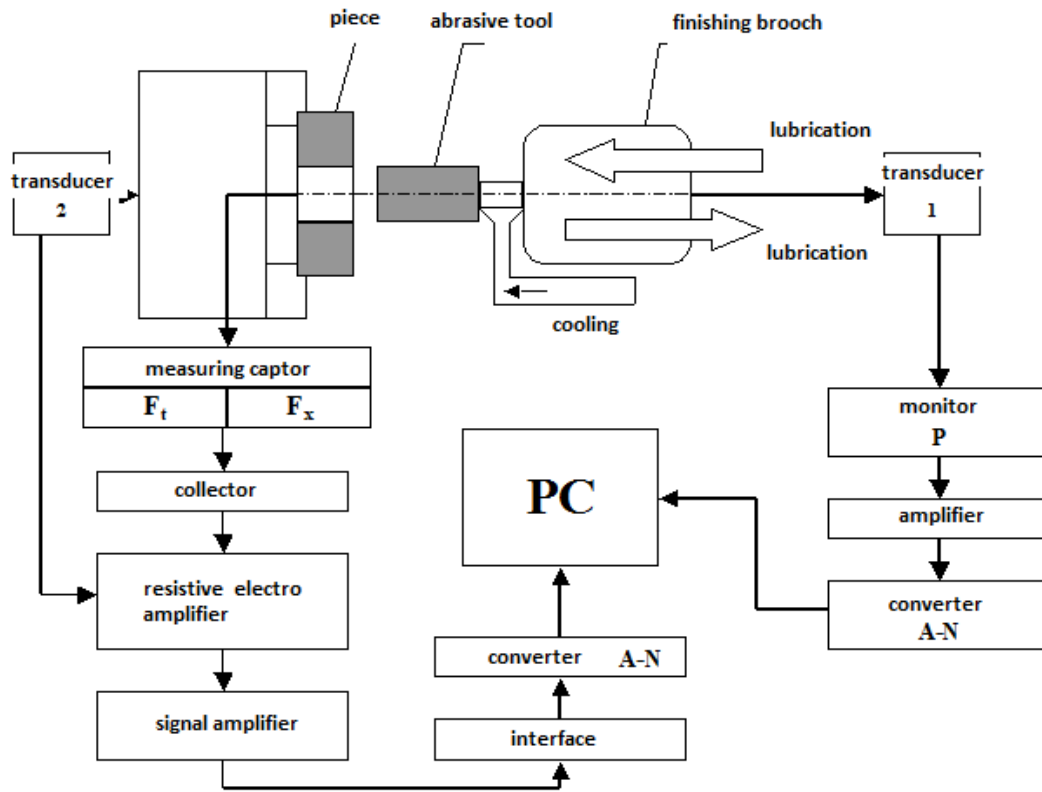

Figure 1: Real block diagram of the measuring chain used, tangential force, axial force

2. DETERMINATION OF THE INFLUENCE OF CUTTING REGIME PARAMETERS ON THE DYNAMIC STABILITY OF FINISHING CNC MACHINE TOOL IN THE EVENT OF A STEEL TEST PART

The variation diagrams of F_t and F_x are drawn for an optimal cutting regime corresponding to fig. 2, 3:
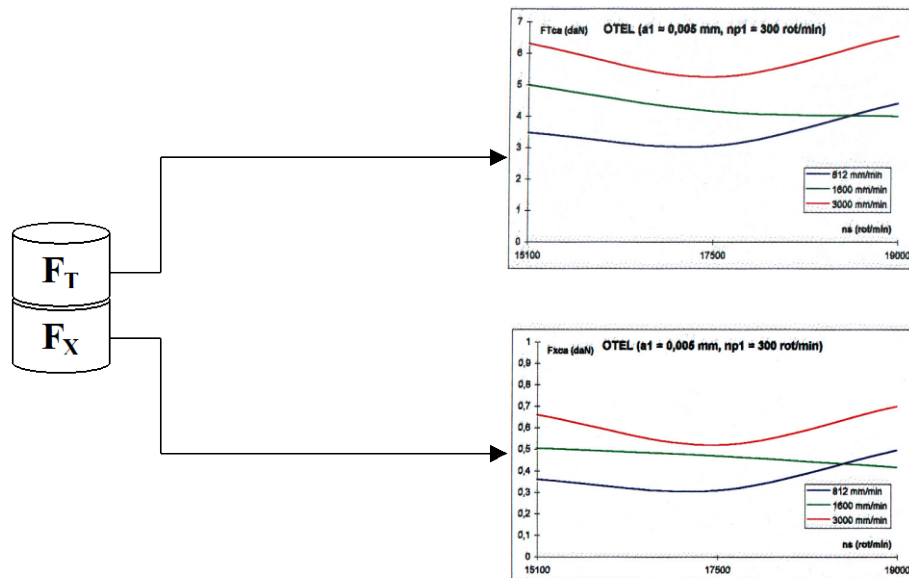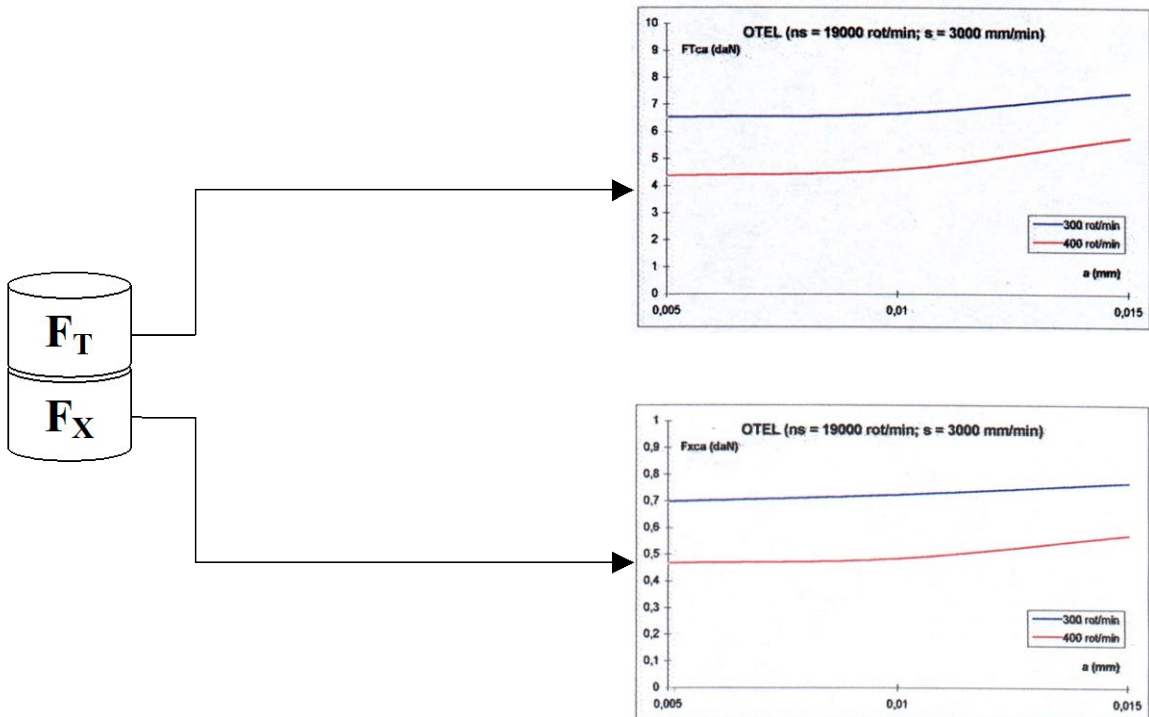
Figure 2: Analysis of the dynamic stability reserve for a given cutting regime when machining steel parts

The modification of the circular advance of the part in the sense of its increase establishes the variations of the two parameters F_T and F_X as in fig. 3:
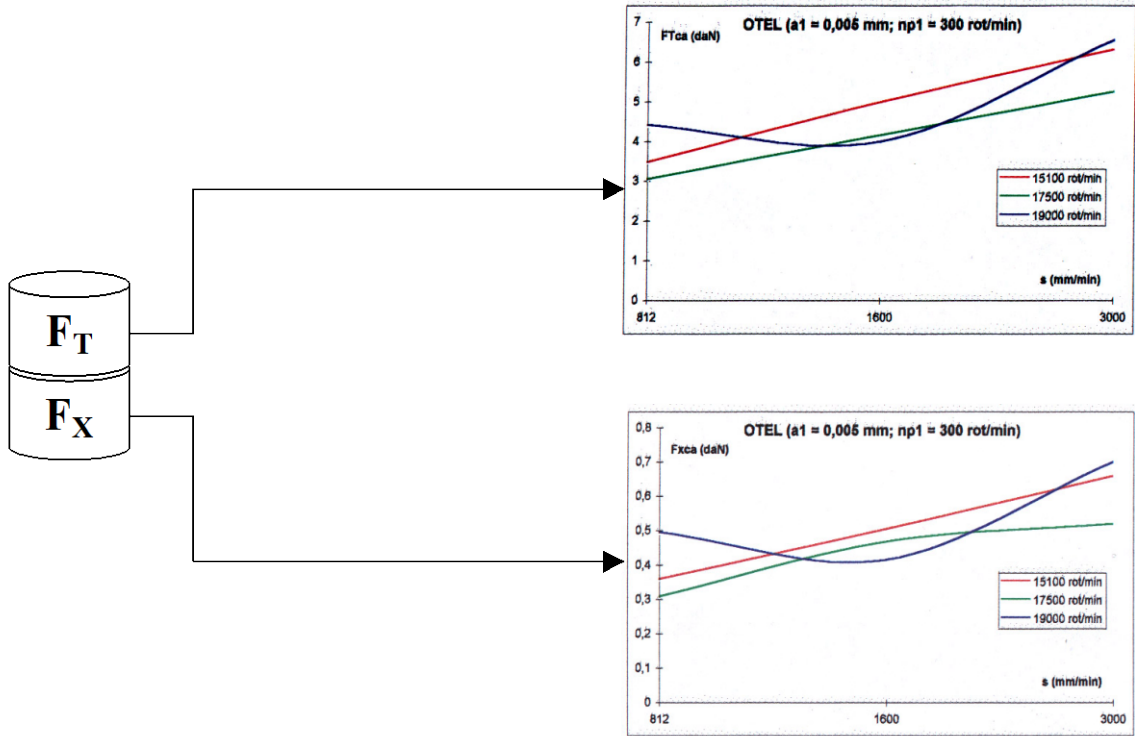

Figure 3: The influence of the circular advance on the dynamic stability reserve (steel parts)

By changing the cutting depth we have the following variation diagrams (fig. 4):

Figure 4: Influence of cutting depth on dynamic stability reserve (steel parts)
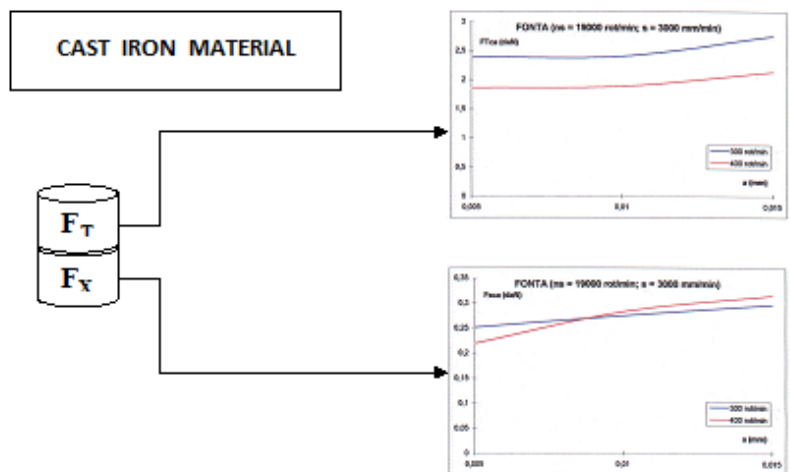
3. DETERMINATION OF THE INFLUENCE OF CUTTING PARAMETERS ON THE DYNAMIC STABILITY OF FINISHING CNC MACHINES IN THE CASE OF TEST PIECES MADE OF IRON AND BRONZE
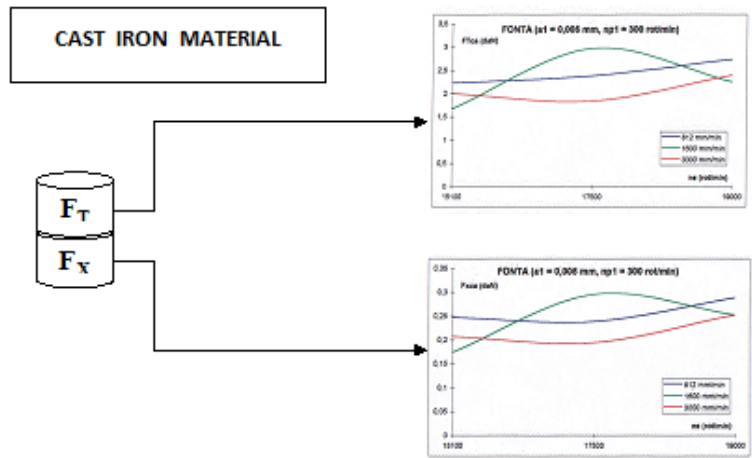
Figure 5: Analysis of the dynamic stability reserve for a given cutting regime when processing cast iron parts
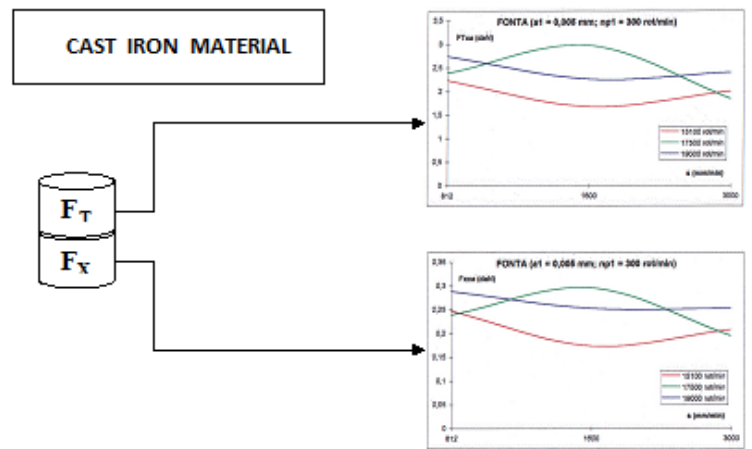
Figure 6: Influence of circular feed on dynamic stability reserve (cast iron parts)

Figure 7: Influence of cutting depth on the dynamic stability reserve (cast iron parts)
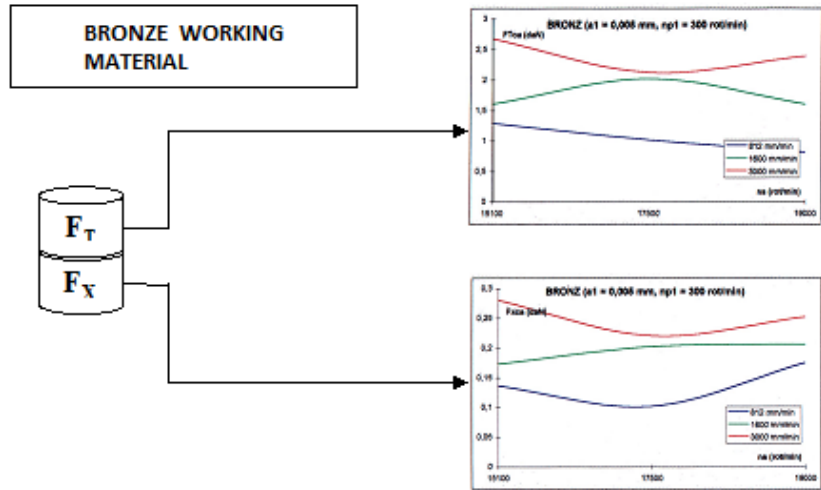
Figure 8: Analysis of the dynamic stability reserve for a cutting regime given to the processing of bronze parts
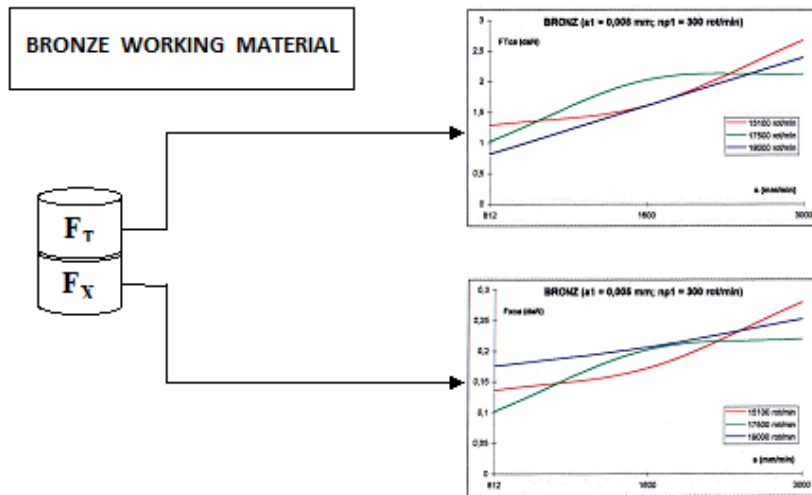

Figure 9: The influence of the circular advance on the dynamic stability reserve (bronze parts)
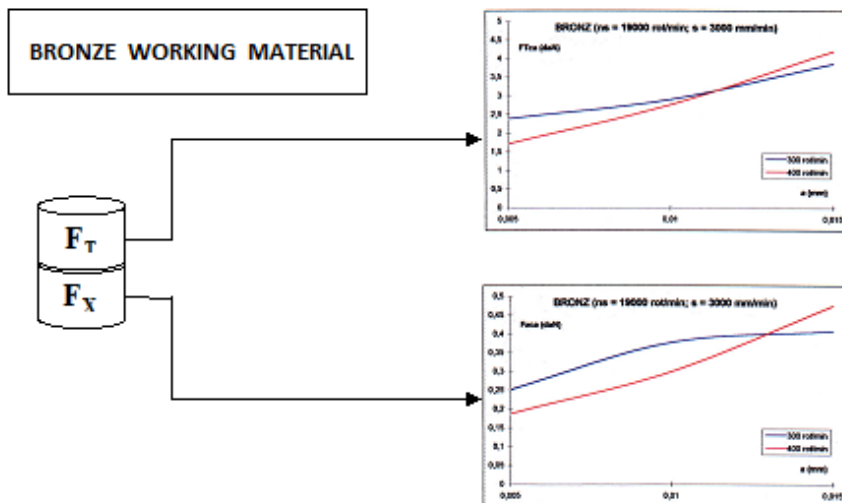

Figure 10: Influence of cutting depth on dynamic stability reserve (bronze parts)

4. CONCLUSIONS

From the analysis of the evolution of the components of the cutting forces it is found that the highest values occur in the case of steel finishing, while in the case of finishing cast iron and bronze they are significantly reduced, the measured values being relatively close [3].

Increasing the cutting depth has a negative effect on the dynamic stability reserve of the finishing machine.

The feed rate and the main cutting speed admit value ranges in which their action is generally positive in a middle range of the cutting speed n_S = 17500 r / m and in a higher range of advance variation f_2 = 1600 mm / min and f_3 = 3000 mm / min.

The best stability reserve was obtained for small cutting depths a_{P1} = 0.005 mm, average advances f_2 = 1600 mm / min and a circular advance of the part increased to n_{P2} = 400 r/m.

Usually if the increase of the stability reserve is imposed by the increase of the advance, of the main cutting speed or of the circular advance of the part, these do not always present effective measures to increase the stability [4], [5], [6].

In the case there is no direct kinematic connection between the main kinematic chain and the feed kinematic chains, so that the speed of the main shaft is independent of the feed size, so that as the speed of the main shaft increases, the feed rate remains constant, the feed decreases, i.e. the positive influence of the increase of the main cutting speed is partially compensated by the negative effect of the corresponding decrease of the longitudinal or circular advance thus canceling the effectiveness of the adopted measure, therefore it is necessary that in these cases, with the increase of the main axis speed, the same direction and the longitudinal and circular advance of the part, which is possible in the case of machine tools provided with adaptive controls [2].

Due to these limitations regarding the measures of increase of n_S and f or n_P, in order to ensure the dynamic stability, it remains certain the decrease of the cutting depth, following that the loss of productivity of the technological operation, caused by the variation of the cutting depth, is partially avoided by the corresponding increase in the circular feed of the part, which generally leads to an increase in the stability of the machine [1].

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