

## Improvement of continuous forming the “Conform” method

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**Abstract.** Improvements of continuous forming method “Conform” are offered, consisting in the possibility of changing the slope angle of the bearing plate relative to the wheel, allowing a number of restrictions to be removed, the setup and operation of the equipment to be substantially simplified. Conditions are determined according to which the workpiece capture and the mounting of the bearing plate at various angles are possible. The reliability of the dependences obtained is confirmed by the studies carried out on the laboratory installation.

### 1. Introduction

Modern development of technology initiates the need for the development and production of complex shapes of increased accuracy, the use of which allows competitive processes and equipment to be created. Usually such shapes are obtained by pressing. However, the classical pressing process has a low productivity due to the large time spent on preparatory operations, often exceeding the processing time, high energy intensity, since all metal volume is subjected to deformation at the same time and as a result it is possible to realize only on expensive metal-intensive equipment.

The disadvantages of the classical pressing process make it difficult and in some cases make it impossible to obtain complex shapes of great length, a high price of the products limits its use, installation and operation of expensive and complex equipment increases the payback period and production cost, which is not desirable in the system of market relations.

The cardinal solution to the above problems is the development of a continuous pressing process based on the use of active frictional forces in the deformation zone [1 - 4]. Among the known methods of continuous pressing, the most interesting from a practical point of view is the method called “Conform” [5].

The advantages of this method include the possibility of welding the metal in the deformation zone, the simplicity of the kinematic scheme, high technological flexibility due to the rapid tool change, deformation does not require heating to high temperatures, since during the shaping process heat is generated ensuring high plasticity of metal. However, the practical implementation of the “Conform” method is restrained by insufficient technical and technological development of this method, little theoretical study and, in this connection, the lack of well-grounded recommendations for the selection of energy-efficient modes of shaping.



## 2. Method of research

To implement the “Conform” method, a rotating roll and a stationary bearing plate are used, covering up to a quarter of the roll circumference. The roll and the bearing plate form a closed channel with a constant cross-section along the length. At the end, the channel is blocked by the stop, and to form the finished shape a matrix is used, usually located in the upper part of the bearing plate in the zone of the stop.

Under the action of active frictional forces the metal is drawn into the channel on the roll surface, where the pressure necessary for pressing is created. Analysis of the known device designs for the implementation of the “Conform” method made it possible to identify their shortcomings, imposing limitations and creating difficulties in practical implementation:

1. The section of the workpiece must correspond exactly to the section of the channel. Otherwise, the active frictional forces will not be sufficient for pressing;
2. At the entrance to the channel, it is necessary to place the master device providing the initial stage of the process;
3. The amount of active frictional forces can not be adjusted and, as a rule, considerably exceeds the required value, which in turn leads to unjustifiably high energy costs;
4. The absence of deformation of the metal between the roller and the bearing plate makes it impossible to use this method to produce simple shapes, flattened tape, transfers the entire load of form the finished shape on the matrix.

The identified shortcomings and limitations can be eliminated by changing the structure of the bearing plate fastening. It is necessary to equip additionally the installation that implements the “Conform” method with a device that changes the slope angle of the bearing plate. Such a constructive solution will allow the shape of the channel formed by the roller and the bearing plate to be changed. The height of the channel will decrease from the entrance to the matrix, which will provide additional deformation of the workpiece in the channel reducing the load on the matrix. Metal deformation in the channel will allow restrictions on the size and shape of the section of the workpiece to be removed.

Changing the slope angle of the bearing plate will allow the area of the deformation center to be changed where active frictional forces act, thereby creating optimal process conditions for energy costs. The possibility of deformation in the narrowing channel formed by the roll and the bearing plate will make it possible to form simple shapes without the use of a matrix, which will significantly reduce energy consumption and make this method of production of simple shapes economically efficient, thereby expanding the range of products.

## 3. Results and discussion

For the practical implementation of the proposed “Conform” method, it is necessary to determine the conditions under which it is possible to implement it. One of the most important is the condition of capture. The workpiece capture will occur when the amount of retracting active frictional forces on the roll surface is equal to or greater than the reactive friction forces acting on the surface of the bearing plate. Implementation of these recommendations is possible with different friction conditions on the working surfaces of the roll and the bearing plate:

$$f_c \geq f_{b.p.}, \quad (1)$$

where  $f_c$  – the coefficient of friction on the surface of the roll;  $f_{b.p.}$  – the coefficient of friction on the surface of the bearing plate

$$f_{b.p.} = n f_c, \quad (2)$$

where  $n$  – a coefficient of proportionality that is less than one.

Knowing the value of the coefficient  $n$ , it is possible to determine at what values of the friction coefficients  $f_{b.p.}$  and  $f_c$  the realization of the studied process is possible. Let us consider the conditions of workpiece capture during deformation by the improved “Conform” method with the changing position of the bearing plate. We will design the forces acting at the point of contact of the sample with the bearing plate and the roll on the axis that coinciding with the axis of the sample. The equation of equilibrium of forces will have the form:

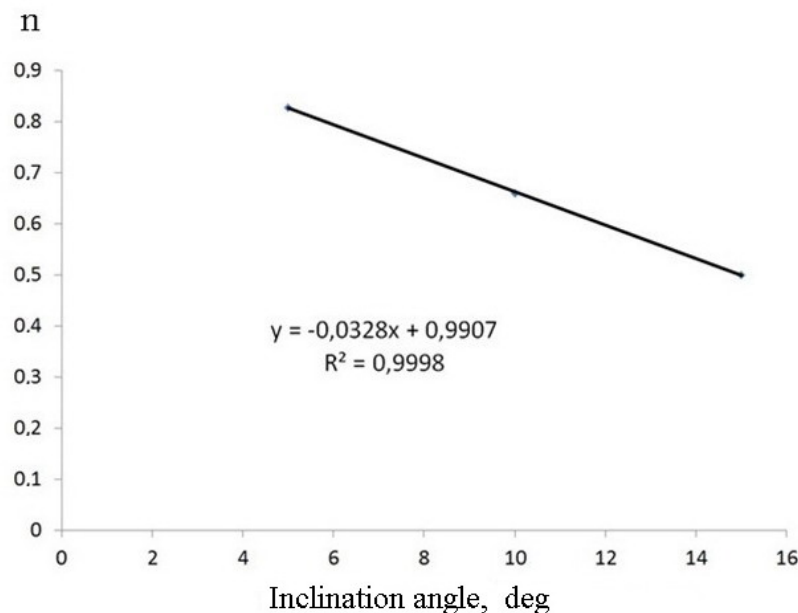
$$\tau_{av1} - \tau_{av2} \cos \omega - p_{av} \sin \omega = 0, \quad (3)$$

where  $\tau_{av1}$  – contact frictional forces acting at the point of contact between the roll and the sample;  $\tau_{av2}$  – contact forces of friction acting in the place of contact between the sample and the bearing plate,  $p_{av}$  – average normal stress;  $\omega$  – the slope angle of the bearing plate.

Assuming that the frictional law of the Amonton-Coulomb acts on the contact surfaces, taking into account (2), we obtain:

$$n \leq \frac{f_c - \sin \omega}{f_c \cos \omega}. \quad (4)$$

If condition (4) is not fulfilled, natural capture is not possible. It should be noted that the obtained condition of capture is valid for both a roll with a smooth surface and with a pass. As follows from the dependence (4) the value of the coefficient  $n$  depends on the slope angle of the bearing plate. Figure 1 shows a graph of the change in the coefficient  $n$  from the slope angle of the bearing plate  $\omega$ .



**Figure 1.** Graph of the dependence of the coefficient  $n$  on the slope angle of the bearing plate  $\omega$ .

To study the possibilities of the improved “Conform” method, an experimental unit with an upper position of the bearing plate was designed. The mechanism of adjusting the bearing plate allows the distance between the roll and the bearing plate to be changed in the horizontal plane, as well as the angle of inclination. The friction conditions on the surfaces of the bearing plate and the roll were adjusted due to the different roughness and different material of the bearing plate (cast iron) and the

roll (steel). The conducted experiments confirmed the reliability of the obtained condition for the improvement of “Conform” method.

When carrying out experiments using a bearing plate and a roll with smooth surfaces and the deformation of a round billet 12 mm in diameter between them, a great value of the broadening value took place (figure 2). The results are given in figure 2, where the sample obtained by the conventional method of rolling is shown at the top, at the bottom – by the “Conform” method using a roll and a bearing plate with smooth surfaces. This phenomenon can be explained by the large reactive frictional forces acting on the surface of the bearing plate and creating an obstacle to the metal movement.

Processes that provide large values of broadening are of interest when implementing the technology of flattening. The main task of flattening is to obtain strips from a round billet with the maximum value of the broadening. Products obtained by flattening are in demand, however, the possibilities of the rolling process used for this purpose are limited and the search for new solutions in particular the application of the “Conform” method is promising and relevant.



**Figure 2.** The broadening value after deformation in the rolls (the upper sample) and by the “Conform” method (the lower sample).

#### 4. Conclusion

Technical solutions have been developed that make it possible to expand significantly the possibilities of continuous pressing by the “Conform” method. The conditions for the implementation of the improved “Conform” method are determined and confirmed experimentally, as well as the perspective directions of its use are discussed. It is established that deformation between a smooth roll and a bearing plate leads to large values of broadening. This circumstance is of interest for obtaining a strip from a round billet.

#### References

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