Research of influence of geometrical parameters of a stamp engraving of setting transitions at setting of semi finished pipe products to receiving defect-free products

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Abstract. The cause of a pipe clip during the setting of the pipe is determined on the basis of modeling. The method, which excludes the formation of a defect in a semi finished product by changing the configuration of the setting transition, is developed.

Forgings of pipes for setting (group V) have the following most common options for setting transitions (wall thickening t) [2] :

- by increasing the outer diameter d (Figure 1, a);
- by reducing the inner diameter d0 (Figure 1, b);
- by changing both the diameters d and d0 (Figure 1, c).

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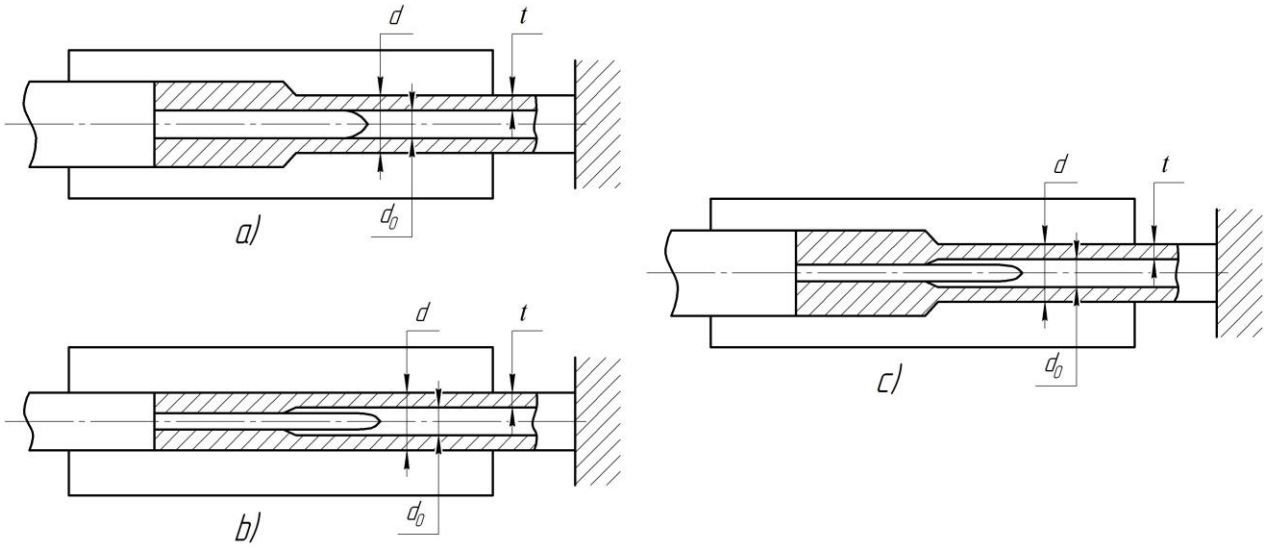


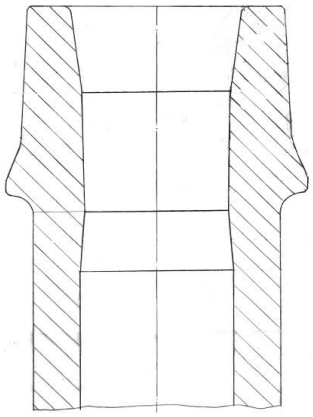
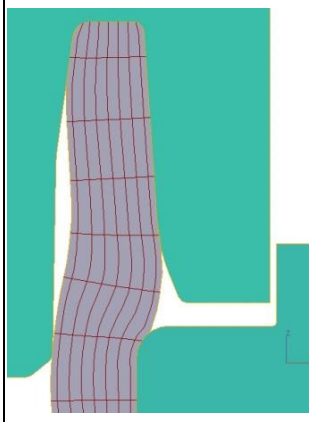
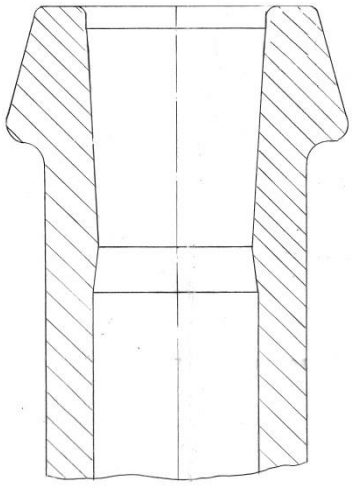
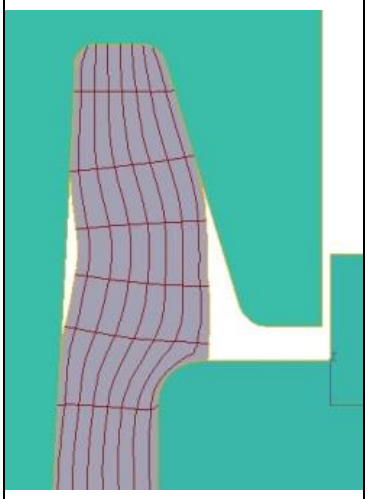
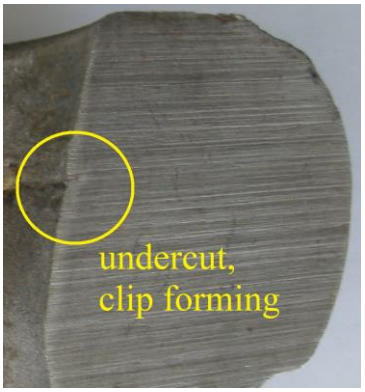
Figure 1. Options of pipe setting.

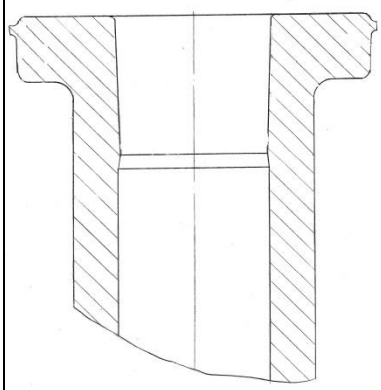
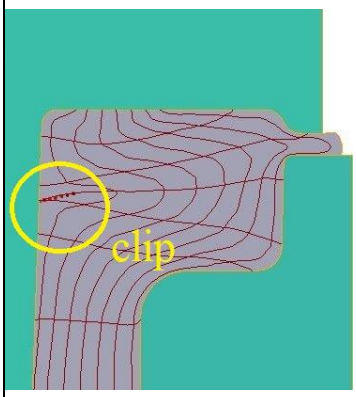
Practicability of a pipe setting method depends on specific conditions: the work piece material, the available equipment, given technical demands to stampings concerning the form, the size of the semi finished pipe, etc.
Technological process of manufacturing semi axle housing in a Forge plant PJSC KAMAZ is a setting of 3 transitions from a pipe Ø121 × 22 mm of 35HGSA brand. Calculation of operating technology transitions are based on the recommendations contained in the directory "Forging and Stamping" [2].
The main problem of this process, periodically occurring when setting, is a defect in the form of cracks in the inner cavity of the flange portion of the forging. The defect is a clip on the inner surface of the forging at the middle portion of the set pipe (Table 1). The depth of the crease formation is 35 - 40 mm and is more than the actual allowance for further machining.
Location of the clip is difficult for visual identification, which increases the risk of getting the details of semi axle housing with a deviation into the assembly of a finished vehicle and its damage during its exploitation.
The actual depth of the clip can be determined only by a method of a test cleaning. Thus, using the current technology of setting, 100 % of the products should be subjected to an additional operation - cleaning of the interior surface contour and grading according to the actual depth of the defect.

Research of the problem in practice and modeling the process in QForm2DV 8.0.4 (Table 1) showed that the formation of a clip in a final transition is caused by an undercut in the first transition encircling the inner cavity of a semi-finished product. In the 2nd and 3rd transitions the undercut is stamped as a crease and forms a ring clip.

According to A.N. Bryuhanov's [3] recommendations, at setting due to an increase of the outer diameter wall of a semi finished pipe, it's sufficiently resistant against buckling only if the length of the set portion exceeds the wall thickness (t) of the semi finished pipe (Figure 1) no more than 2,5-3 times. It is extremely difficult to comply with this ratio in practice, because inner and outer diameters are limited by the size of the products, and the set has a significant amount of a material. In case of forging with a representative the height of a set portion is 116 mm, which is more than 5 times larger than the wall thickness of the initial pipe.

Table 1. Comparison of theoretical and practical results.

	Theoretical transition	Modeling in QForm2D	The cut of a semi-finished product
Transition 1			
Transition 2			 

Transition 3			

To analyze the process of a semi finished pipe forming, the process of modeling of free 30% settling of the initial height of the pipe by tools of different configuration (Figure 2) in the software QForm3D V 8.0.4 with the following conditions took place: the parameters are close to real conditions of the task (semi finished steel work piece 37CrMo5, DT = 121 mm, t = 22 mm, the heating temperature of the work piece before stamping T = 1220 ° C, the grease on the engraving of the stamp - graphite + water), DT = lim.

Modeling is carried out for tools with parameters Δ = 0.25 ; 0.5 ; 0.75, base angle of α = 0 °; 15 °; 35°; 45 ° and a punch with radius of curvature R equal to the wall thickness t (Figure 2).

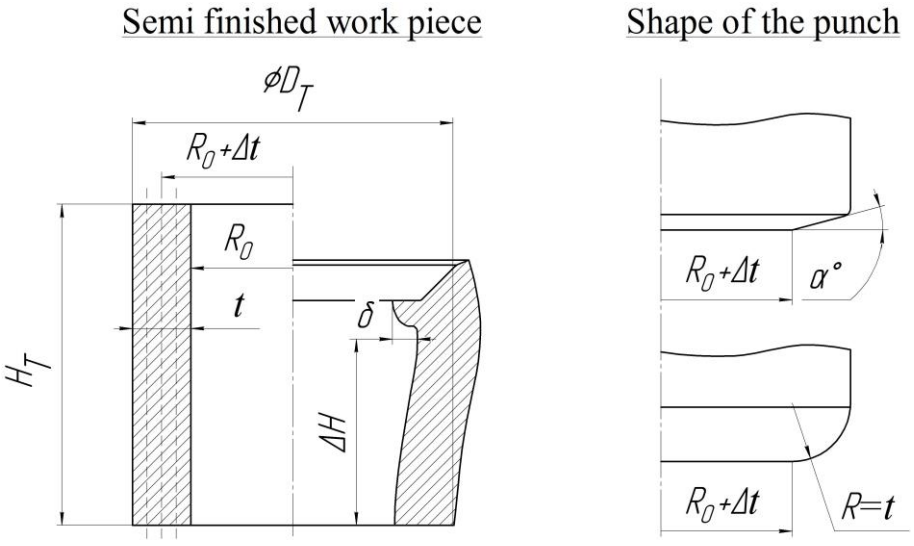


Figure 2. Options of a pipe settling.

It is assumed that the shaping with the tool shown in Figure 2 will minimize the formation of undercuts on the inner contour of the pipe. According to the modeling results (Figure 3) in the case of settling with the tool with parameters R0 + 0,5 t and α = 15 ° the depth of the undercut formation may be reduced by 20% compared with the settling of a punch with a flat butt end α = 0 °.

To prevent the formation of undercuts when setting the 1st setting transition it's proposed to consider the limitation of the semi finished pipe by the outer contour and reduce the diameter of the punch mandrel to provide setting by reducing the inner diameter (Figure 4) [4].

In the current option (Figure 4, a), the mandrel 1 is securely fixed to the insert 2 and a "lock" technology of fixing the upper 2nd and lower 3rd inserts is used, in order to avoid displacement of the upper and lower halves of the stamp setting. In the proposed technology (Figure 4, b) shaping takes place in two stages: the closing of the upper 2nd and lower 3rd inserts, direct setting by the punch 1 moving in the insert-mandrel 2 [5].

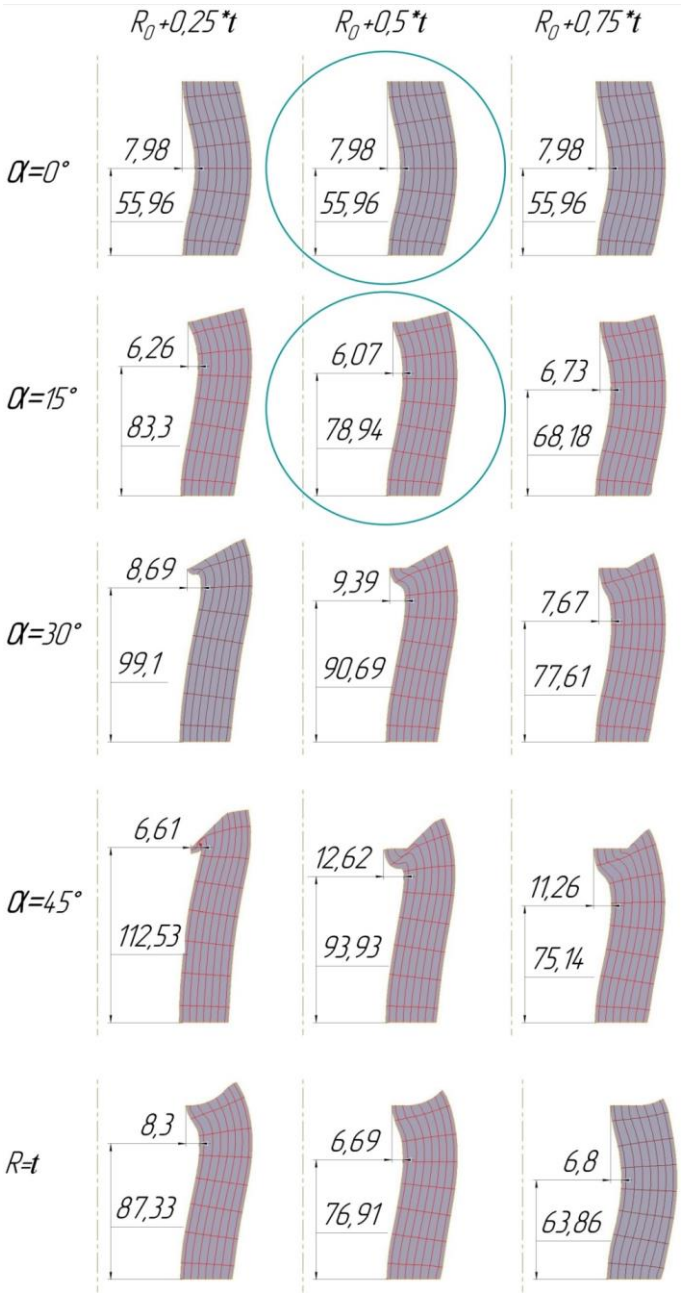


Figure 3. The results of settling modeling with punches of different configurations.

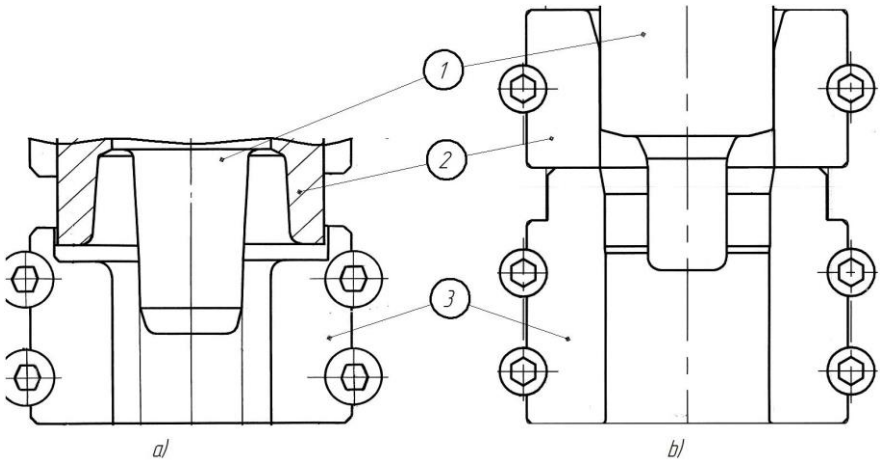


Figure 4. The current and proposed transitions of the1st setting transition.

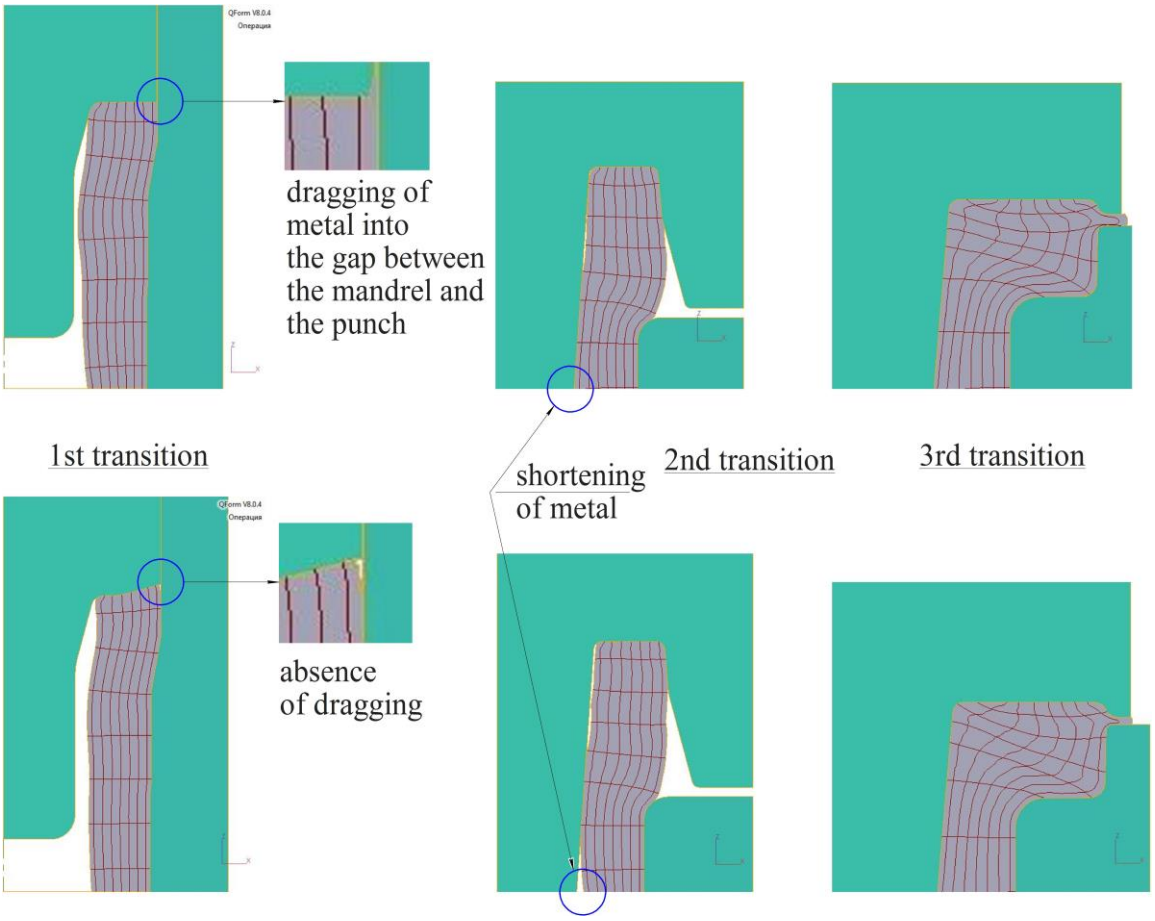


Figure 5. Modeling options for setting of a forging-representative for α = 0 ° and 15 °.

Based on the results of the modeling (Figure 3) further research should be carried out for the second in results tool with a slope of 15 ° (Figure 5). The second and final transition for both versions of setting is the same.

In the first transition the main negative difference between the variant of setting with α = 0 ° is a significant risk of dragging a burr into the gap between the parts of a die rigging. The die rigging and mutual friction of its elements leads to permanent wear and increase of gaps.

In further transitions this deviation would lead to a defect of a burr stamping into the body of a forging. Studying of the 2nd setting transition indicates the predominance of a settling process when setting with a punch slope of 15 °, which is characterized by less need of stamping force. When setting with α = 0 ° the excess in the central part of the 1-st transition of metal in the axial direction of the central punch is reduced.

In the 3rd final setting transition a relatively more uniform arrangement of fibers during the setting of the transition with α = 15 ° is noted.

Based on the above said, for improving the technology of a forging-representative setting of a semi axle housing it is advisable to use a cylindrical punch, having geometrical sizes α = 15 ° C and R0 + 0,5 t. If necessary, according to the recommendations presented in the paper [6], it's possible to determine the change in power during the setting and to estimate the possibility of cracking.

Conclusion.

The cause of a "clip" defect in the existing technology is analyzed and confirmed by modeling. A method for forming setting transition, aimed at the elimination of a "clip" defect in the finished product in the example of a forging -representative of semi axle housing. The proposed method is applicable to the process of setting of similar forgings from semi finished pipes.

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