

TALAT Lecture 3504

Impact Extrusion Design Aspects and Properties

11 pages, 11 figures

Basic Level

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Objectives:

- To describe the forms and shapes which can be fabricated by impact extrusion
- To point out limiting factors in the freedom of design of impacts
- To learn about the factors affecting tolerances and surface roughness of impacts

Prerequisites:

- Basic knowledge about the formability of metals
- Background in mechanical engineering

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3504 Impact Extrusion Design Aspects and Properties

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3504.01 Types of Forms which can be Produced by Impact Extrusion

Figure 3504.01.01 illustrates examples of forms which can be impact extruded from aluminium.

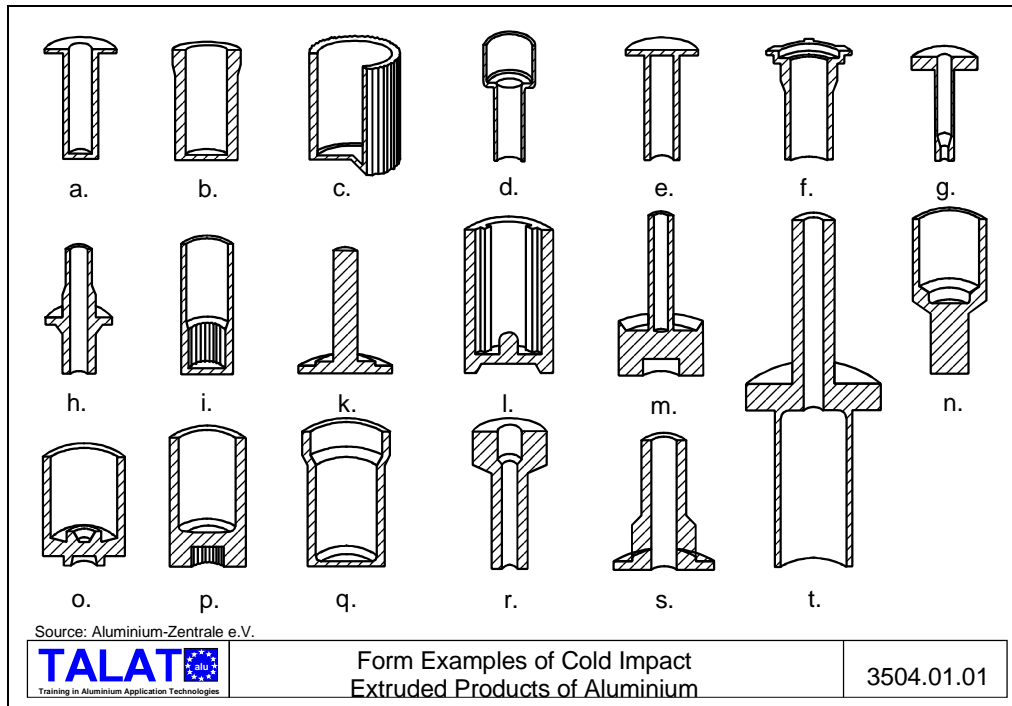


Figure 3504.01.02 describes the characteristics which have to be considered while designing aluminium impacts.

Design characteristics of aluminium impacts

- Circular, oval or rectangular cross-section,
- solid or hollow cross-sections,
- thin, thick, displaced or conical walls,
- solid base with or without holes,
- base with flanges, protrusions, plugs, ears, channels, and stiffeners,
- single or multiple walls,
- inside or outside walls with stiffener ribs,
- undercuttings cannot be produced (exception: lateral impact extrusion)

Source: F. Ostermann

		Design Characteristics of Impacts Made out of Aluminium	3504.01.02
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Figure 3504.01.03 describes the different types of wall forms which can be produced.



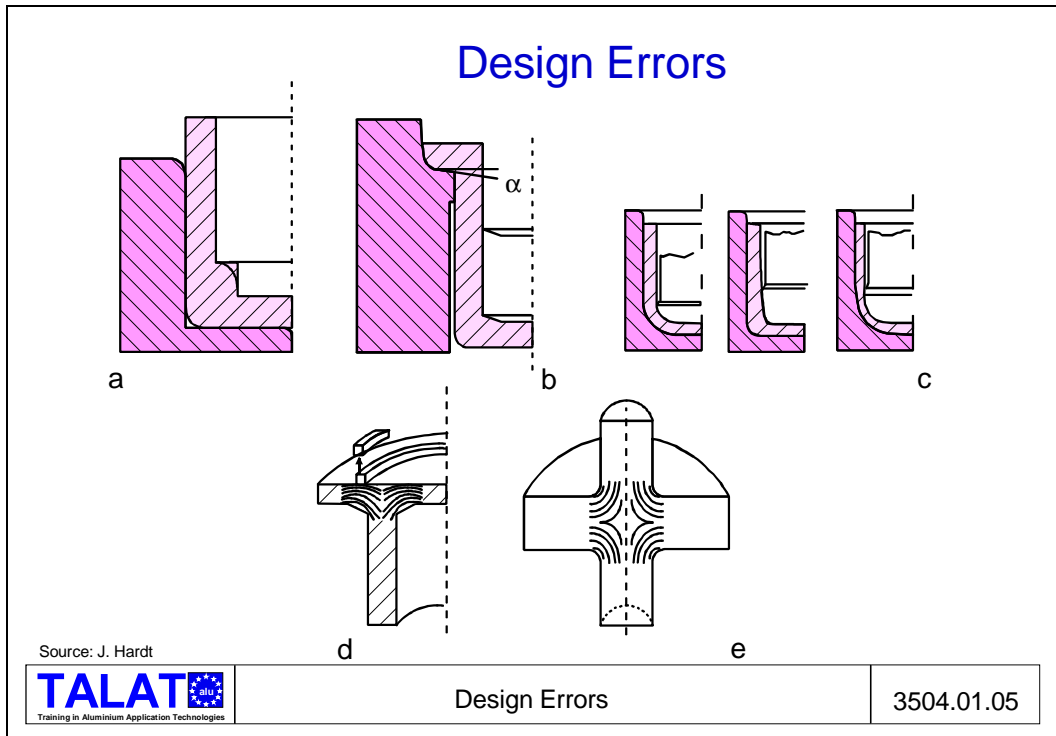
<h2 style="color: blue;">Impact Forms (I)</h2> <p style="text-align: center;">Types of forms which can be fabricated</p> <p style="color: magenta;">(a) Types of wall forms</p> <ul style="list-style-type: none">- no undercuts- circular cross-sections are ideal from pressing point of view, but not essential- for cross-sections which are not circular, at least two axes of symmetry should be present- longitudinal profiles and longitudinal ribs are possible, whereby extreme differences in cross-sections between wall and ribs should be avoided <p style="font-size: small;">Source: Aluminium für techn. Fließpreßteile, vol. 29</p>		
 <small>Training in Aluminium Application Technologies</small>	Types of Wall Forms	3504.01.03

Figure 3504.01.04 describes the different types of base forms which can be produced.

<h2 style="color: blue;">Impact Forms (II)</h2> <p style="color: magenta;">b) Types of base forms</p> <ul style="list-style-type: none">- Variations are possible on both sides of the base.- Symmetry should be strived.- Asymmetry is possible, if the eccentricity is not too large and the length of the pins is not much larger than their diameters.- Bases with thicknesses which vary along the cross-section are possible. The minimum base thickness should be 10 to 25% larger than the wall thickness.- Flat cavities (impressions), e.g. identification markings on the base are possible, provided these markings are not required to be too sharp.- Internally arranged pins should not have a diameter which is larger than $\frac{1}{4}$th of the punch diameter. <p style="font-size: small;">Source: Aluminium-Zentrale e.V.</p>		
 <small>Training in Aluminium Application Technologies</small>	Types of Base Forms	3504.01.04

Limiting Conditions for Work-Piece Forms

Figure 3504.01.05 shows design errors which can be made while designing the aluminium impacts



Rules (see **Figure 3504.01.05**)

- Spiral ribs and flutes on the walls can be made only up to angles less than the self-locking angles.
- The base must be designed thicker than the walls.
- Avoid using punches with recesses having right angles or sharp edges and corners (**Figure 3504.01.05 a**). Likewise, the die should not contain sharp edges or corners.
- Very narrow shoulder angles lead to cracks in the impact (**Figure 3504.01.05 b**).
- The types of punch forms shown in **Figure 3504.01.05 c** are to be avoided, especially for thin-walled parts, since these increase friction, are detrimental for lubrication and increase the centre displacement.
- Forward impact extruded parts with thin flanges should not have any sharp-edged protrusions in the immediate vicinity of the region with the largest deformation strain, since the material flows past these protrusions without filling them (**Figure 3504.01.05 d**).

- If a flange is designed with two strands in the same axis, then the high shear stresses that occur in the core of the work-piece can cause a hole to be created here (**Figure 3504.01.05 e**).

3504.02 Factors Affecting the Manufacturing Tolerance

Figure 3504.02.01 illustrates the factors which affect the production tolerances for impacts. In order to achieve high production lives, the tools used are constructed so that at the commencement of operations, the external (outside) diameter conforms to the lowest and the diameter of holes in the work-piece conform to the highest value of the tolerance range. Under these conditions, it is possible to polish worn tools a number of times in order to improve the surface conditions.


The elastic deformation of the machine causes deviations in the base thickness and eventually in extensions which depend on the distance between punch and die. These deviations are larger, the closer the forming force approaches the rated power of the press. The operating condition of the machine is important to avoid aligning errors. Too high a slack in the punch leads to a misalignment and a displacement of the axis of the inside and outside diameters. If, after years of operation, the clamping surface of the die is no longer at right angles to the punch or the axis of the punch direction of movement, the machine has to be reworked so that it can still operate with an acceptable amount of tolerance. Tool wear in the modern high-production impact extrusion presses for light metal alloys should be controlled using a statistical quality control method.

Factors Affecting the Manufacturing Tolerances

The tolerances attained during impact extrusion depend on the following factors:

- Precision with which the tool is manufactured and aligned
- Operating condition and distortion of machine and tools have a major influence on dimensional errors of impacts
- Precision with which the semifabricated and raw parts are fabricated
- Surface treatment of the raw parts

Source: Günter Brix

	Factors Affecting the Manufacturing Tolerances	3504.02.01
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During the production of semifabricates, care must be taken to assure that the sheet used for producing blanks has a uniform thickness or that the round rods from which the


slugs are sawed out are produced with narrow tolerances. Normally, the tolerances laid down for sheets and rods in the DIN standards are too large for semifabricates which are to be used to produce the raw material for impact extrusion. Efforts must be undertaken to ensure that the weights of semifabricates produced vary only within a very narrow range. Furthermore, the outside diameter of the raw part (starting stock) should be as uniform as possible.

Deviations in the properties of the material often have a very difficult to assess influence on tolerances of the work-piece. These cause dimensional as well as form and alignment errors. Differences in grain sizes lead to deviations in the length of the impacts which cause problems during the automatic removal from the machine and during the subsequent working.

The surface treatment of the raw material, especially the lubrication, has an effect on the production tolerances. Too much lubricant on the raw material leads to larger alignment errors, since the punch tends to swim on this excess lubricant and slip over the material [3].

The tolerance of an impact is made up of dimensional errors, alignment errors and form errors [4], see **Figure 3504.02.02**.

Dimensional errors are deviations of the actual dimensions from the specified values laid out for certain reference distances in the drawing, e.g., deviations in base thicknesses, the outside and inside diameters as well as lengths. Alignment errors are displacements of the axes relative to each other. Thus, a parallel displacement of the inside and outside diameter axes results in the impact being thicker on one side than at the other. Form errors are deviations of the actual form from that specified, i.e., ovalisation, taper of outside diameter occurring, eg., during the use of conically ground dies for tubes and due to a bending of the work-piece due to several reasons [3].

<h2 style="color: blue;">Production Tolerances</h2>		
The tolerance of an impact is made up of:		
<input type="checkbox"/>	Dimensional errors:	Deviations from required dimensions (inside and outside diameters, ...);
<input type="checkbox"/>	Alignment errors	: Displacements of the axes from their desired positions (eccentricity, angular deviation, ...);
<input type="checkbox"/>	Form errors	: Deviations from the required geometrical form (ovalization, bending, ...);
Source: VDI-Richtlinie 3138, part 1		
	Production Tolerances	3504.02.02

Reference Values for Determining the Allowable Tolerances for Simple Impacts

The correct choice of tolerances influences the economy of the process as well as the operating life of the tools and is often the decisive criterion for determining whether the part can be produced at all by impact extrusion. On the other hand, a judicious design is an essential factor in determining whether the required tolerances can be adhered to. Since the type and amount of tolerances depend on many factors, no general guidelines and rules can be laid out for determining these. Reference values for determining the tolerance as a function of dimension are shown in **Figure 3504.02.03** for simple, axially symmetrical impacts. In spite of this, it can be necessary in some cases to reach an agreement with the manufacturer regarding allowable tolerances [5].

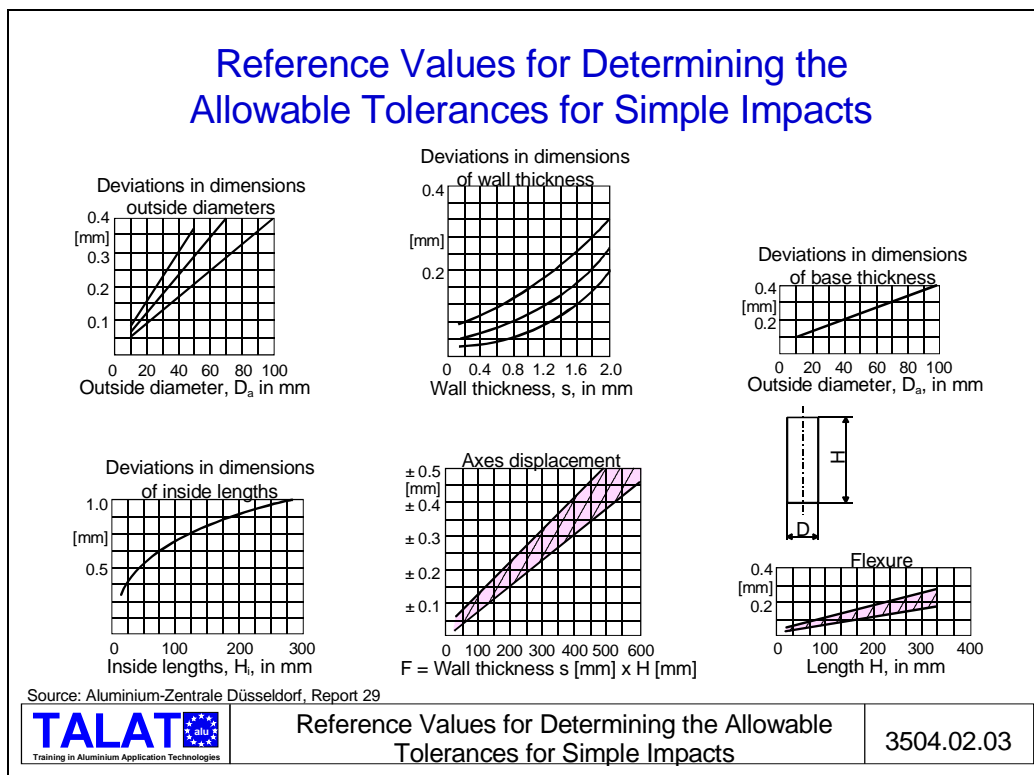


Figure 3504.02.04 explains the reasons which cause dimensional deviations to occur in the impacts.

Causes of Tolerances During the Impact Extrusion of Aluminium

- Inconsistency of material properties
- Inconsistency of heat-treatment and surface treatment (lubrication)
- Precision with which semifabricates and slugs or blanks are produced
- Precision of tool during manufacturing and assembly
- Operating condition and distortion of machine and tools

Source: VDI-Richtlinie 3138, part 1



Causes of Tolerances During the Impact Extrusion of Aluminium

3504.02.04

Factors Affecting the Surface Roughness of Impacts

Normally, impacts have surfaces of high quality with practically no notches on the surface, which could lead to stress concentrations, and a good resistance to wear. Since the surface roughness depends on numerous factors, a certain amount of scatter of this property is unavoidable [4], see **Figure 3504.02.05**.

Factors Affecting the Surface Roughness of Impacts

- Surface quality produced with impact extrusion combined with supplementary fabricating processes (including dimensional variations of the preformed or raw parts)
- Surface quality or surface condition of tools
- Lubricants and methods of their application
- Deformation strain in connection with flow conditions
- Grain size in microstructure

Source: VDI-Richtlinie 3138, part 1

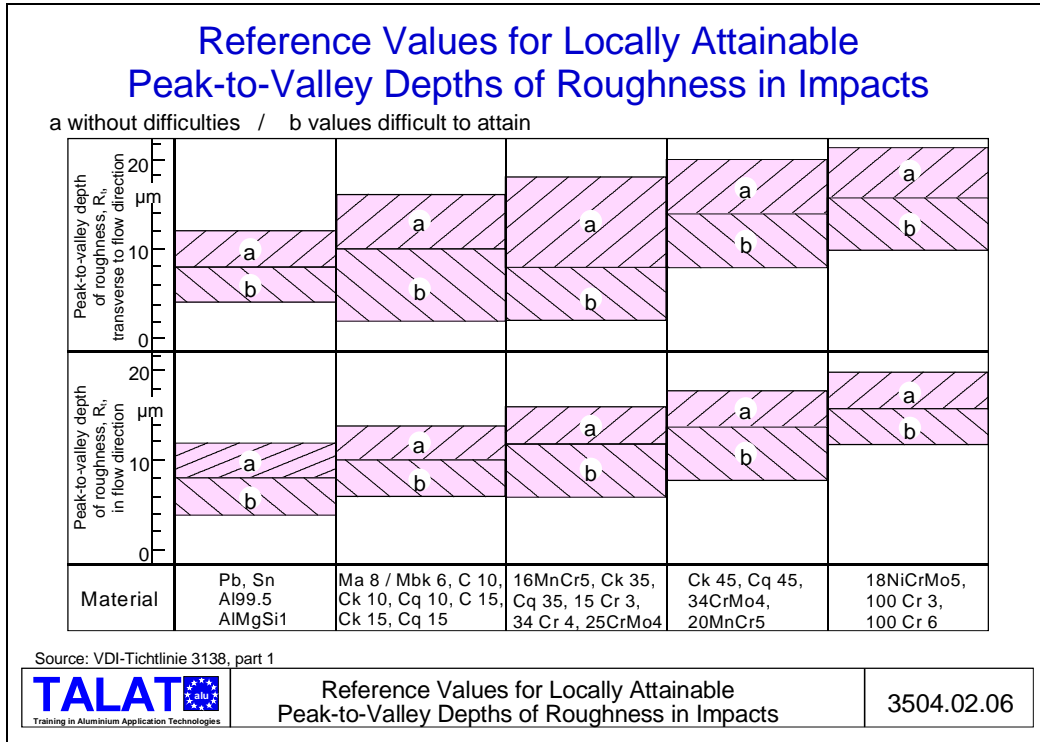


Factors Affecting the Surface Roughness of Impacts

3504.02.05

Different values for peak-to-valley depths of roughness, R_t , are obtained in the impact extrusion direction and transverse to it as well as on or under the phosphate coating or

lubricant layer. **Figure 3504.02.06** shows reference values for a charge of approximately 10,000 impacts. For steel impacts, the whole range of roughness depths are valid. For nonferrous metals, the lowest values for the depicted range can be generally attained. The term "difficult to attain values" refers to the special surface finishing for the tool parts subjected to wear as well as their repeated replacement [4].



3504.03 Literature

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- [3] D. Brix: Kaltfließpressen von Leichtmetall - Qualität und Wirtschaftlichkeit. Draht (1975)5, p. 216 - 219.
- [4] VDI-Richtlinie 3138: Kaltfließpressen von Stählen und Nichtmetallen, Grundlagen, Blatt 1. Berlin: Beuth-Verlag 1970.
- [5] Aluminium-Zentrale e.V., Report No. 29 "Aluminium für technische Fließpreßteile", Dusseldorf, 1982.

3504.04 List of Figures

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3504.02.04	Causes of Tolerances during the Impact Extrusion of Aluminium
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