TALAT Lecture 3505

Tools for Impact Extrusion

10 pages, 10 figures

Basic Level

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Objectives:

– To provide knowledge about design philosophy and tool materials for impact tools, which are a cost factor and eminently important for successful impact extrusion

Prerequisites:

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

Date of Issue: 1994

3505 Tools for Impact Extrusion

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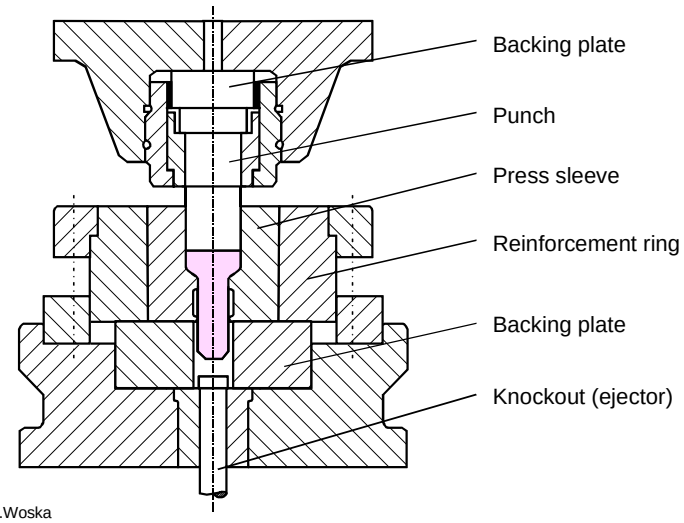
3505.01 Construction of Impact Tools

Considering the high cost of process and tool development, impact extrusion should best be used for medium to large production series. This means that the impact extrusion tools should be designed for a high life. In practice, one usually uses tool systems which consist of standardised base frames and interchangeable inserts specific for the work-piece. These inserts are mostly punches, sleeves (usually as a reinforced formation) and counter punches or ejectors. Tools used for impact extrusion of aluminium are subjected mainly to wear. Tool breakage during the impact extrusion of aluminium occurs rather seldom. Production of impacts made of high-strength and deformation resistant aluminium alloys is only successful with high-strength tools with complicated geometrical forms.

The basic construction of tools is similar for all impact extrusion processes. **Figure 3505.01.01** shows the construction of a tool for „solid forward“ impact extrusion. Guiding column frames, available as standardised elements, can be utilised as a useful help for assembling and aligning, but is not suited for absorbing lateral forces which occur during pressing. Normally, horizontal toggle-lever presses are used for the single step impact extrusion of aluminium.

Construction of Impact Extrusion Tools

Tool for Solid Forward Impact Extrusion



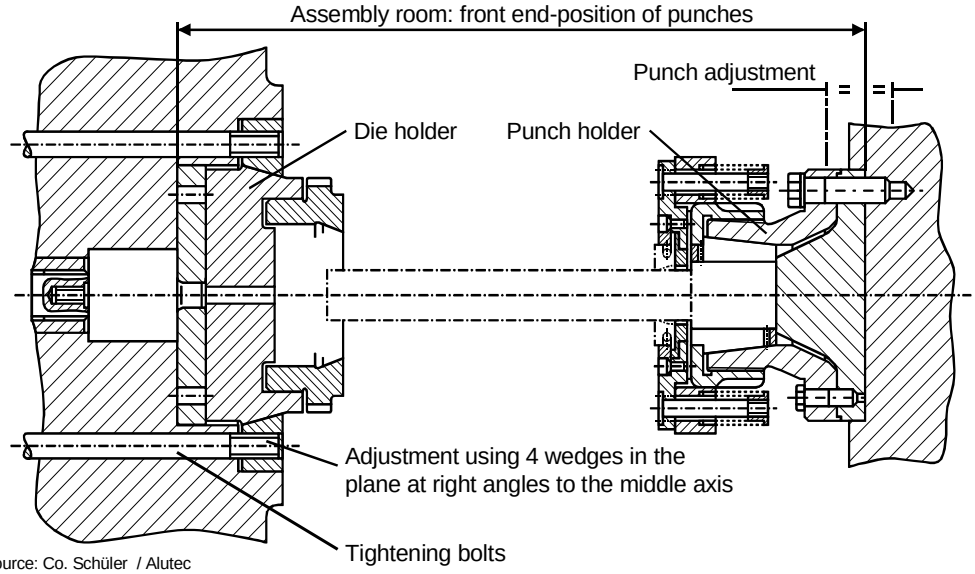
Source: R.Geiger / R.Woska

TALAT Training in Aluminium Application Technologies	Construction of Impact Extrusion Tools	3505.01.01

The assembly room of a horizontal toggle-lever press is illustrated in **Figure 3505.01.02**. The alignment of die and punch is made possible by using wedges on the die side.

Tool assembly and construction

Tool assembly room of a horizontal toggle-lever press

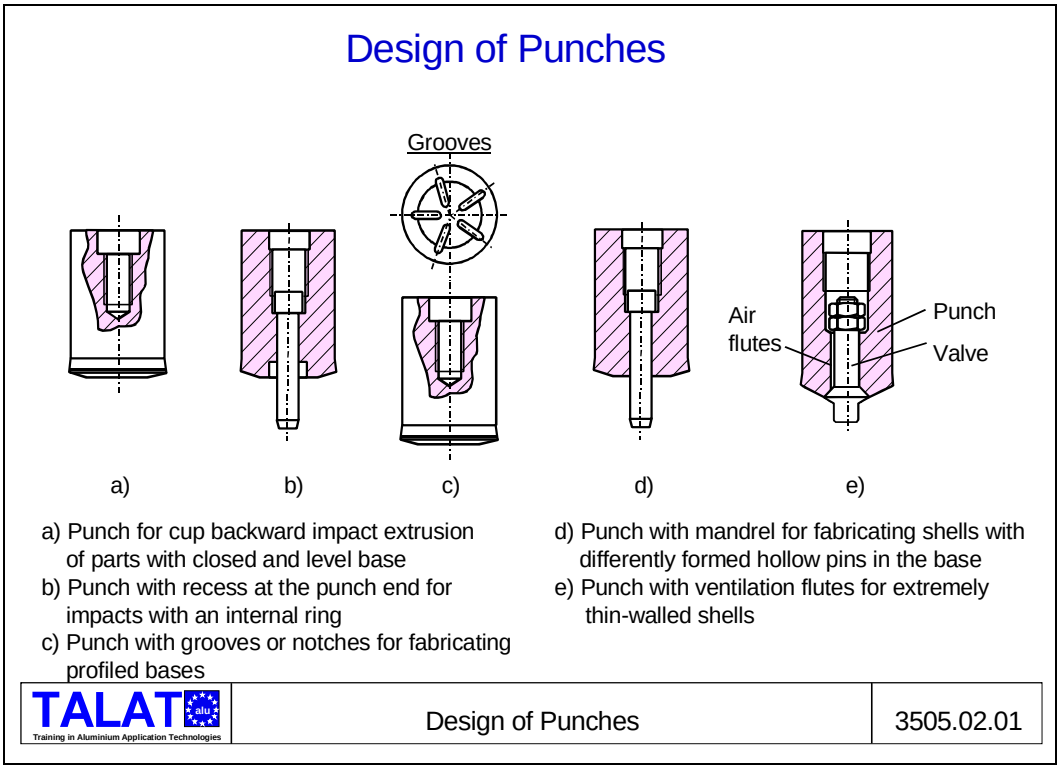


Source: Co. Schüler / Alutec

TALAT Training in Aluminium Application Technologies	Horizontal Toggle-Lever Press	3505.01.02

3505.02 Design of Punches

The punch is a component subjected to high stresses. The loading it is subjected to is of the compressive and buckling type. The buckling load is minimised by using as short punches as possible. For this purpose, a punch head is screwed on to the punch shaft with a reamed bolt. **Figure 3505.02.01** illustrates the most commonly used punch head forms for the „cup backward“ impact extrusion of cans, tubes and shells.



3505.03 Design of Press Sleeves

The design and calculation of a press sleeve depends on the form of the work-piece and on the stresses occurring during the forming.

The press sleeves used for solid and for hollow impact extrusion are usually single-piece types or types which are split longitudinally or transversally. Single-piece types are usual for low press forces as in the case of pressing aluminium. For longitudinally split sleeves, a die insert with an oversize of 2 to 4 parts per thousand in diameter is used. For cup impact extrusion of aluminium, single-piece and two-piece transversally split dies with ejectors are normally used. For the cup impact extrusion of aluminium tubes, single-piece dies without ejectors are usual. For transversal splitting, an axial pre-strain is recommended, in order to prevent an opening-up of the transverse joint under the

axial forces and thus allowing material to flow into the gap during forming (**Figure 3505.03.01**)

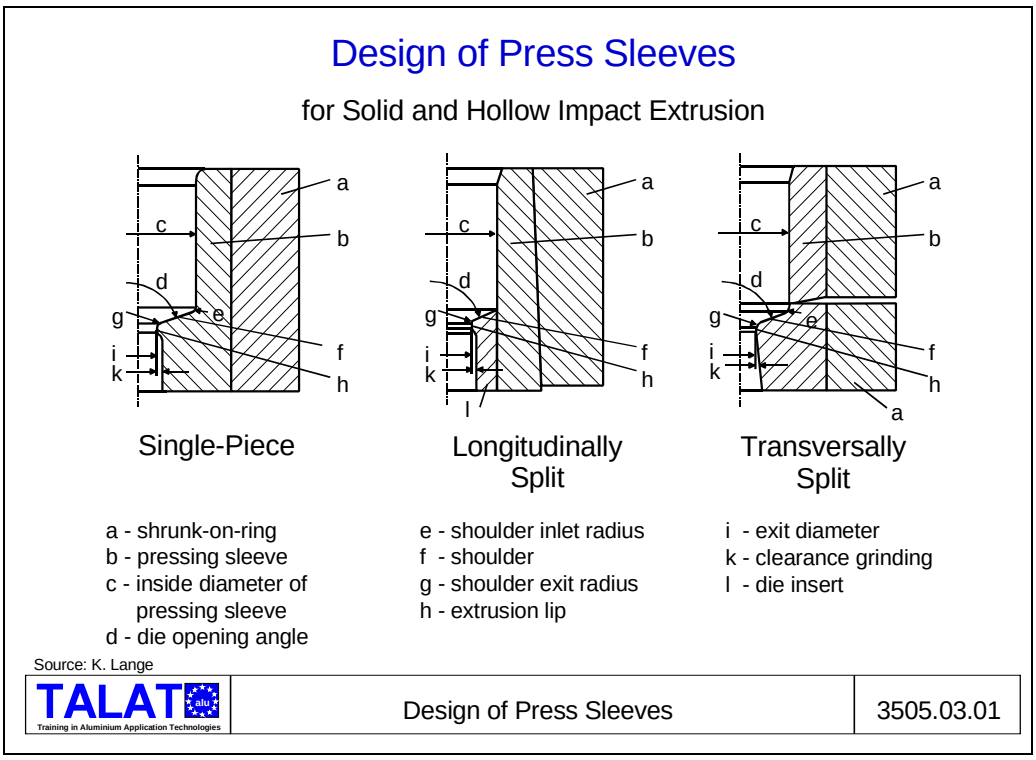
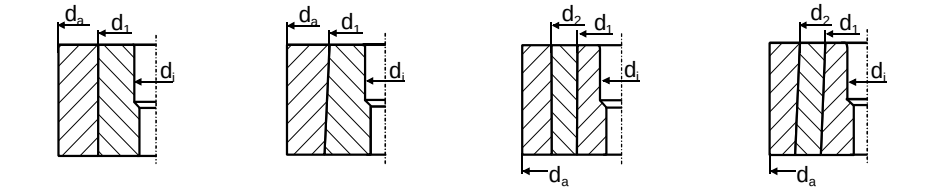


Figure 3505.03.02 shows several variations in construction of reinforced press die combinations. Reinforced and radially prestrained dies are essential for pressing high-strength aluminium alloys. Press sleeves are prestrained radially by slipping reinforcement rings over them. The number of rings used depends on the magnitude of the internal pressure acting on the die, on the tool material as well as on the available assembly space.

Variations in Construction of Press Die Combinations



Simple reinforcement cylindrical joint | Simple reinforcement conical joint | Double reinforcement cylindrical joint | Double reinforcement conical joint

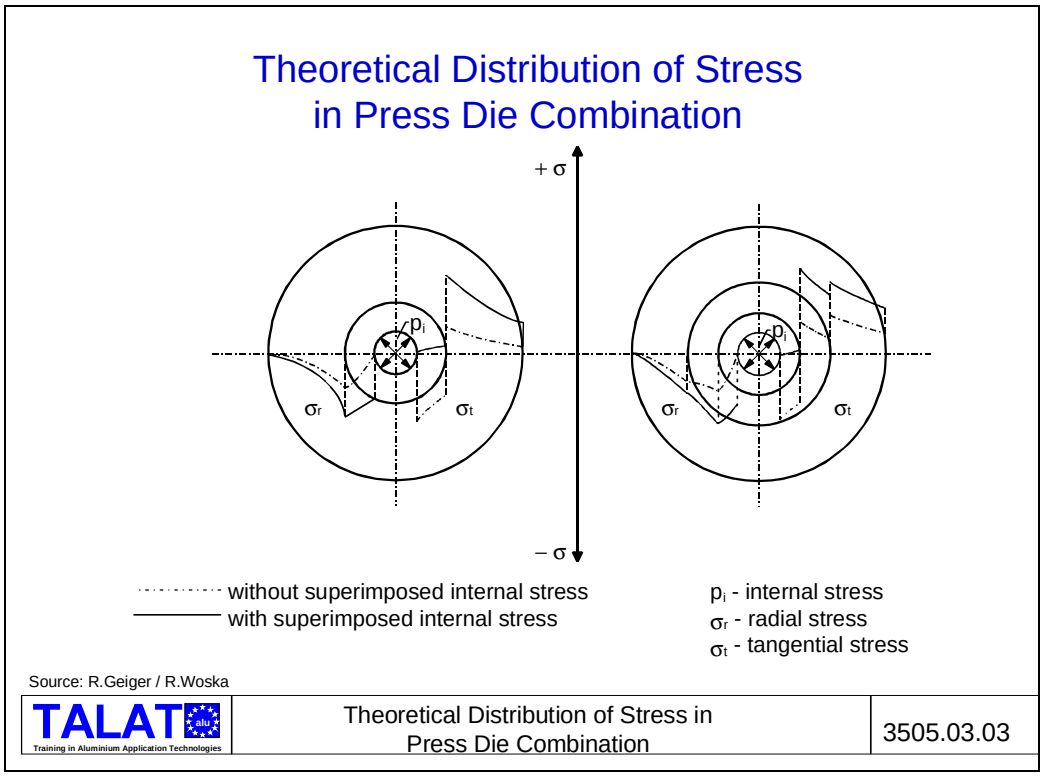
Internal Stress p_i N / mm²	Number of Reinforcement Rings	Diameter Ratio d_a / d_i	Approximation Equation for joint Diameter d_f mm
up to 1.000	0	2 to 4	-
1.00 to 1.600	1	2.5 to 4	$d_1 >> 0.9 \times (d_a \times d_i)^{1/2}$
1.600 to 2.000	2	3 to 4.5	$d_1 : d_i = 1.6$ to 1.8 $d_2 : d_i = 2.2$ to 2.8

Source: K.Lange

TALAT Training in Aluminium Application Technologies | Variations in Construction of Press Die Combinations | 3505.03.02

Combined dies (die bindings) can be calculated using the VDI guideline 3186 or roughly constructed using the guide values given in the table in **Figure 3505.03.02**. Since the internal pressures created during the impact extrusion of aluminium and its alloys seldom exceed 1,500 N/mm², simple reinforcements are sufficient to equalise the tangential tensile stress in the inside wall.

Figure 3505.03.03 illustrates the theoretical stress distribution that occurs in the individual parts of a reinforced combination with and without a superimposed internal stress. It can be seen here that the tangential tensile stress is clearly reduced. If a proper type of reinforcement is used, overloading cracks in the press sleeves can be reliably avoided.

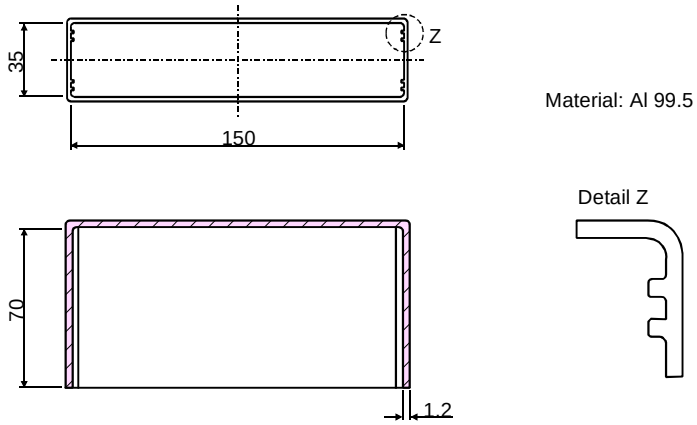


3505.04 Example of an Impact Tool

Aluminium cups with various ratios of lengths to breadths are impact extruded. Rectangular cups having a length to breadth ratio of less than 1.5 can, as a rule, be easily produced. In the printed circuit board holder, shown in **Figure 3505.04.01**, for the electronic industry, the ratio between length and breadth is unfavourable, so that the material flow during impact extrusion causes the holder to crack along the middle of the longer side. Besides this, warping can occur at the opening and along the longer side.

Example of an Impact Extrusion Tool

Integrated Circuit Board Holder



Source: M.Kammerer

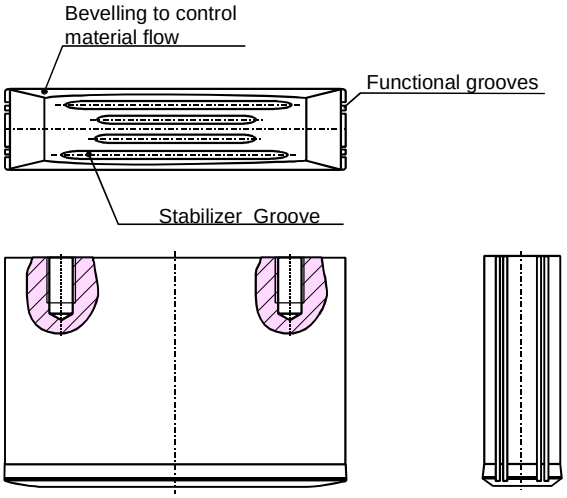
TALAT Training in Aluminium Application Technologies	Impact Extruded Board Holder	3505.04.01

By a proper choice of lubricants and by optimising the punch form, it is possible to influence the material flow in such a manner that the impact produced is true to form and within the required tolerance. The punch form can be optimised as described below.

In order to have a favourable material flow, the short sides of the punch are bevelled, as shown in **Figure 3505.04.02**. Grooves cut into the end face of the punch make the material flow slower and at the same time help to give the punch lateral stability during the pressing operation.

Example of a Tool

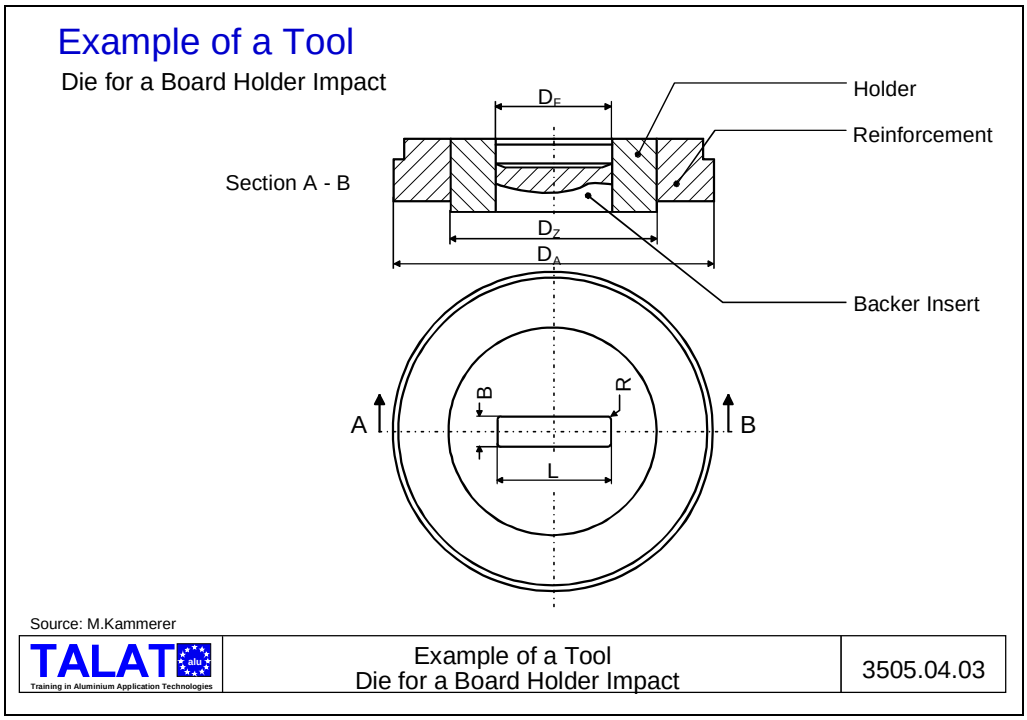
Punch for an Integrated Circuit Board Holder Impact



Source: M.Kammerer

TALAT Training in Aluminium Application Technologies	Example of a Tool Punch for a Board Holder Impact	3505.04.02

Figure 3505.04.03 shows a sketch of a die combination with a base insert which was used to produce the board holder impact.

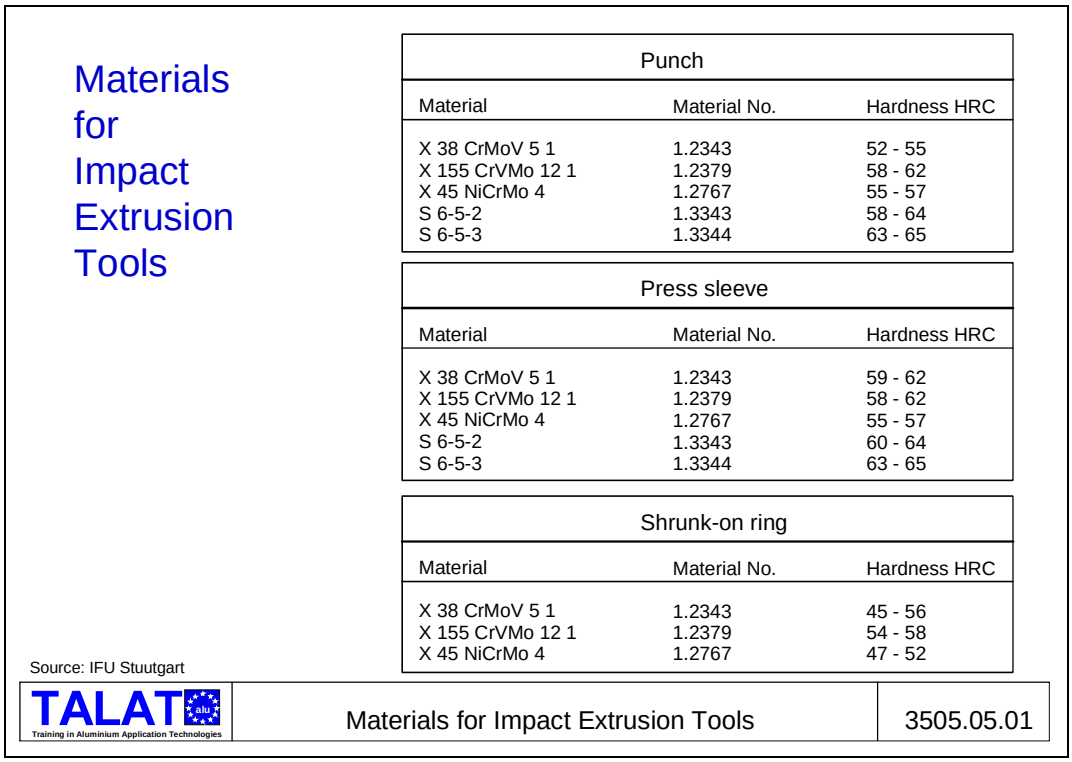


3505.05 Materials for Impact Tools

Due to the loads and stress levels in impact extrusion tools, the tool materials must have high strengths, hardness, toughness and wear resistance. For this reason, the material chosen is always a compromise solution. The most important criteria for the choice of tool material are:

- Type and magnitude of tool stresses
- Construction and geometry of the tool
- Number of parts to be produced and the required work-piece tolerances
- Toughness and fatigue behaviour
- Wear resistance
- Compressive and tensile strength
- Ease of machining and cost of tool material

Figure 3505.05.01 lists materials for impact tools. Tools for impact extrusion are mostly made of tool steels. These have the advantages of low material and working costs as well as high toughness and strength.



Sintered carbides are most suitable when a high wear resistance is required, as is the case with tools required to produce a large series of parts or with tools having narrow tolerances.

High speed steel gives a good combination of wear resistance and toughness. According to one company, high speed steel should not be used for surfaces which come into contact with light metals during impact extrusion. For these purposes, a 12 % Cr steel should be used. The 12 % Cr steel has a high hardness retention and strength at high temperatures and should, therefore, also be utilised for tools which are subjected to high temperatures.

3505.06 List of Figures