TALAT Lecture 4102

Clinching

13 pages, 14 figures

Basic Level

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Objectives:

- to describe the detailed processes of single-step and multiple-step clinching
- to show the differences of the various clinching methods concerning the amount of shearing
- to illustrate the major differences in mechanical properties of clinch joints compared with resistance spot welds

Prerequisites:

- General mechanical engineering background
- TALAT Lecture 4101

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4102 Clinching

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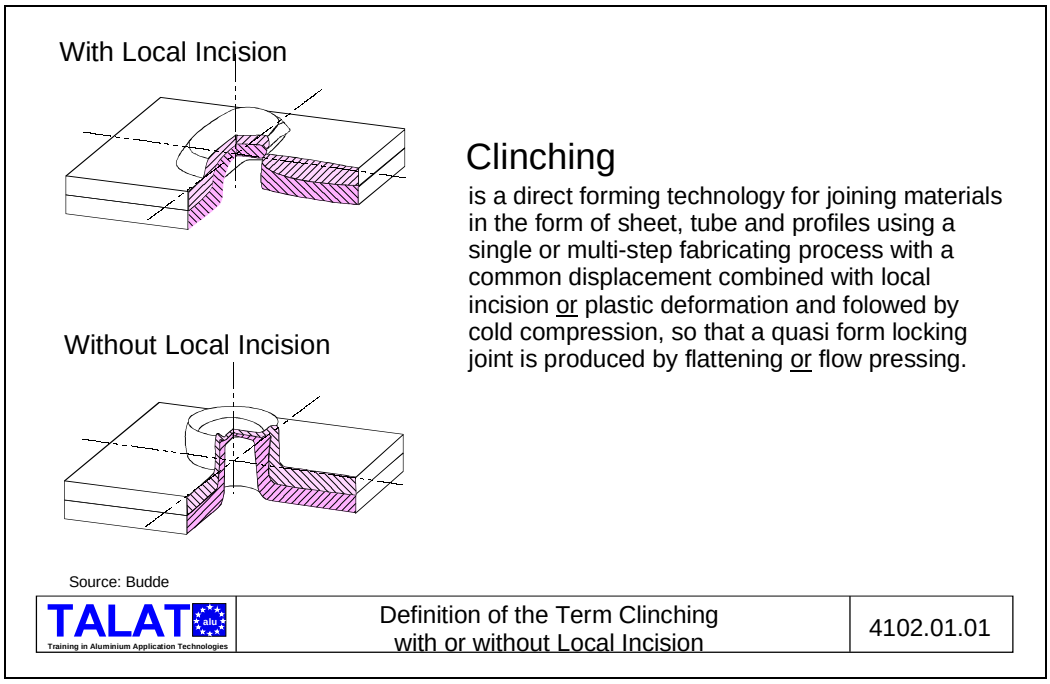
- **Definition of the Term Clinching With or Without Local Incision**

Compared to the state of development of conventional fastening methods, the clinching technology for joining shaped sheet components and sections is still new, although the first patent for this process was granted as early as 1897.

Clinching is a direct joining of materials using the forming technology. A flattening or material flow (impact extrusion) creates a quasi form locked joint (**Figure 4102.01.01)**.



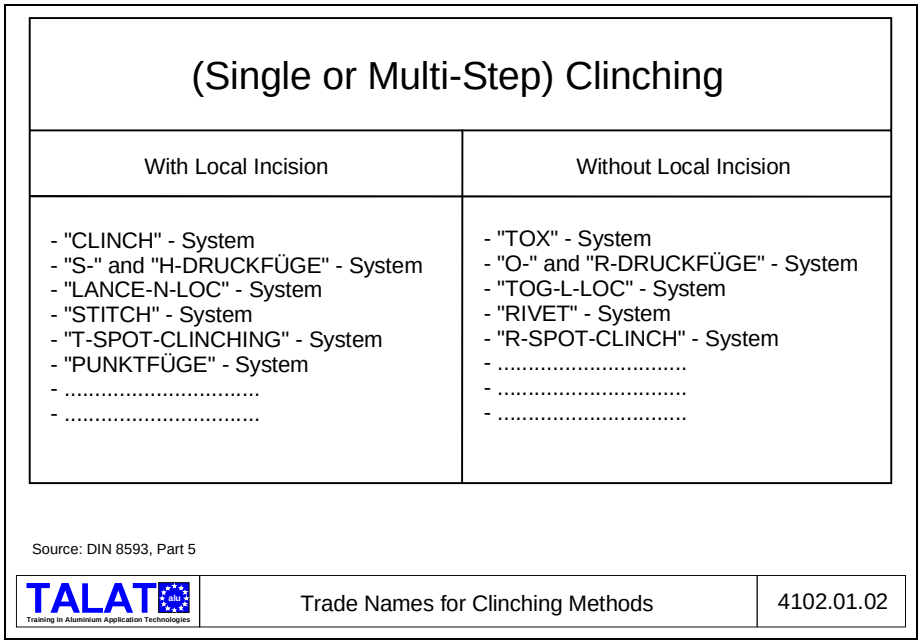
- **Trade Names for Clinching Methods**

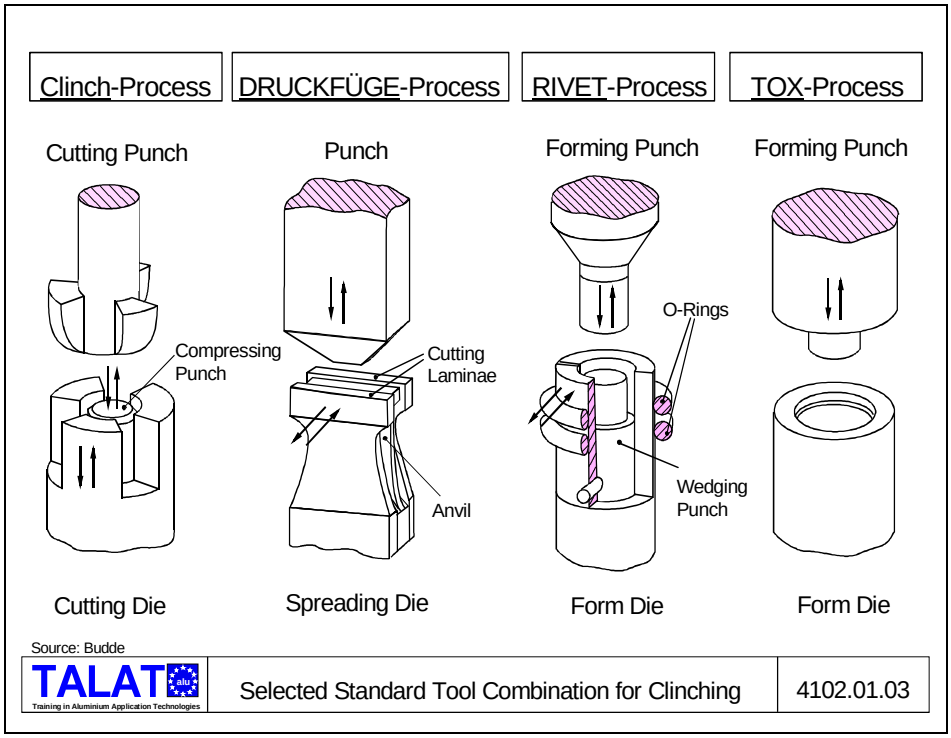
Within the scope of the general definition for clinching, each company is free to choose an own name, which generally reflects the tool design used for the fastening process.

As a result, the individual process variations used in the metal processing industry are better known under their trade names (**Figure 4102.01.02**).

- **Selected Standard Tool Combinations for Clinching**

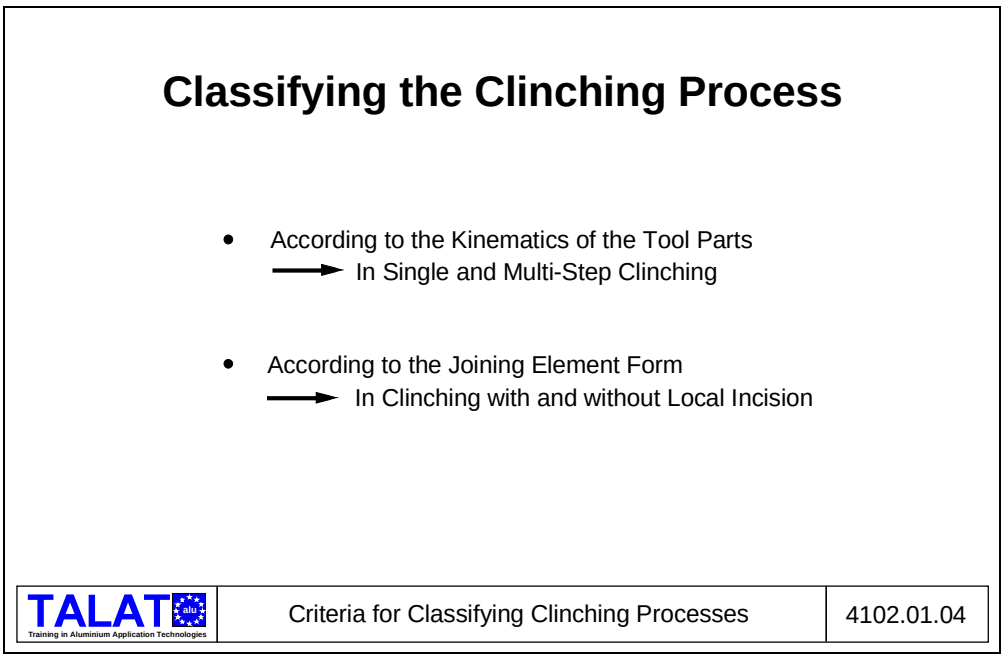
A selection of standard tools for clinching based on local incision and/or forming processes illustrates the high state of the art for these mechanical fastening methods (**Figure 4102.01.03**).
The joint strengths that can be attained depend, among others, on tool design so that the tools for the individual clinching processes are being constantly developed and improved.





- **Criteria for Classifying Clinching Processes**

Based on the DIN standard 8593, part 5, it is possible to characterise clinching either according to the kinematics of the tool components (single or multi-step clinching) or the shape of the joint itself (clinching with or without local incision, see also **Figure 4102.01.04**).



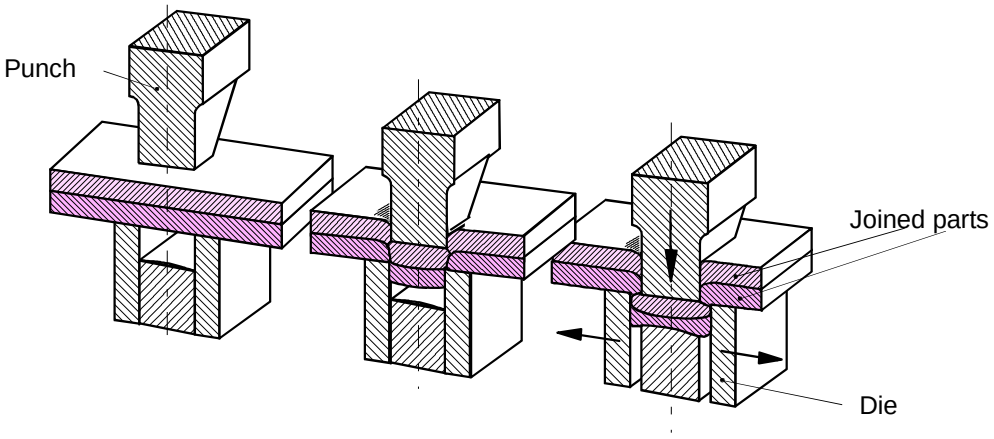
4102.02The Clinching Process

- Process steps in single-step clinching with local incision
- Process steps during two-step or multi-step clinching with local incision
- Geometry of a clinched joint formed by clinching with or without local incision
- A comparison of the properties of clinched joints and spot welded joints
- Process steps of a single-step clinching process without local incision (die with movable parts)
- Process steps of a single-step clinched joint without local incision (die without movable parts)
- Formation of a flat clinch element without local incision
- Process steps of a multi-step clinched joint without local incision
- Comparison of clinch elements with varying local incisions and formed parts
- Holding and stripping systems for clinching

- **Process Steps in Single-Step Clinching with Local Incision**

Clinching with local incision creates an undetachable (permanent) joint under the combined action of shear and penetration processes, in which the penetration and incision limit the joint region, and a cold compression process, in which the sheet material pushed out of the sheet plane is compressed and flattened in such a manner that a quasi form locked joint is created.

The single-step clinching process derives its name from the fact that the joint is created during an uninterrupted stroke of a single tool component (**Figure 4102.02.01**).



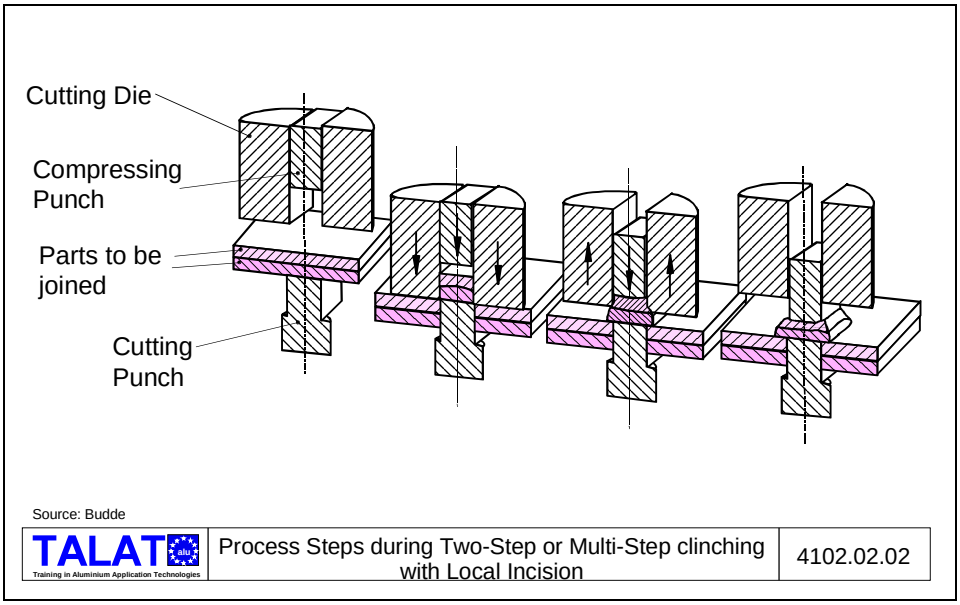
Source: Budde

TALAT Training in Aluminium Application Technologies	Process Steps in Single-Step Clinching with Local Incision	4102.02.01

- **Process Steps During Two-Step or Multi-step Clinching with Local Incision**

The clinch joining element of a two-step or multi-step clinch process with local incision is created under the action of successive motions of the tool components .

Although the multi-step clinching process works, unlike the single-step clinching process, with a single tool combination for the corresponding joint geometry, this process, because of its more complicated alignment technique, has not been very successful till now (**Figure 4102.02.02**).



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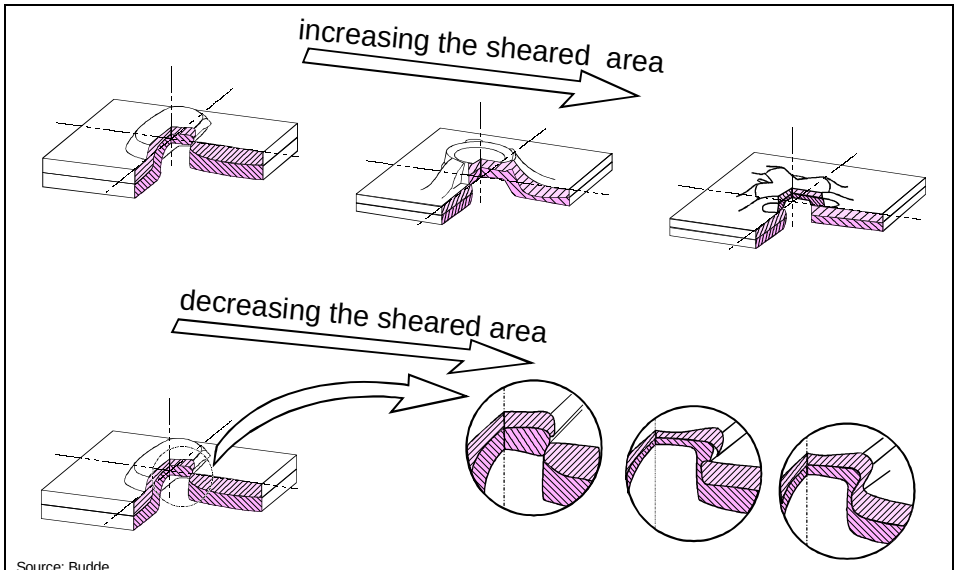
TALAT Training in Aluminium Application Technologies	Process Steps during Two-Step or Multi-Step clinching with Local Incision	4102.02.02

- **Geometry of a Clinched Joint Formed by Clinching With or Without Local Incision**

In recent years, a large number of fastening elements, based on the principles of the clinched joint element, have been developed.

Characteristic for all these recent developments is an increase in the joint strength resulting from the enlarged shear area as well as from the reduction of the locally incised part which is replaced by a corresponding increase in the plastically formed part (see **Figure 4102.02.03**).



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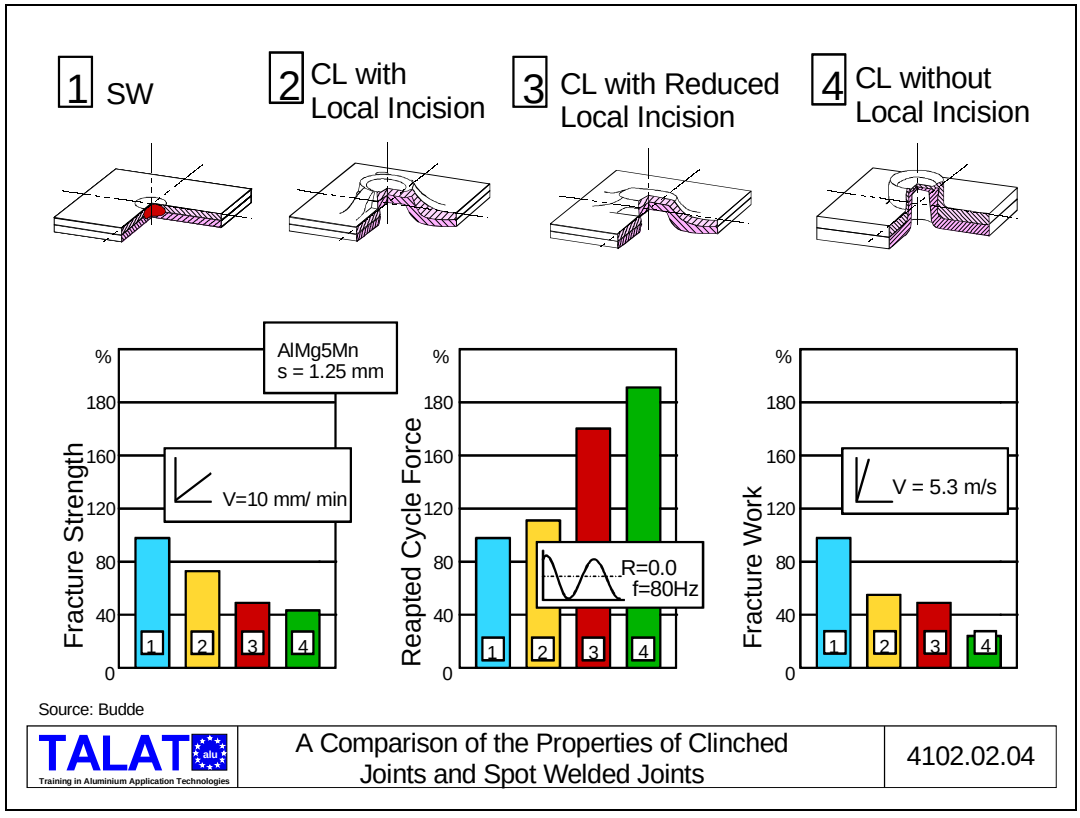
TALAT Training in Aluminium Application Technologies	Geometry of a Clinched Joint Formed by Clinching with or without Local Incision	4102.02.03

- **A Comparison of the Properties of Clinched Joints and Spot Welded Joints**

Results of experiments with single-element clinch fastenings with various locally incised and formed parts as well as various shear areas demonstrate that under quasi static and dynamic impact loadings, these joints do not attain the strength of a single spot welded joint (see **Figure 4102.02.04**). This result is also valid for clinch joints with enlarged clinched elements.

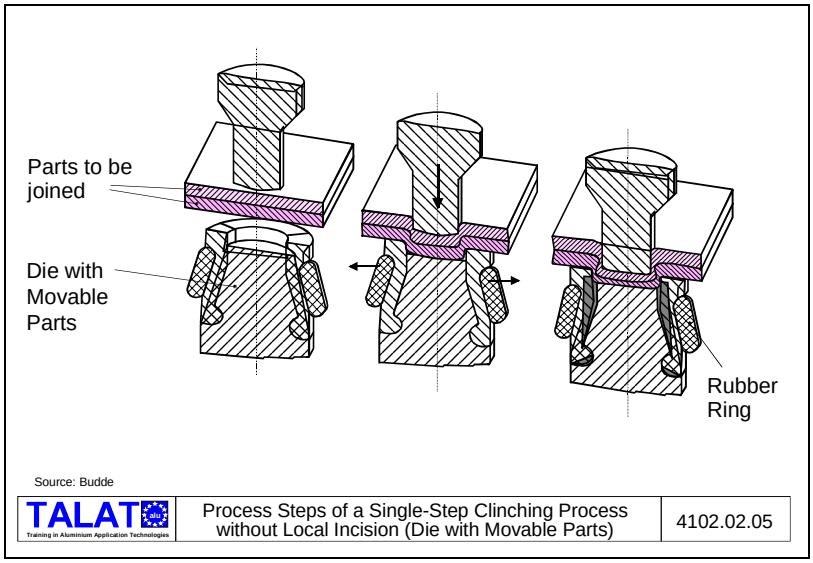
On the other hand, in the case of dynamic loading, the strength of clinched joints is superior to that of spot welded joints, especially if the local incision is reduced in favour of the formed part, thereby reducing the notch action.



- **Process Steps of a Single-Step Clinching Process without Local Incision (Die with Movable Parts)**

In the clinching process without local incision, a combined penetration and clinch operation (whereby the fastened region is limited by the penetration) is followed by a cold compression process (whereby the displaced volume of material is flattened by compression) leading to a quasi form locked joint formed by material flow (impact extrusion) (see **Figure 4102.02.05**).

The displaced material of the clinch joint, relevant for the fastening strength, is formed by the varying flow characteristics of the material on the die and punch sides.

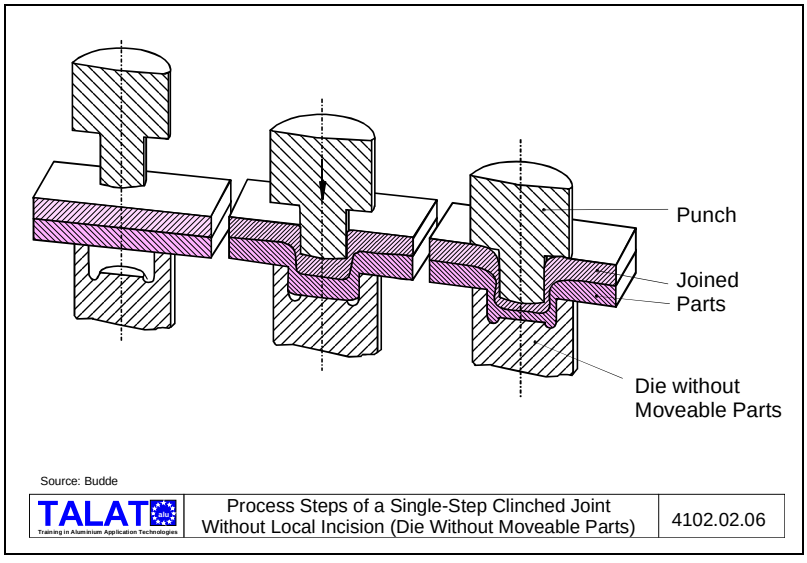


- **Process Steps of a Single-step Clinched Joint without Local Incision (Die without Movable Parts)**

Tool systems with and without moving parts have been designed for the single-step clinching process without local incision .

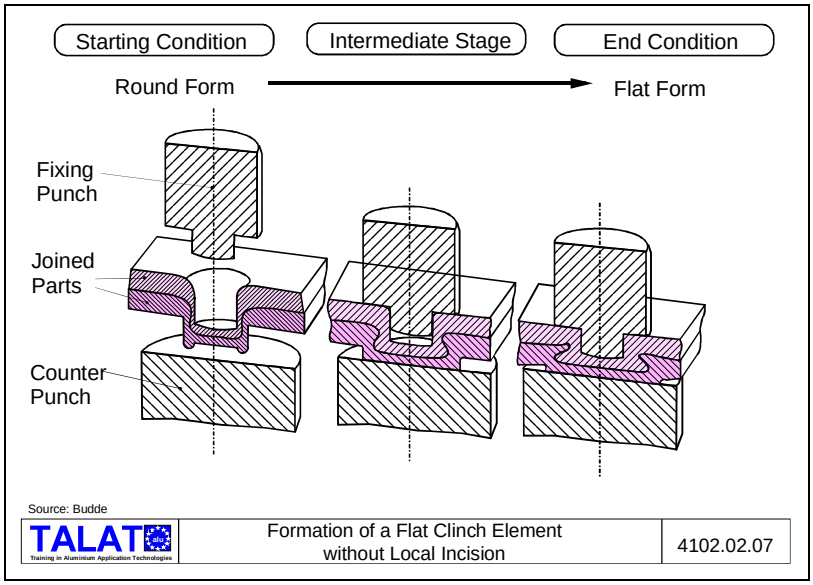
During the single-step clinching process with movable die parts, the different flow characteristics of the material of the parts to be joint is caused by a yielding of the sheets. On the other hand, in the single-step clinching process without movable parts, a grooved ring in the die forces the displaced material of the sheets to flow differently (**Figure 4102.02.06**).

The advantage of the die without moving parts lies in the absence of wear of the components. The disadvantage is that oiled aluminium sheets can lead to the formation of a "hydrostatic cushion" in the closed die, leading eventually to the destruction of the die.



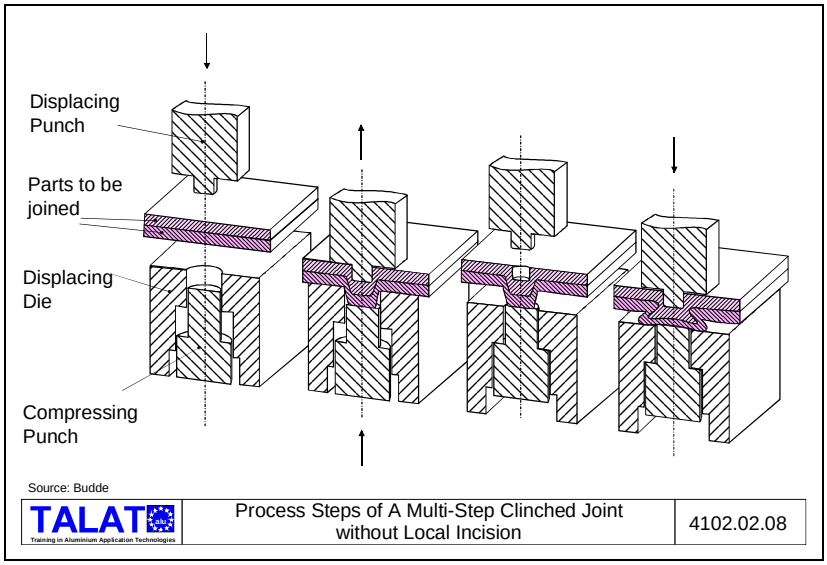
- **Formation of a Flat Clinch Element without Local Incision**

New variations of the clinching process which overcome the process limitations of the single-step and multi-step clinching process with and without local incision, are being developed constantly. The basic principle, however, remains unchanged.
Thus, it is possible to flatten the typical edged form of the clinch element without local incision in a second operation, so that this side can be used for the visible surface (**Figure 4102.02.07**).



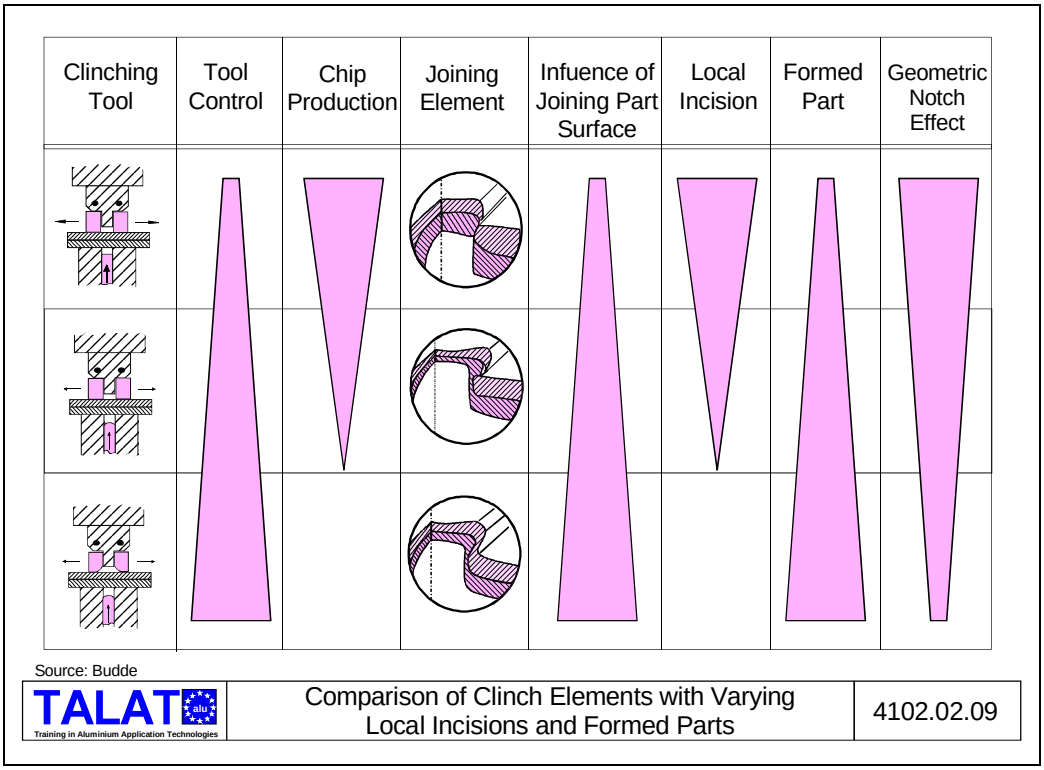
Similar to clinching with local incision, it is possible, in a two-step or multi-step process, to produce a clinch element without local incision (**Figure 4102.02.08)**.

The two-step or multi-step process for clinching uses about 20 % less energy than that required for single-step clinching, due to the fact that the penetration and compression (flattening) steps of the former occur in consecutive steps.



- **Comparison of Clinch Elements with Varying Local Incisions and Formed Parts**

As illustrated in the comparison of clinch elements with varying local incisions and formed parts, reducing the local incision part in favour of the formed part is coupled with a reduction of notch effect - i.e. primarily an improved behaviour of the joint under dynamic loading - as well as reduced chip production. At the same time, however, this leads to the need for tools able to meet the added requirements.



This means that reducing the incision part amounts to an increased effort in aligning punch and die (**Figure 4102.02.09**).

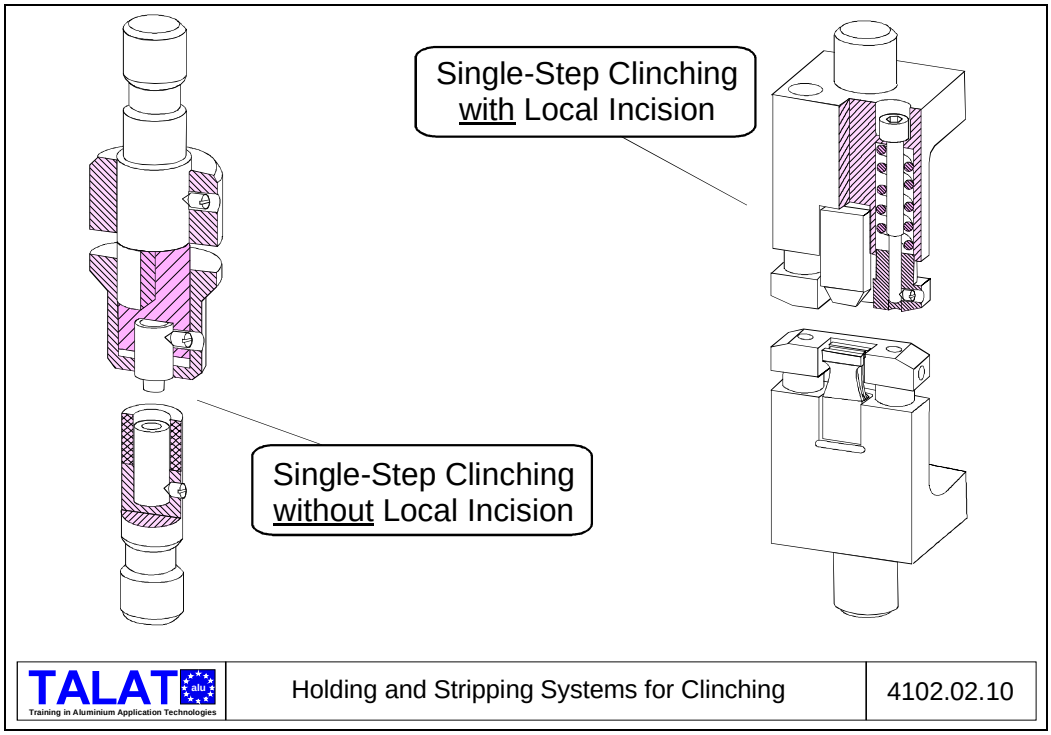
In order to align clinching tools accurately for joints without local incision, special clamps with double-C frames have been developed, making the use of clinching robots possible.

- **Holding and Stripping Systems for Clinching**

A faultless holding system, a prerequisite for producing high quality clinching, must clamp the aligned parts, so that the material flow during the clinching process does not cause a movement of the position of joining groups relative to each other.

Appropriate holding systems can be used to clamp the joining parts as well as strip the finished part from the dies.

Just as in the case of clinching, holding systems must also be adapted for use in punch riveting (**Figure 4102.02.10**).



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4102.04 List of Figures