

## **TALAT Lecture 4106**

# **Quality Assurance and Process Control**

9 pages, 8 figures

Basic Level

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### **Objectives:**

- to describe the basic methods of quality assurance and process control for mechanical fastening methods

### **Prerequisites:**

- General mechanical engineering background
- TALAT lectures 4101 - 4105

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# 4106 Quality Assurance and Process Control

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## 4106.01 Process Analysis

- Comparison of quality assurance of different joining technologies
- Direct process control as a supplement to statistical process control
- Path of a mechanical fastening process


### Comparison of Quality Assurance of Different Joining Technologies

The predictability of mechanical fastenings in the production technology depends largely on the reproducibility of the joint, which, in turn, is correlated to the tolerance of the production process.

Contrary to the combined adhesive and spot welded fastening, clinched and self-piercing riveted joints - as typical examples of mechanical joining methods - can, to a certain extent, be tested using non-destructive testing methods (**Figure 4106.01.01**).

Joining Technology Characteristics	Adhesive Joining	Spot Welding	Clinching	Riveting
Quality Assurance	<p>Process Control Possible Only in Partial Steps</p> <p>Joint cannot be Tested Non-Destructively</p>	<p>Process Control Only Conditionally Possible</p> <p>Joint cannot be Tested Non-Destructively</p>	<p>Process Control Only Conditionally Possible</p> <p>Joint can be Tested Non-Destructively Conditionally</p>	<p>Process Control Only Conditionally Possible</p> <p>Joint can be Tested Non-Destructively Conditionally</p>

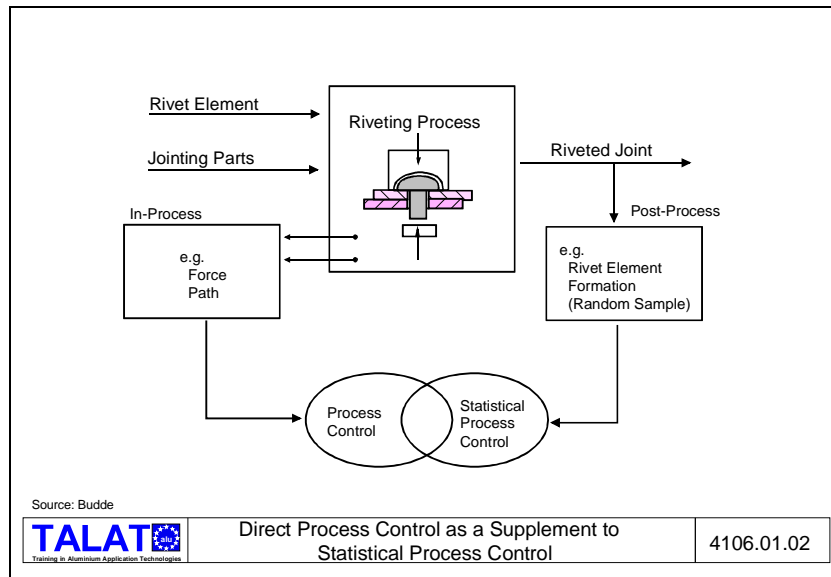
Source: Budde

 <b>TALAT</b> Training in Aluminium Application Technologies	Comparison of Quality Assurance of Different Joining Technologies	4106.01.01
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### Direct Process Control as a Supplement to Statistical Process Control

It has often been pointed out here that the quality assurance of mechanical fastenings for aluminium constructions is of paramount importance. With automation it is possible to eliminate the influence of random and chronologically limited personal errors on the quality of the fastening. Supplementary to the destructive and non-destructive testing of samples, the process control and regulation of the mechanical fastening process offers a promising additional quality assurance method.

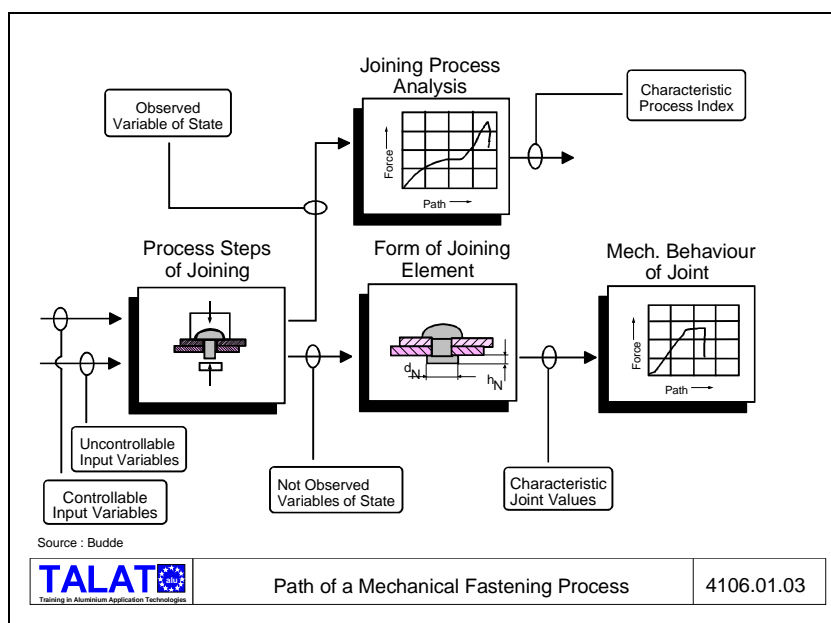
The direct process regulation and control based on the relevant data extracted during the actual joining process - i.e. in addition to the statistical process control - plays an important role in the mechanical fastening process (**Figure 4106.01.02**).



### Path of a Mechanical Fastening Process

The force-motion analysis builds the basis of the direct process control and regulation of mechanical fastening (see **Figure 4106.01.03**). Based on process analysis, it is possible to follow the mechanical joining process qualitatively and, at the same time, to determine the quantitative correlation existing between the relevant chronological changes in the joining process and the quality of the joint produced, whereby the term quality is defined as the joint strength at varying loads.

The operational path of the mechanical fastening process illustrates that the process control and regulation is based on the determination of the actual current geometrical formation and on the assumption that each joint geometrical form (evaluated on the basis of the geometric joint characteristics) has an individual defined quality.



## 4106.02 Controlling Process Parameters

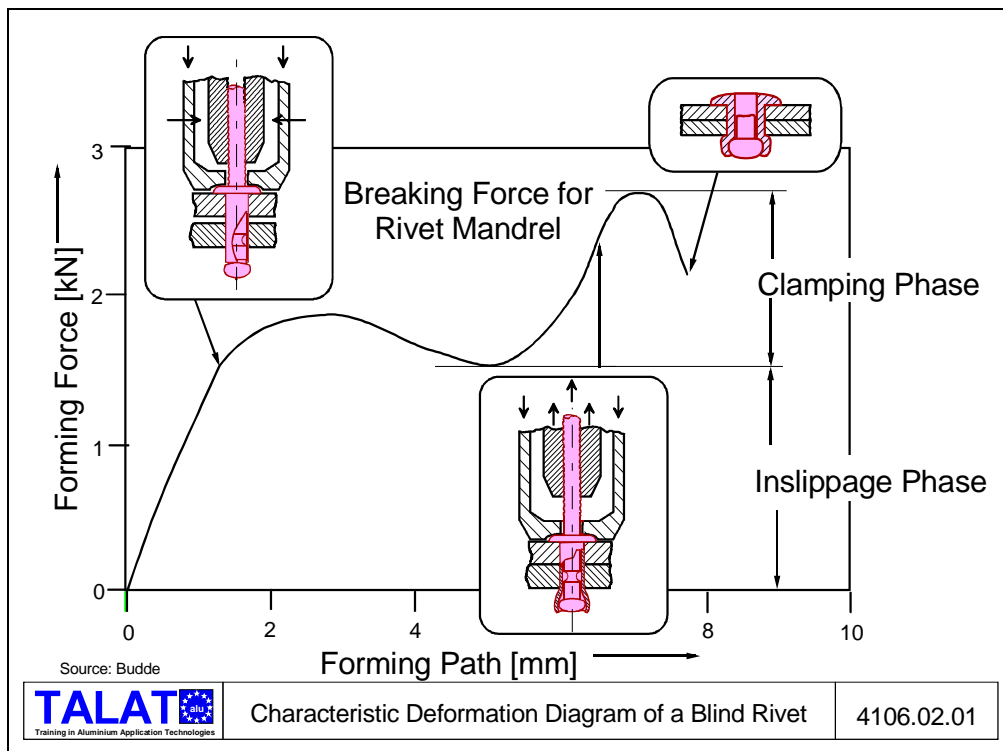
- Characteristic deformation diagram of a blind rivet
- Controlling the limiting values for mechanical fastenings
- Characteristic force-motion studies for clinching with local incision
- Cross-section of a clinch joint with characteristic values for joint geometry
- Example of a process analysis for clinch joints with local incision

### Characteristic Deformation Diagram of a Blind Rivet

Blind riveting (mechanical fastening with auxiliary parts) and clinching (mechanical fastening without auxiliary parts) are processes for which process control and regulations have been applied (**Figure 4106.02.01**).

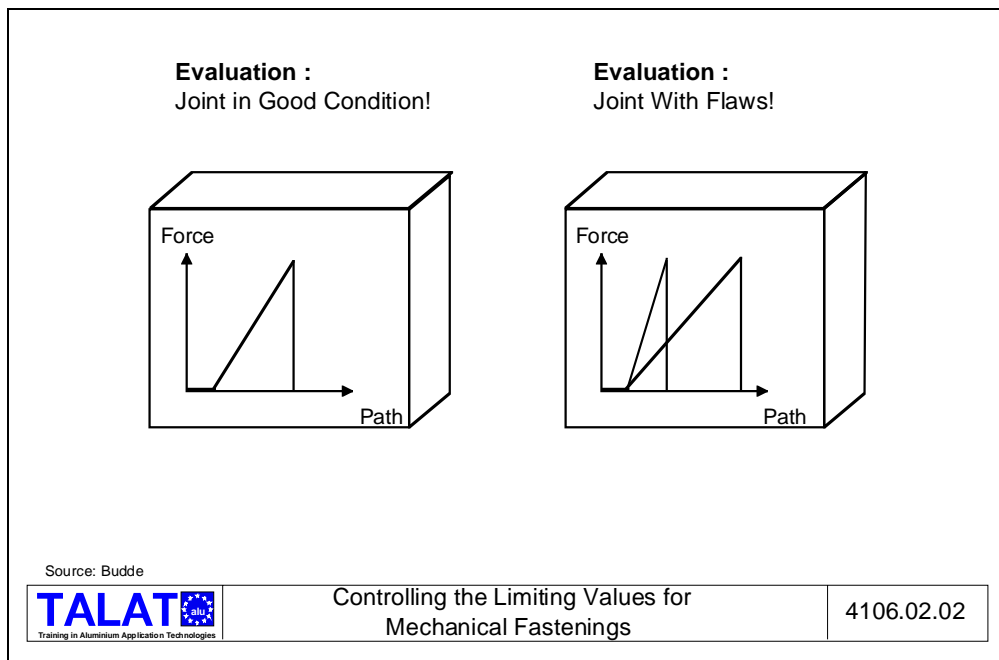
The process steps during blind riveting can be divided into a in-slippage phase (in which the stem is pulled) and a clamping phase (in which the fastening parts are subject to a pre-stress).

The clamping force and consequently the quality of the riveted joint can be predetermined by analysing the deformation diagram for blind riveting.



## Controlling the Limiting Values for Mechanical Fastenings

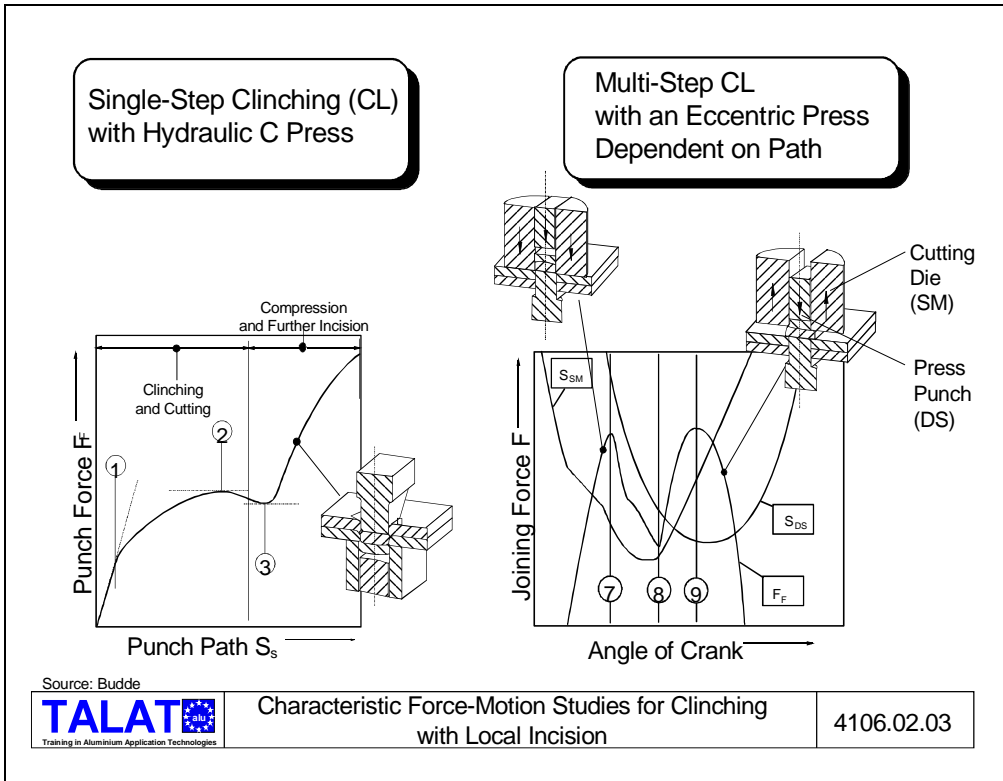
At the end of the process analysis of the mechanical joining process, one has to decide whether the quality requirements can be reliably fulfilled or whether a direct process control has to be carried out continuously. During a process control, the characteristic joint values are determined and constantly evaluated. On the basis of the process analysis, it is possible to develop appropriate control strategies like, for example, a control of the limiting values (**Figure 4106.02.02**).



## Characteristic Force-Motion Studies for Clinching with Local Incision

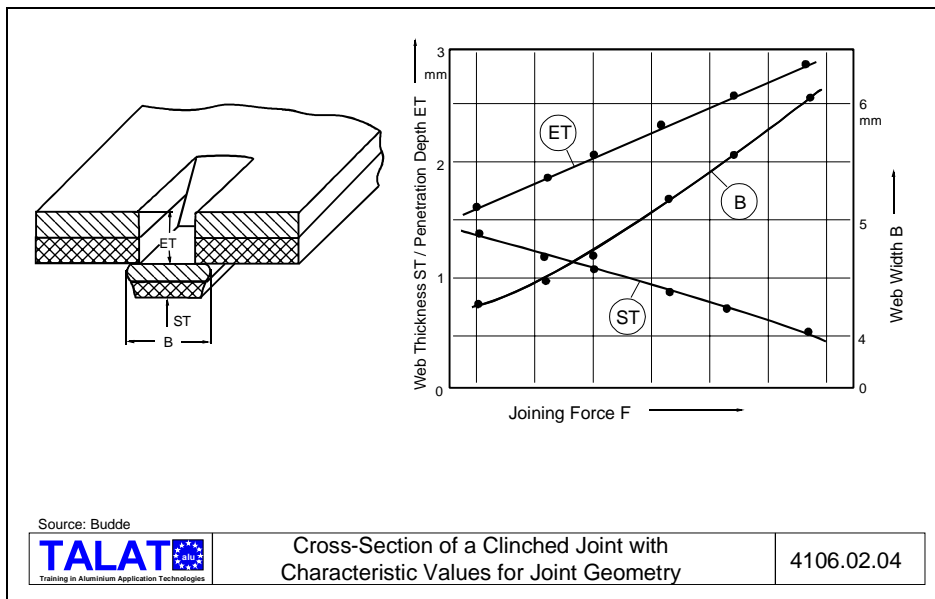
Just as in the case of self-piercing riveting, it is possible to use force-motion diagrams to study the individual phases of the joining process during clinching (**Figure 4106.02.03**).

Experiments have shown that the joint force determined point-wise (locally) or interactively can be treated as a universal control parameter. The chronological change of the joining force offers very significant information about the process and the forming of the joint.



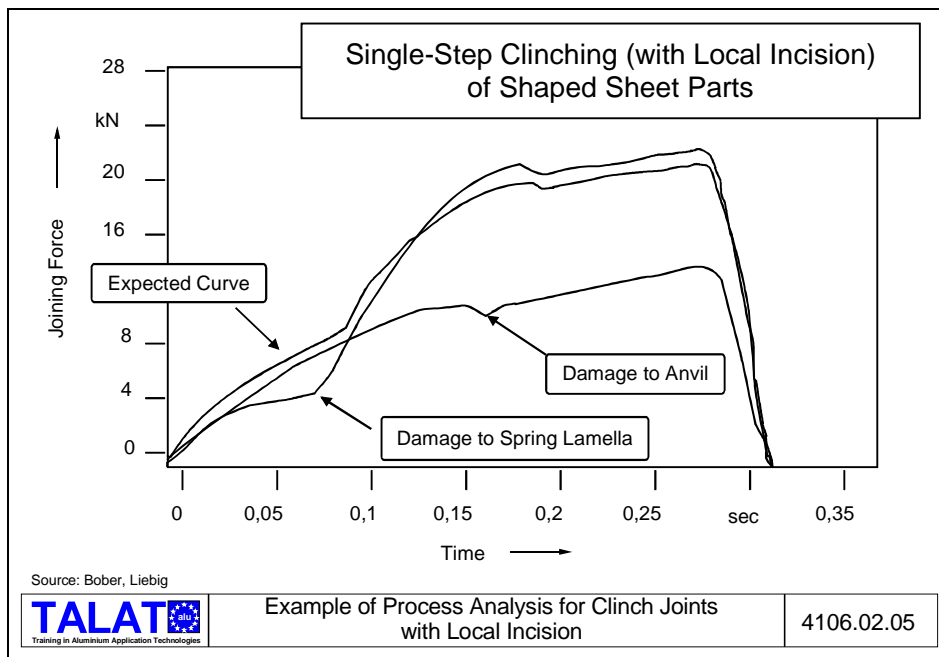
### Cross-Section of a Clinch Joint with Characteristic Values for Joint Geometry

Two types of characteristic values exist for the joint geometry, depending on whether these values can be measured with or without destroying the joint element. It has been found that for clinch joints, a linear correlation exists over a large range among the joining process dependent values of web thickness, web breadth and the joint strength. Consequently, the web thickness and/or breadth are used to optimise the joint and for non-destructive testing of the same (see also **Figure 4106.02.04**).



## Example of a Process Analysis for Clinch Joints with Local Incision

Through the control of the joining force, it is possible to control every clinching or punch riveting process quasi on-line. Thus it is possible, for example, to clearly recognise different damages of the die during the single-step clinch process by studying the force-time curve (Figure 4106.02.05).



This makes it possible to evaluate the quality of mechanical joints in aluminium shaped sheet and profile products using non-destructive methods.

Although the process control during riveting and clinching makes it possible to guarantee the joint quality control of the mechanical fastening process, it is still necessary to collect comprehensive data if one wants to be able to influence the design of the aluminium construction within the framework of a more global quality assurance.



### 4106.03 Literature/References

1. **Budde, L.** Untersuchungen zur Kombination quasi-formschlüssiger und stoffschlüssiger Verbindungsverfahren. Dissertation Uni-GH-Paderborn, 1989
2. **Schmid, G.** Methoden der Qualitätssicherung beim Durchsetzfügen. Bänder Bleche Rohre 32 (1991) 61-64
3. **Budde, L.** Qualitätssicherung beim Nieten - Möglichkeiten und Grenzen. Bänder Bleche Rohre 32 (1991) 64-74
4. **Liebig, H.P. und Mutschler, J.** Qualitätssicherung beim Stanznieten prozeßbegleitend überwachen. Bänder Bleche Rohre 34 (1993) 5, 52-54
5. **Warnicke, H.-J. und Schweizer, M.** Bleche sicher verbinden - Automatische Nietprozeßüberwachung. Wissenschaft und Technik. Springer Verlag (1993) 1, 50-52
6. **Lappe, W. und Budde, L.** Qualitätsbewußt - Möglichkeiten der Prozeßüberwachung beim Stanznieten von Blechen und Profilen. Maschinenmarkt 99 (1993) 48, 60-64
7. **Liebig, H.P., Bober, J. und Göpfert, D.** Qualitätssicherung durch rechnerunterstützte Überwachung des betrieblichen Druckfügeprozesses. Blech Rohre Profile 39 (1992) 6, 466-471

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