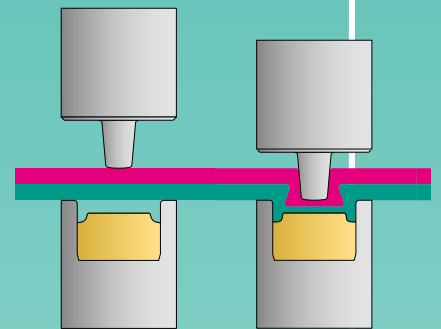


TOX®-Joining-Systems

- TOX®-Round Joint
- TOX®-SKB
- TOX®-Flat Joint
- TOX®-MICROpoint
- TOX®-TWINpoint
- TOX®-Vario Joint
- TOX®-ClinchRivet



The TOX[®]-Joining Systems

The best answer to every challenge

Why a new technique?

Because all previous methods have involved economic and technical problems, for example. A complex, expensive process which can only be applied to precoated sheet metal or aluminium with great difficulty. Surface coatings are damaged or sheet metals are not joined properly. And there is still no reliable automatic process control for all these imponderable factors.

The TOX[®]-Joining Technique puts an end to these problems. It joins different materials by means of a deep drawing-pressing process. And it does so without damage to the surface, purely by displacing and forming.

Practice has already shown the benefits of TOX[®]-Joining, both technically and economically.



Dr. Rudolf Eberle innovation prize for exemplary achievement.

Advantages for a good connection



See for yourself:

- + TOX®-Round Joint: 30 to 60 % cost savings as compared to spot welding.
- + The TOX®-Joint achieves up to 70 % of the static strength of a spot weld.
- + The dynamic strength of TOX®-Joint is higher than in spot welding.
- + The joining process can be automatically monitored and documented.
- + Simple, non-destructive quality control is possible.
- + The materials are strain hardened at the connecting joint and are therefore stronger compared to spot welding, which has significant stresses around the weld nugget, the TOX®-Joint does not exhibit any metallurgical residual effects.
- + Optimal corrosion resistance with galvanized and prepainted materials, since the protective layer flows with the material.
- + Perfect joints are produced even with narrow flanges and small mounting spaces.
- + Outstanding conductivity for electric components.
- + Cold forming process is ideal for hybrid connections (gluing and clinching).
- + The TOX®-Round Joint can carry shear and pull stress loads, independent of the load orientation.

Convincing features:

- + The TOX®-MICROpoint is especially applicable for very thin metal sheets.
- + The TOX®-TWINpoint: The non-rotating TOX®-TWINpoint with excellent electrical conductivity characteristic.
- + TOX®-ClinchRivet: Comparable strength to self-piercing rivets but without cutting the sheet metal layers.

For each operation a suitable solution:

- + Point diameter from 1.5 to 26 mm
- + Individual sheet thicknesses from 0.1 to 11 mm
- + 2 – 4 sheet metal layers
- + Hybrid connections (steel/glue/aluminium)
- + Extensive know-how
- + Worldwide service

How may we help you?

With our TOX®-Test Report we guarantee our technology.

TOX®-Round Joints have by far the best electrical conductivity in comparison to other mechanical joining techniques
Source: TU Dresden, report of the group Joining as of 2012

TOX®-Technology

Clinching facts

The strength behind the TOX®-Joint

In the TOX®-Round Joint process, the material strain hardening in the neck area and the lacking of any notch effects produce the high retaining forces. This is the direct result of the fixed, rigid die. For this reason, even the TOX®-SKB Die has fixed segments.

The TOX®-ClinchRivet process combines the advantages of the Round Joint with those of a riveting process.

Flexibility

The same tool set can be used to join sheet metals of different sheet thicknesses. The tool set suitable for the application is determined in the TOX®-Test Report which guarantees the required holding forces.

Durability

Static strength up to 70 % of a spot weld, with positive strain hardening, without damage to the surface coating, and typically more economical. Isn't all this worth looking at?

Fatigue strength under the most adverse conditions

Corrosion tests have shown that because the surface coating is not damaged during the round joint process, the anti-corrosive properties of the joined sheet metals, e.g., aluminumized or galvanized, are maintained. The TOX®-Joining-System does not cut the surface of the materials to be joined, as the coating flows with the material and remains intact.

The dynamic strength is higher than in spot welding

Advantageous dynamic strength without notch effect in the joint – this means: The life of the TOX®-Round Joint lasts much longer than that of a weld point.

On the right:

The TOX®-Joint in customer test

Results of endurance tests for samples with TOX®-Round Joints and spot welds. The joints were exposed to an initial load of 1 kN and a frequency of approximately 35 Hz. The fatigue life of the joint was measured until failure.

This is how a TOX®-Joint is formed

- Penetration
- Interlock formation of punch side sheet metal
- Completed TOX®-Joint

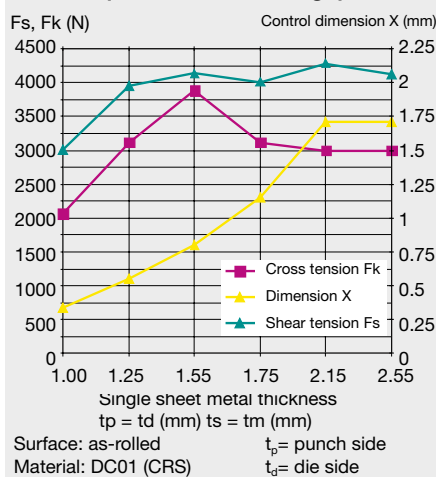
TOX®-Round Joint



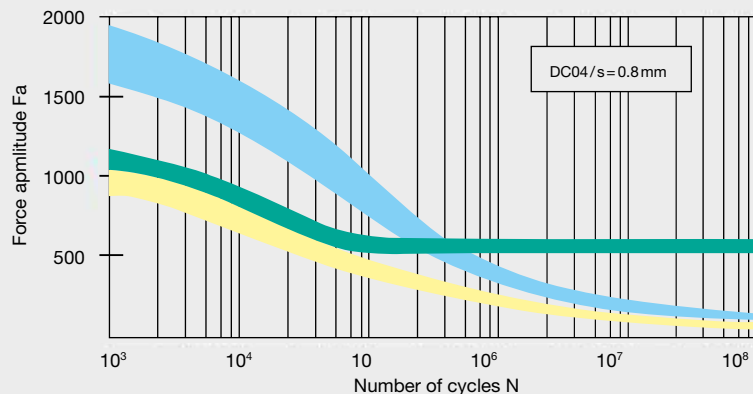
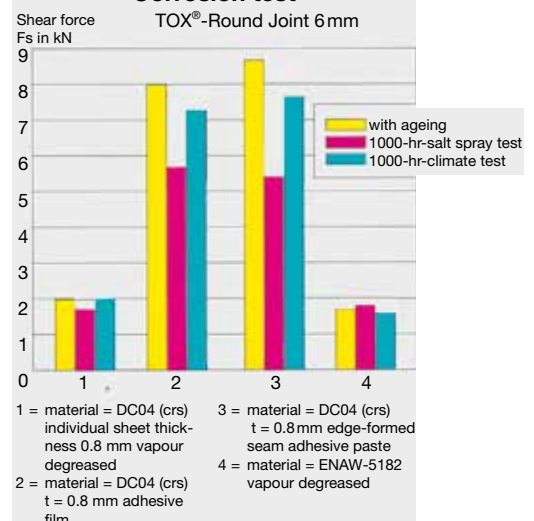
TOX®-ClinchRivet



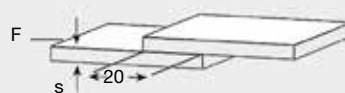
Test series standard tool set (without tool change)



Corrosion test



Joined samples, vapour degreased



F _D 100%	F _D = fatigue strength
280 N	Spot welding
250 N	Clinching, star shape
560 N	TOX®-Round Joint

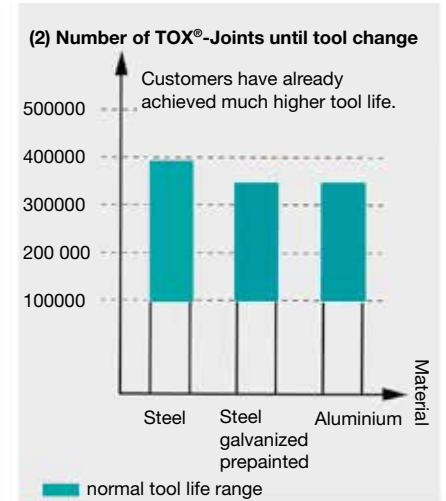
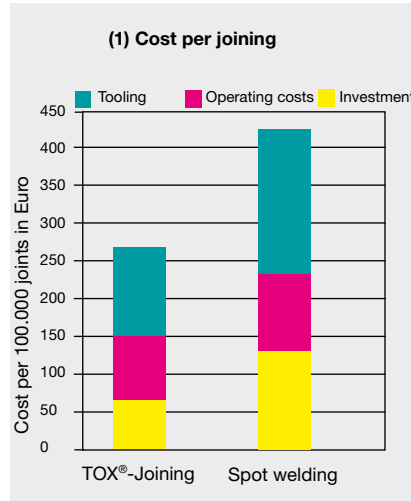
TOX[®]-Technology

The advantage for you and the environment:
cost effective and efficient

TOX[®]-Joining: the simple process cuts your manufacturing costs. The system efficiency and the service life of the tools are closely interdependent.

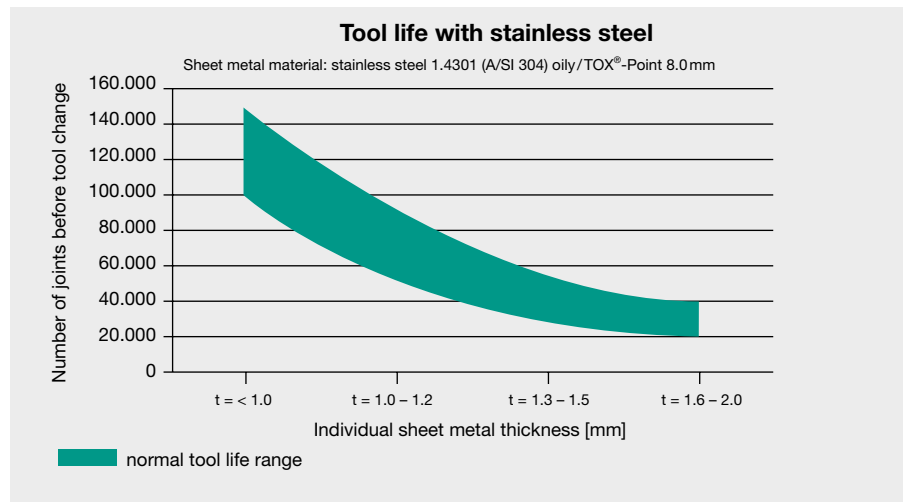
(1) shows a cost comparison for the single joint technique between spot welding and TOX[®]-Joining for a mild steel application. The TOX[®]-Joining-System can be used in multipoint applications, which can increase considerably the cost difference between TOX[®]-Joining and spot welding.

(2) shows the normal service life of TOX[®]-Tools. The given values and guidelines depend on the particular application.



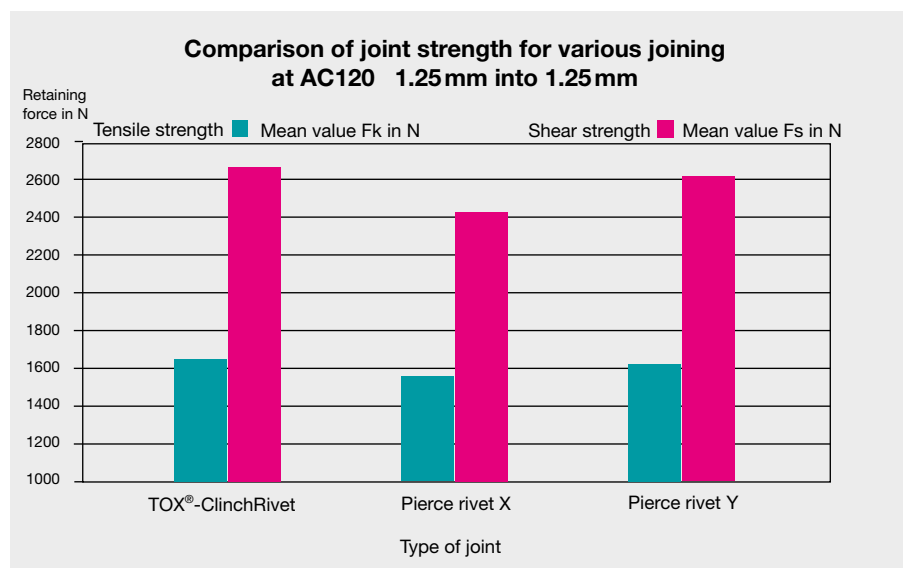
Joining of stainless steel

Stainless steel presents special requirements for forming processes. The required higher forming forces result in higher surface stresses on the joining tools. The TOX[®]-Joining Technology can be used safely and efficiently even for stainless steel applications. Continuous tool development and experience with many applications have resulted in high tool life.



TOX[®]-ClinchRivet

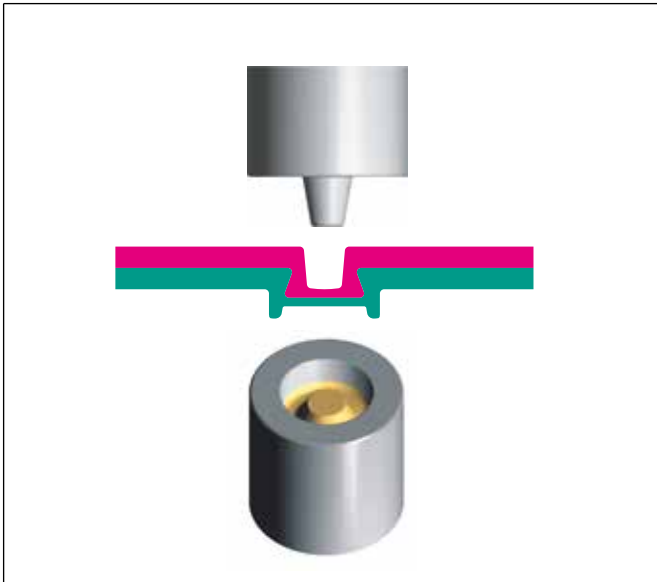
The TOX[®]-ClinchRivet is a logical further development of the TOX[®]-Round Joint. By filling the joint with the rivet, the TOX[®]-ClinchRivet process increases the joint strength considerably, especially the shear strength. Higher strength can be achieved when compared to pierce rivets, especially with thin sheet metals. It is important to mention that with TOX[®]-ClinchRiveting, the upper sheet metal layer will not be cut: No risk of corrosion.



The TOX[®]-Joining-Systems

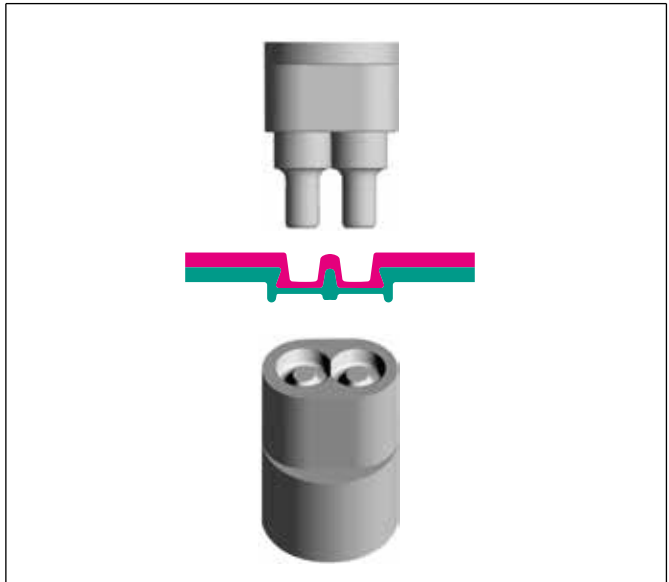
Simplicity is our strength

TOX[®]-Round Joint



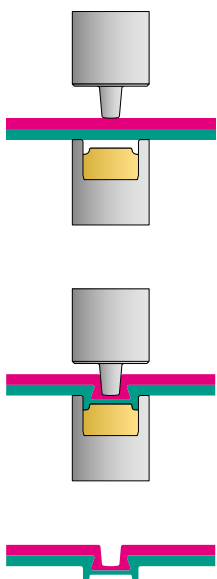
The patented **TOX[®]-Round Joint** is the core of our technology. A simple round punch presses the materials to be joined into the die cavity. As the force continues to increase, the punch side material is forced to spread outwards within the die side material. The result: An aesthetically pleasing round button, which joins clearly without any burrs or sharp edges on which corrosion could set in. Even with aluminized or galvanized sheet metals, the anti-corrosive properties remain intact as the protective layer flows with the material. The electrical conductivity is excellent.

TOX[®]-TWINpoint



The **TOX[®]-TWINpoint** provides **protection against rotation** and, in comparison to the single joint, clearly increases the joint strength. The TOX[®]-TWINpoint has an excellent electrical conductivity characteristic. A solid die and the same process as for the single joint guarantee the full advantages of the TOX[®]-Round Joint. The TOX[®]-TWINpoint is ideal for small flanges and limited installation space.

Process sequence



The TOX[®]-Round Joint:
Smart joining technology with no added fasteners

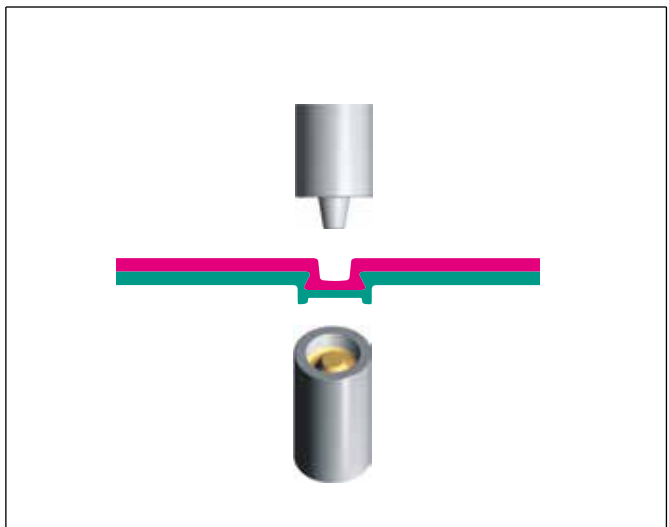
Increasing strength:

The materials are plastically deformed in the joining area, therefore, increasing the strength. There are no stress concentration factors. The advantages of the TOX[®]-Joining-System can also be appreciated in regards to the **environment** – particularly in comparison to welding. Just think of welding aluminium, galvanized or prepainted sheet metal!

Cutting costs

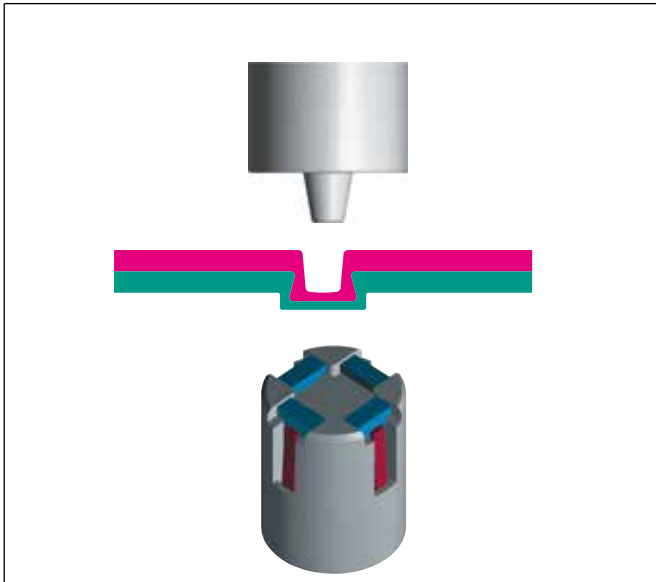
Besides the directly measurable cost advantages, considerable savings can also be made with a much simpler production sequence. For example, it is often possible to punch, bend and join in one progressive die. This saves an entire working cycle as well as transportation to the joining station – or welding shop. Which is a great advantage in terms of logistics.

TOX[®]-MICROpoint



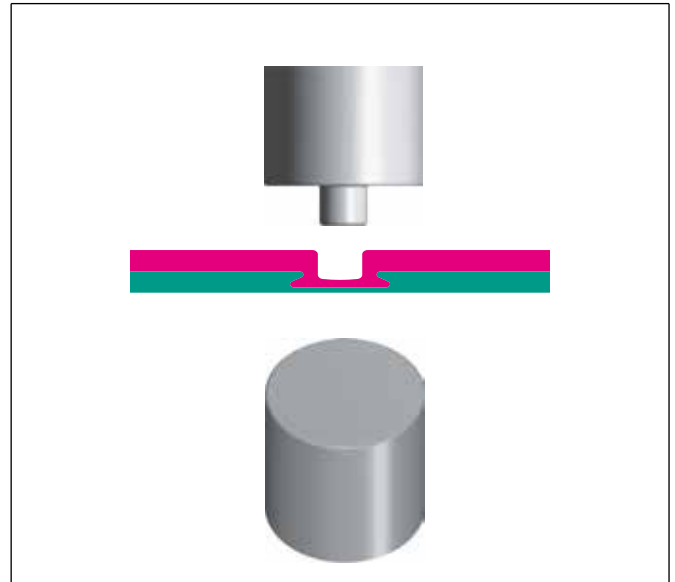
The miniature TOX[®]-Round Joint with point diameters of 1.5 to 2 mm is the answer to the miniaturization of components. It is ideal for sheet metal thicknesses from 0.1 – 0.5 mm and narrow flanges. The electrical conductivity between the joined layers is outstanding.

TOX®-SKB



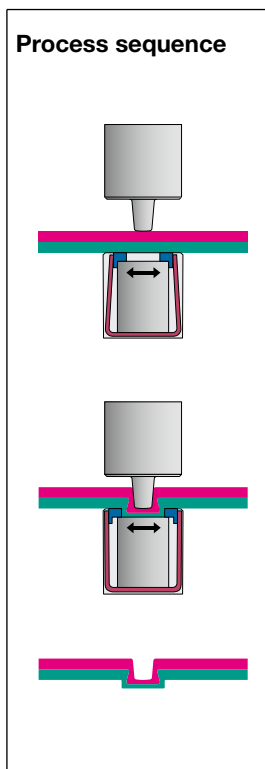
A special clinch-die has **solid and flexible** segments. The materials and the punch are centered by the fixed segments, thereby guaranteeing that the joint formation is perfectly concentric. The mobile elements between the solid segments allow an interlocking of the material in the joint.

TOX®-Flat Joint/TOX®-SKB Flat



In some instances, the button formed by the TOX®-Point may be undesirable. That's why we developed the **TOX®-Flat Joint** and the **TOX®-SKB Flat**.

Process sequence

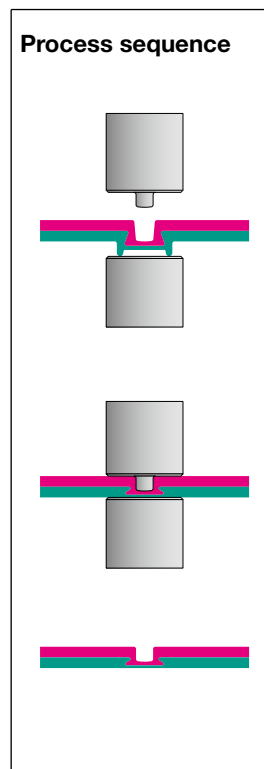


The advantages are seen in a **more flat protrusion of the joint** and a **higher flexibility** when sheet metals of different thickness have to be joined with one tool set.

The special arrangement of the springs allows extremely slender tools and thus better accessibility and **minimal interference** compared with conventional die construction without solid part.

The TOX®-SKB Die shows its strength specially when **glue** is used between the sheet metal layers. Furthermore, it has been successfully implemented for the TOX®-ClinchRivet (see page 8).

Process sequence



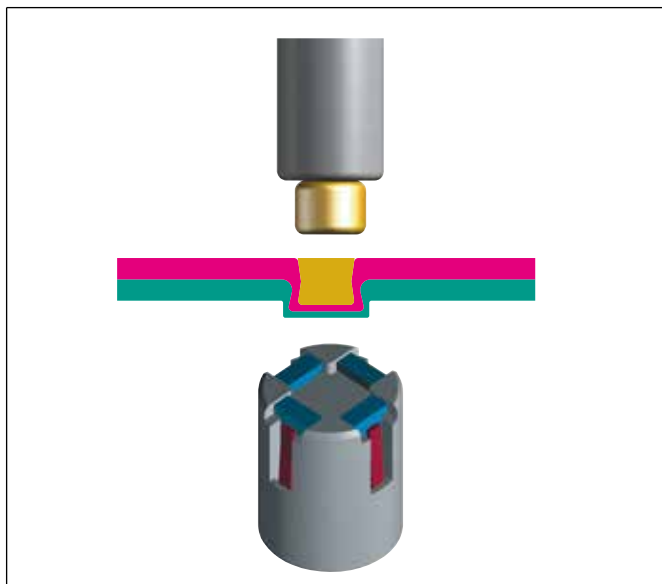
Forming the **TOX®-Flat Joint**:

- The first step is to produce the standard TOX®-Round Joint or TOX®-SKB.
- The resulting button is flattened (± 0.1 mm) in a secondary operation.

The high shear and pull strengths of the TOX®-Point are left virtually intact.

Specialities of the technology

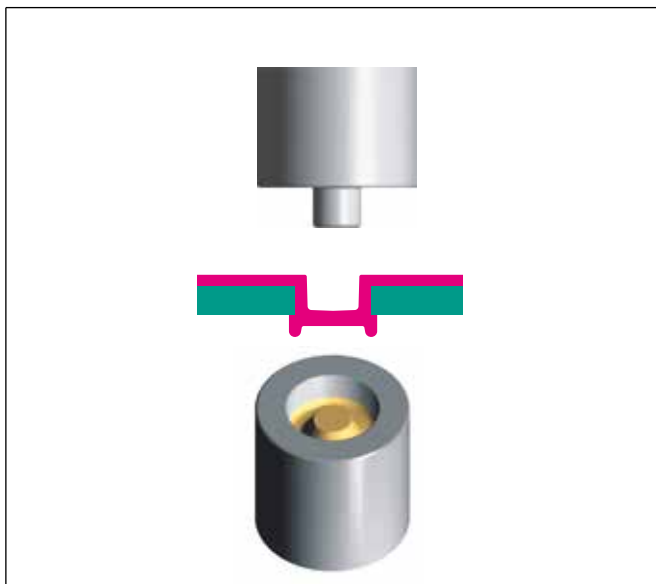
TOX®-ClinchRivet



In the case of the patented **TOX®-ClinchRivet**, the actual rivet joining is made from a simple cylinder rivet in a joining process using drawing/pressing methods. Similar to the TOX®-Round Joint, the material to be joined is not cut but led through the die form thus producing a very resistant joint – also in the case of thin materials.

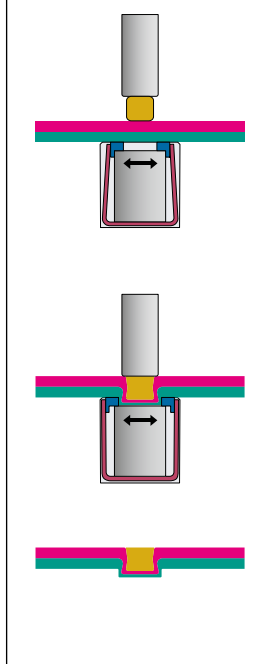
Multijoint applications increase cost advantages.

TOX®-Vario Joint



The **TOX®-Point** for difficult cases: Joining of sheet metal with large differences in thickness, joining of high strength or non ductile materials with ductile materials or joining of non metallic materials.

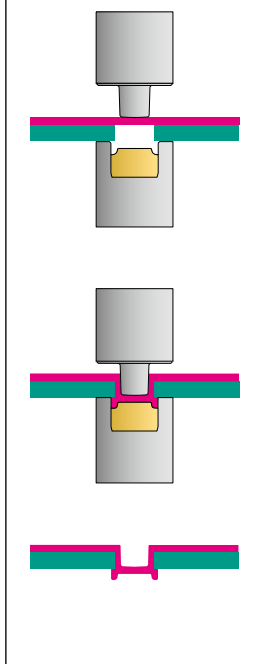
Process sequence



The special advantage of the **TOX®-ClinchRivet** is the simple, symmetrical and inexpensive rivet. This results in the troublefree feed and compression. The materials to be joined gain an additional retaining component. A clean and highly reproducible joint is created.

All technological characteristics and quality criteria of the TOX®-Round Joint also apply to the TOX®-ClinchRivet.

Process sequence



Characteristics:

- One layer is pre-punched, the ductile material is then pushed through the hole.
- The connection has radial and axial strength.
- Multiple joints can be applied in a single press stroke.
- This process requires precise alignment of the parts.

TOX®-Standards

The modular program – flexible and field-proven

TOX®-Tools



TOX®-Tool Holder With integrated stripper



TOX®-Die Sets

The most economical way to use TOX®-Joining. Multiple points can be produced in one operation.



TOX®-Flat Plate Die

Offers unbeatable access in hard to reach corners.



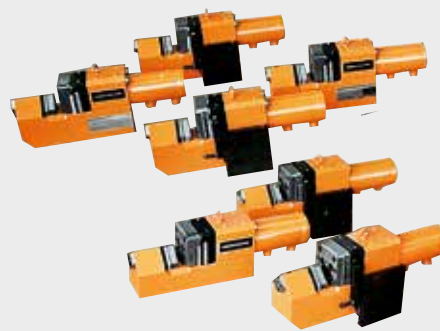
TOX®-ClinchRivet

Standardized swage heads including feed and fill level control. For use in single and multijoint applications. Appropriate for robots.



TOX®-Handheld Tongs

The suspension offers an optimum handling.



TOX®-Tongs Fixtures

In single and multipoint design, specially adapted to your component. They are pneumatic, pneumo-hydraulic or hydraulic driven.



TOX®-Robot- and Machine Tongs

With pneumo-hydraulic, electric or hydraulic drive.

TOX®-FinePress

High-quality benchtop presses – compact and perfect.



TOX®-Presses

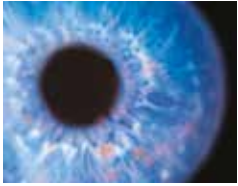
With integrated multipoint die sets, safety equipment, control system and process monitoring. Our know-how, your benefit.



TOX®-PowerKurver

For simultaneous clamping and joining. No need for repeated clamping and fixturing. Optimal accessibility for large panels due to > 90° operating angle. With pneumatic or electric drive.





TOX[®]-Monitoring

NETWORK

TOX[®] softWare
Ethernet
Interbus/ProfiNet/Profibus
PLC

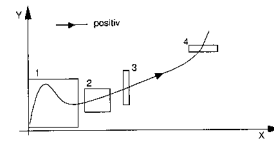
TOX[®]-Process Monitoring keeps a constant check on your clinch points.

The specially adapted **process monitoring system** for the **TOX[®]-Joining Technique** helps you to check the **competitive factor of quality**:

- For **each** produced **component**
- For **each** clinch **point** in the component

A **cost effective production monitoring** for short cycle times requires a control system which is integrated into the line – in short, a system like the TOX[®]-Process Monitoring System.

The TOX[®]-Process Monitoring System guarantees your quality standards, not only for **mass production**, but also for **small-scale manufacturing**.



Evaluation units for monitoring of clinch processes

Resistance to pull and shear loads is dependent on the control dimension X, provided that the joining parameters and the service life of the tools have been observed.

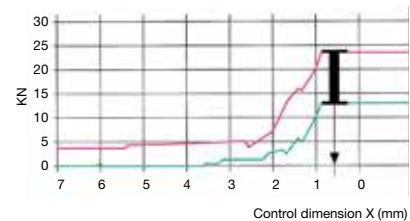
The evaluation device can be selected according to each requirement. From 1- to 12-channel clinch monitoring all the way to continuous measuring in force-travel-pressing monitoring.

Various evaluation methods allow for different analysis of your processes. Diverse communication interfaces allow for simple and quick data transfer to the data storage.

TOX[®]-Process Monitoring CEP 400/400T



- Force monitoring of clinching processes
- Trend monitoring
- Process sequencing
- Network capability over Ethernet TCP/IP
- Expandable to userdefined processes
- With and without display



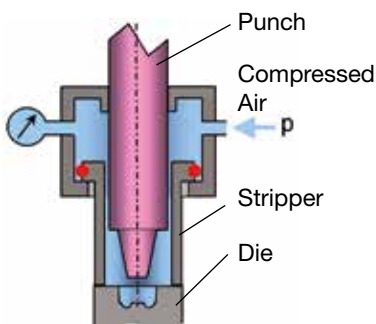
Functional principle:

Force sensors measure the press force at the clinch points. A position indicator monitors the attainment of control dimension X (quality dimension). Once the position indicator signals that control dimension X has

been reached, the press forces measured by the load cells are compared with the nominal press forces. The TOX[®]-Point is satisfactory if the measured press force lies within the preset tolerance range. Thus, it is possible to make an assessment on

material type, strength and thickness, right tool combination as well as tool failure or missing layer of sheet metal. As alternative it is possible to evaluate the complete force-travel-characteristic curve (EPW 400 measuring principle).

TOX[®]-ToolCheck pneumatic testing of clinching dies



The die monitoring system TOX[®]-ToolCheck, together with the process monitoring, checks the condition of the TOX[®]-Clinching Dies. This ensures that the joining process is always performed with an intact die. Any potential defects (like missing or e.g. by contamination jammed moving elements of the SKB die, as well as ruptures on either the solid TOX[®]-Die

or on the fixed segments of SKB) are identified within < 1 second.

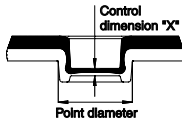
- + Optimum tool life quantity
- + Increase production reliability
- + Maximum tool life usage



Controlled precision clinching using electric drives

The control dimension X

In case of TOX®-Clinching, the control dimension X describes the remaining bottom thickness after having joined two or more sheet metals with a clinching point.



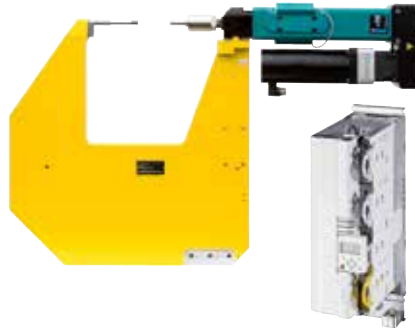
The control dimension X is easily accessible and is therefore an ideal dimension for estimating the quality of the clinch joining. It is shown in the TOX®-Test Report which defines all process parameters.

Everything under control when joining

Using the servo controllers line-X from the TOX®-ElectricDrive program and the software modules especially developed for this program, the control dimension X is guaranteed independent of any fluctuations regarding sheet thickness, strength and friction conditions. Here, an accuracy of ± 0.04 mm is realized. The combination of flexibility, precision and minimum setup times is stunning.

Typical application

TOX®-Robot Tongs for clinching tasks with electromechanical drive
TOX®-ElectricDrive and servo controller including TOX®_{softWare}.



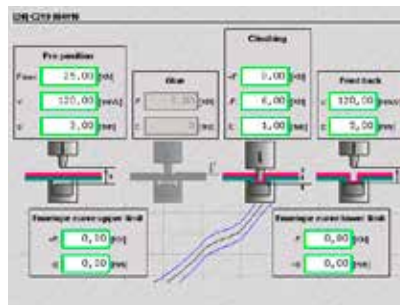
TOX®-Robot Tongs and axis controller

TOX®_{softWare} = Simply good!

With the TOX®-ElectricDrive servo drives and the TOX®-Process Monitoring units, the TOX®_{softWare} is included in the delivery by default.

All processes can be parameterized or automatically taught-in via the user friendly user.

No programming knowledge is required!



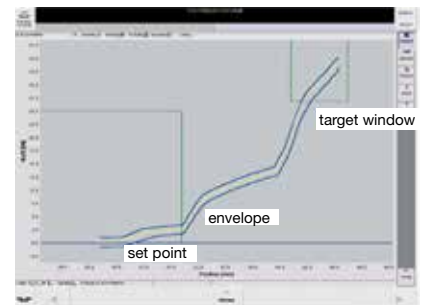
TOX®_{softWare} – Input of parameters directly on screen

Process monitoring using envelopes

The line-X servo controller additionally provides process monitoring functions via an envelope combination.

With this, the force/travel course of joining/pressing or clinching processes can be completely monitored and documented.

The recorded force/travel characteristic must not leave the predefined corridor.



Display of envelopes in the TOX®_{softWare}

If the envelope is violated, you can decide whether:

- ➔ the process should be continued until the target window is reached.
- ➔ the process should be interrupted immediately.

TOX®-Joining Systems for solid punch rivets

With the introduction of the solid punch riveting technology another solely mechanical joining method is added to the portfolio of TOX®-Sheet Metal Joining Systems. Solid punch riveting has its preferred applications in the field of automotive lightweight constructions, respectively for the joining of hybrid components and assemblies of alternative materials. The complete solutions include the know-how, the competence and the

equipment for all solid punch riveting requirements: the technology, the tooling, presses and riveting devices, single or multiple rivet supply lines, controls.

The rivet placing can be accomplished by c-bow or column presses, handheld or robot tongs as well as by custom made devices and machines.



Typical shape of a solid punch rivet



Product Range

TOX®-Powerpackage



TOX®-ElectricDrive



TOX®-PowerKurve



TOX®-FinePress



TOX®-Presses



TOX®-Tongs



TOX®-Controls
TOX®-Monitoring



TOX®-Joining-Systems



TOX®-Punching
TOX®-Coining



TOX®-Press-Fitting



TOX®-Production Systems



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