SKOLVAR

Engineered for the Soft Zone Dies in Press Hardening

Marcus Pettersson
Application manager, Hot Work tool steels

Introduction to press hardening

Press hardening is a thermomechanical process used to manufacture ultra-high-strength structural components from advanced high-strength steels (AHSS). It enables the production of complex shapes with minimal springback, while achieving tensile strengths of up to 2000 MPa. [1] This technology has become essential in the automotive and transport industries, where reducing weight and enhancing crash performance are top priorities.

In conventional hot stamping, a blank from a steel sheet is heated to its austenitization temperature, typically around 880°C, then quickly transferred to a die where it is simultaneously formed and quenched. The rapid cooling rate, exceeding 27°C/s, transforms the steel's microstructure from austenite into predominantly martensite, dramatically increasing its hardness and yield strength. [1] This results in consistent mechanical properties throughout the finished component.

Figure 1 Illustration of a press hardening tool for B-pillars.

From a metallurgical perspective, the success of press hardening depends on precise control of heating, forming, and cooling to achieve the desired shape and microstructure while preventing unwanted phase transformations in the finished product. A common sheet material used in this process is 22MnB5, which is designed to receive its mechanical properties after quenching. Sheet material can be both coated and uncoated.

In press hardening we see failure mechanisms like wear, plastic deformation, cracking and temper back, which puts a high demand on the die material. Therefore, it is crucial to have tool steels with tailored compositions in combination with precise production to extend the tool life. As one of the global leaders in tool steel development, Uddeholm and ASSAB focuses on high performance solutions to meet these demanding requirements to prolong the tool life.

Soft zone dies

In advanced press hardening applications, tailored tempering has been developed to improve the crash performance and reduce the weight in a vehicle. By using tailored tempering, it is possible to keep a single part manufacturing and use the design freedom to increase safety and reduce weight.
By implementing dies kept at elevated temperatures called soft zone, in the press hardening process, it is possible to produce components with tailored mechanical properties by controlling the cooling rate in specific areas. This is achieved through localized thermal management in the die-set, often by incorporating actively heated zones.
Actively heated zones are a die insert with electric heating elements installed below the surface. This will ensure that the die is kept at elevated temperature, in a controlled way.

To reduce cross heat transfer between the die sets, insulation plates can be used between the soft zone and cold zone. The insulation plates usually consist of lower thermal conductive materials, e.g., ceramic or steel, and will ensure a better transition of mechanical properties in the finished part.

These heated areas reduce the cooling rate during quenching, promoting the formation of softer bainitic or ferritic-martensitic microstructures, instead of the fully martensitic that has higher hardness. Slower quenching will lower the hardness locally, which will improve the elongation, hence better ductility. This will result in a component with high strength in critical areas, but still have areas with improved ductility for e.g., impact energy absorption during a crash, or post-forming operations like joining or forming.

However, the introduction of heated dies increases the thermal and mechanical demands on the tool steel. Soft zone dies typically run between 550°C to 630°C, this puts a high demand on the die material. The most common failure mechanism is wear and plastic deformation, as a consequence of temper back. This happens when tool steel is exposed to elevated temperatures during a long period of time, which will lower the hardness in the surface. A lower hardness in the die surface will increase the risk of failure, causing more maintenance or even scrapped dies.

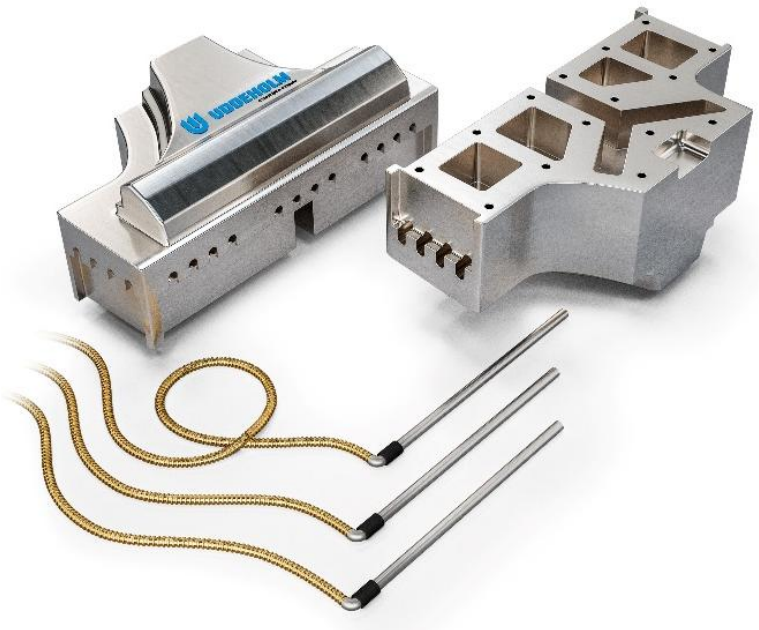
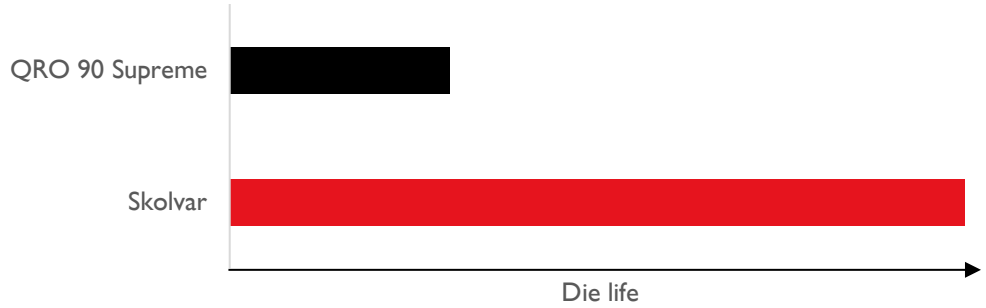


Figure 2 Die insert for soft zone, with heating elements.

Tool steel selection for soft zone dies

Historically, QRO 90 Supreme has been the industry benchmark for soft zone die applications due to its superior resistance to temper back. This property allows the die to retain its hardness and desirable mechanical properties even under long exposure to elevated temperatures. However, our newly deloped material, Skolvar, is specifically developed for hot forming applications and has demonstrated outstanding performance in press hardening for soft zone dies.

Recent industrial trials confirmed Skolvar as a next-generation alternative, delivering more than three times the tool life of QRO90 Supreme by withstanding the extreme thermal and mechanical streses of soft zone forming.



Skolvar delivers the same exceptional temper-back resistance as QRO 90 Supreme while introducing two key improvements: higher achievable hardness (up to 61 HRC) and enhanced abrasive wear resistance. These properties provide a higher initial hardness with outstanding softening resistance, along with the ability to endure abrasive wear even after softening. Due to its patented chemical composition, Skolvar is an ESR-remelted tool steel enriched with vanadium carbides, offering the abrasive wear resistance comparable to cold-work tool steels while maintaining good machinability and weldability. This makes it well suited for maintenance when localized damage or wear occurs. The combination of these characteristics ensures predictable, extended die life, and reduces the total cost of the finished part.

Figure 3 shows the temper back resistance at elevated temperatures. Skolvar and QRO 90 Supreme, in comparison with AISI H13/W-Nr. 1.2344 as a reference steel grade.

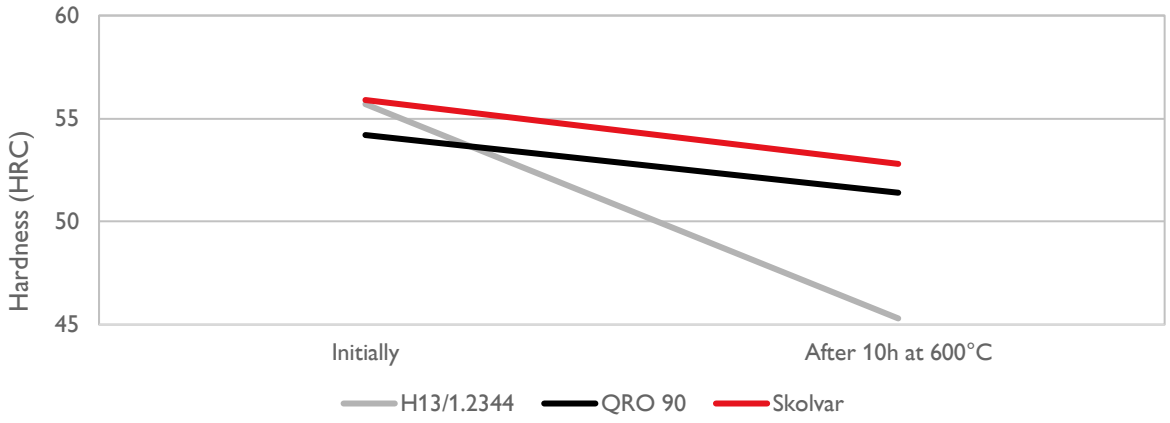


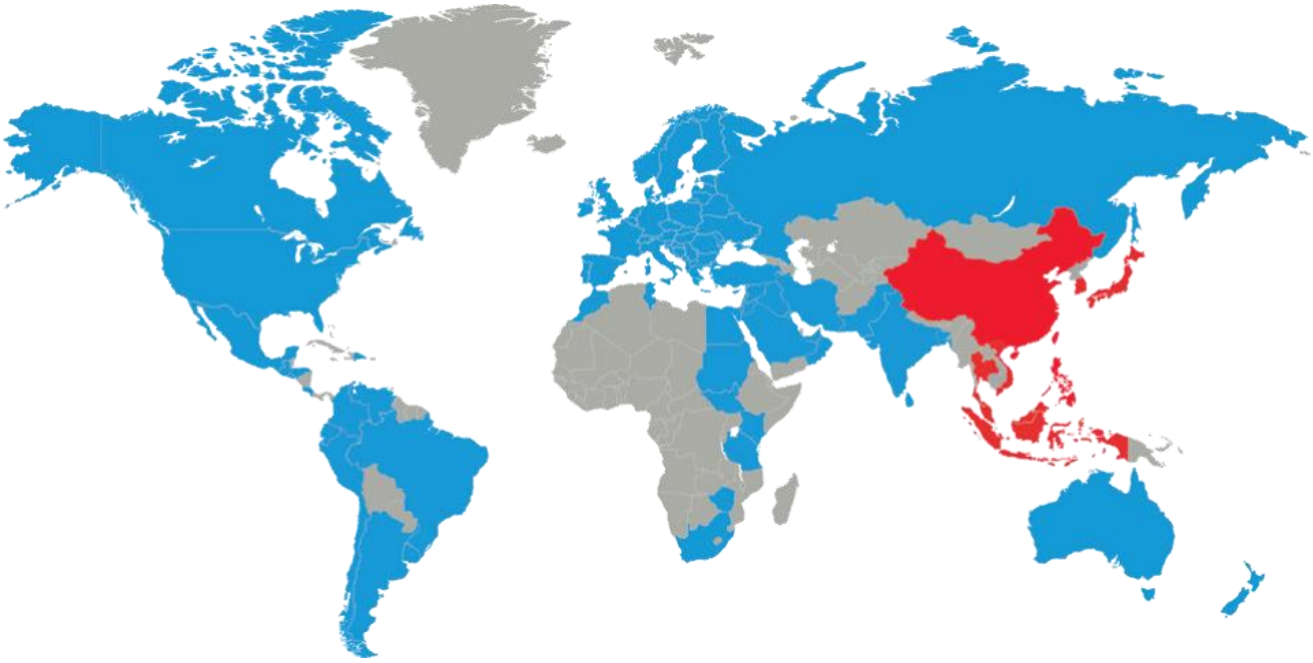
Figure 3 Softening of the material after 10h at 600°C, showing temper back resistance.

For these reasons, we recommend Skolvar as the preferred material for soft zone dies in high volume production. It is an excellent choice when tool performance, uptime and maintenance efficiency are critical to overall process stability, and the importance of making production more cost effective.

Figure 4 Illustration of a die-set with a soft zone insert.

References

[1] E. Billur, *Hot Stamping of Ultra High-Strength Steels*, 1st ed. Cham: Springer, 2018. ISBN: 978-3-319-98870-2.



Choosing the right steel is of vital importance. ASSAB engineers and metallurgists are always ready to assist you in your choice of the optimum steel grade and the most suitable treatment for each application. ASSAB not only supplies steel products of superior quality, but we also offer state-of-the-art machining, heat treatment, surface treatment services and additive manufacturing (3D printing) to enhance your tooling performance while meeting your requirements in the shortest lead time. Using a holistic approach as a one-stop solution provider, we are more than just another tool steel supplier.

In Asia Pacific, ASSAB anchors the distribution network for Uddeholm, a Swedish tool steel manufacturer with more than 350 years of experience in the tool steel industry. Both are integral parts of voestalpine AG, a prominent Austrian-based company listed on the Vienna Stock Exchange since 1995. Together, we establish ourselves as a key player in the steel and technology sector, with a diverse range of products and services.

For more information, please visit
www.assab.com