EFFECTIVELY STRAIGHTENING ADVANCED MATERIALS

WHITEPAPER

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Effectively Straightening Advanced Materials

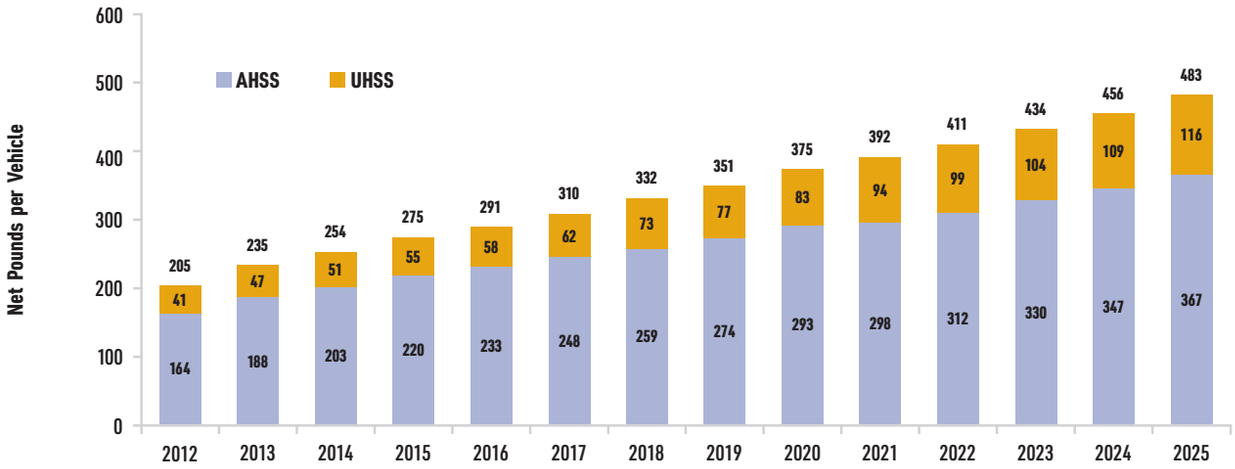
EFFECTIVELY STRAIGHTENING ADVANCED MATERIALS

The most challenging step in the process of delivering AHSS sheet to the press is straightening. We see this as the biggest need in the industry today, and the biggest shortcoming of the equipment that's been manufactured and in use by stampers during the last 30 years or so.

Research shows that AHSS is the fastest growing material in automotive applications. This growth is a direct result of steel's performance flexibility, as well as its many benefits including low cost, mass reduction capabilities, safety attributes, reduced greenhouse gas emissions and superior recyclability.

AHSS offer complex steel chemistries and thermo-mechanical processes for improved strength and ductility, yet challenges stampers with greater spring back, higher yield strengths, thinner materials, and tougher formability issues. Over the past decade, stampers have gained a knowledge base helping them to deal with these challenges and have applied this to the actual die and stamping process. However, to successfully process AHSS, there is a need to look at every aspect of the stamping line – including the press feeding operations and, in particular, straightening.

NA LIGHT VEHICLE AHSS AND UHSS UTILIZATION FORECAST

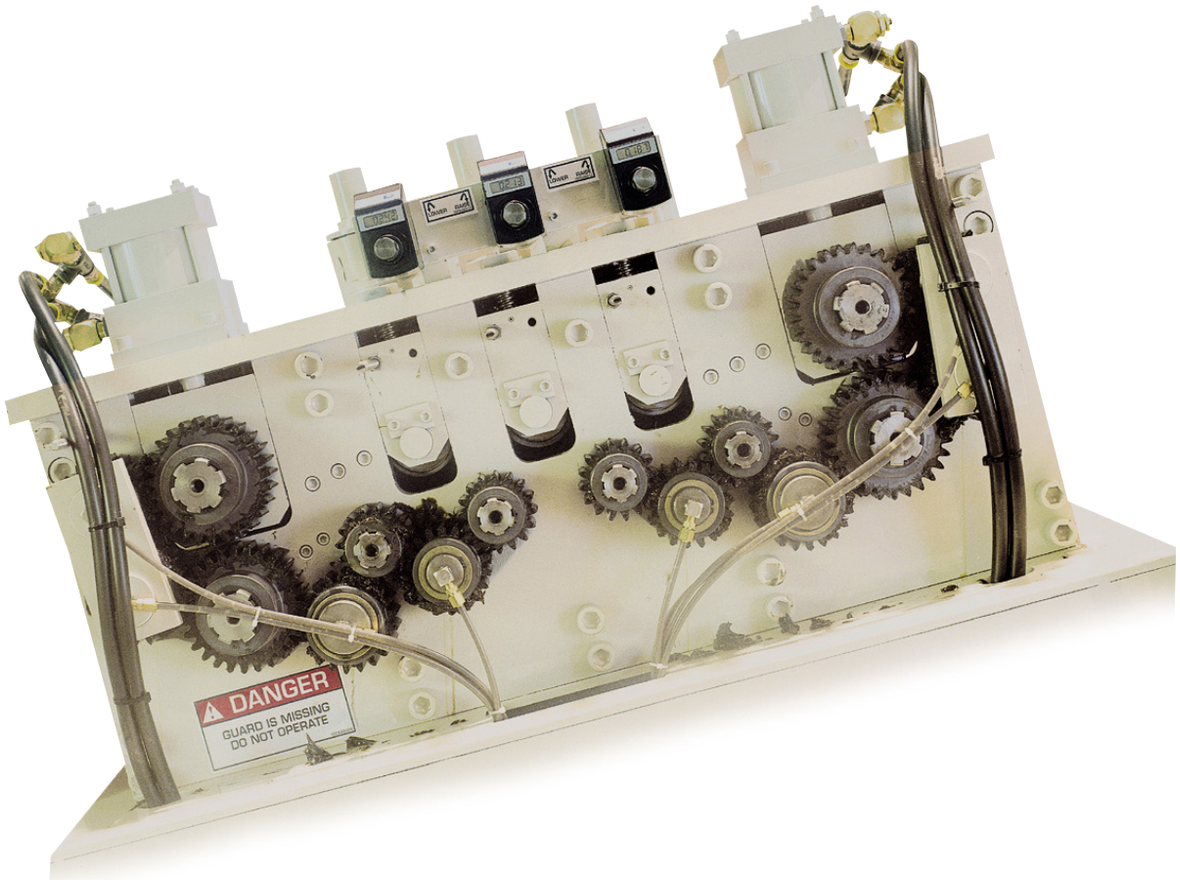


Source: Ducker Analysis

The 2014 average AHSS use in North American produced light vehicles is 254 pounds and expected to nearly double to 483 pounds by 2025. Originally published in the "Advanced High-Strength Steels Application Guidelines, v6"

The purpose of straightening in a typical coil feed line is to prepare the material shape so that an acceptable finished part can be produced from the flattened steel. The requirements for straightening vary depending on the material defects present, the requirements of the die, or the finished part requirements. In the case of forming operations, it may only be necessary to flatten the material sufficiently to pass easily through the die. If blanks are being produced and stacked for further processing or flatness-critical parts are being stamped, then flatness in the continuous coil is extremely crucial.

Straightening is most commonly accomplished by bending the strip around sets of rollers to alternately stretch and compress the upper and lower surfaces to exceed its yield and erase coil set. Then it is reformed in a way so that both surfaces end up the same length after spring back, resulting in flat material. When straightening AHSS greater forces are required, and this influences the straightener design including choice of components, materials and power sources.



A traditional straightener head with a slide block arrangement for upper rolls and a standard cluster gearing for driving the lower rolls. It straightens coil by bending the strip or coil around sets of rollers to stretch and compress the upper and lower surfaces alternately to exceed its yield and remove coil set.

The areas of consideration to develop an effective straightener for AHSS materials are shown here:

WORK ROLLERS

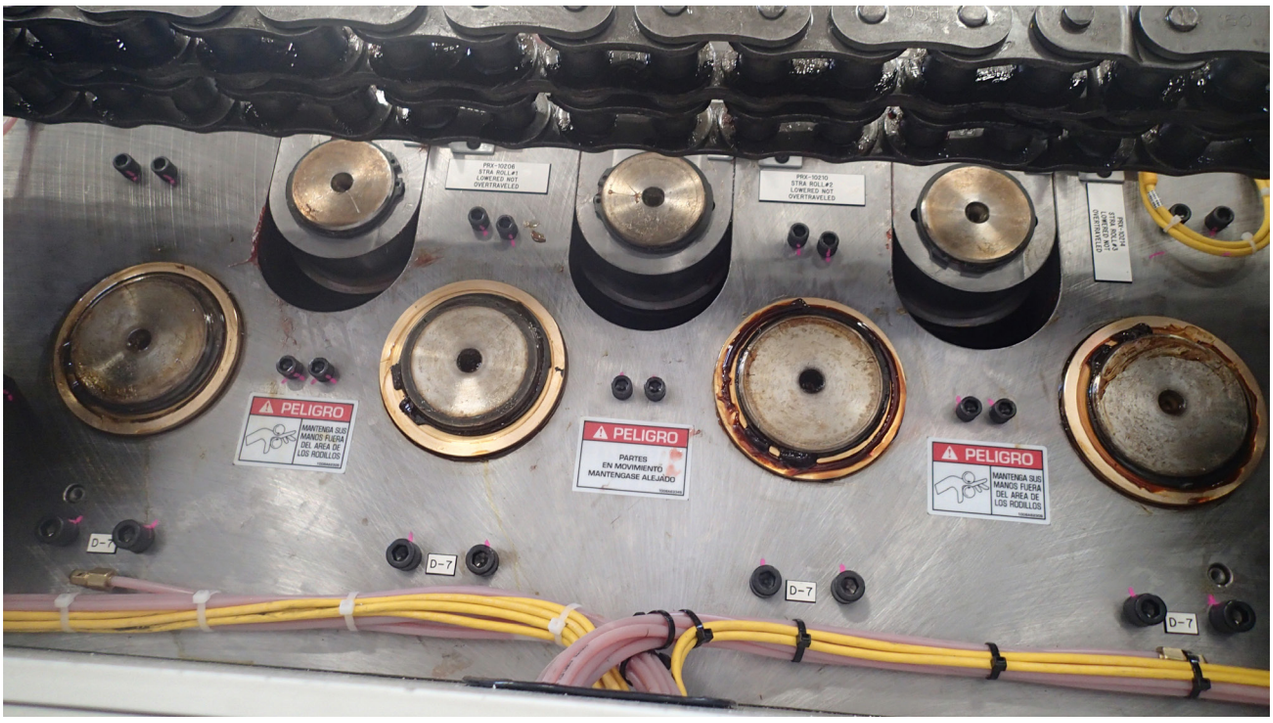
Diameter: Straightener rollers for AHSS generally need to be smaller in diameter to provide a smaller radius around which to bend the material. This is a result of AHSS needing to be bent more severely in order to exceed its higher yield point.

Spacing: Work roller center spacing needs to be closer for AHSS than for comparable mild steel applications. Closer spacing means that more force is required to back bend the material and greater power is required to process it.

Support: Larger journal diameters with bigger radii and larger bearing capacity are needed to withstand the greater roll force and higher power required to straighten high strength material using the closer roller center spacing.

Material: Higher strength materials and special heat treatments must be employed to ensure rollers have the ability to withstand greater stresses for longer periods without experiencing fatigue failure.

Roll Depth Penetration: In order to effectively yield AHSS, the straightener must be designed in a way that the upper rolls have adequate travel between the lower fixed rolls. This can be as much as 50% - 60% greater than what is required for conventional straighteners designed for MCRS.



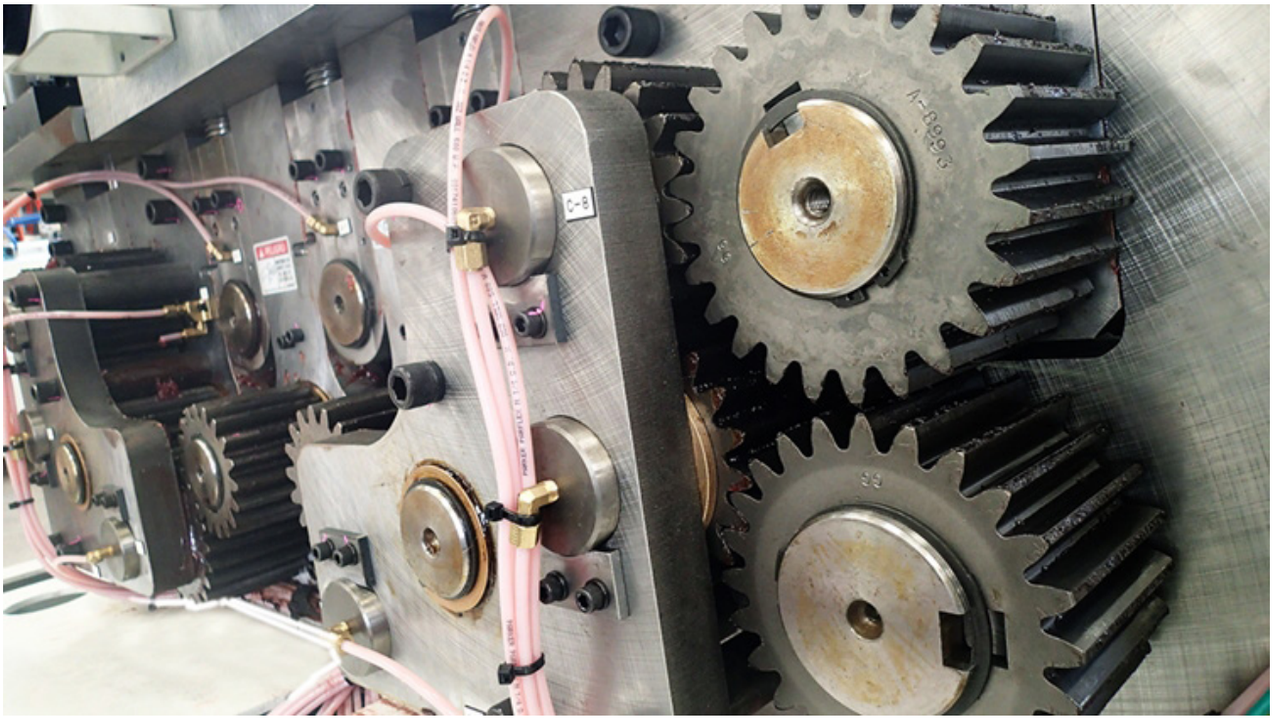
Processing of AHSS requires increased roll depth penetration.

GEARS

Size: Wider gear face widths are required as well as outboard support of journals and idler shafts in order to produce higher gear power ratings.

Positioning: Closer roller center spacing requires higher power transmission and results in a smaller gear pitch radius, which reduces gear power ratings.

Material: Gears should be produced from heat-treated high strength materials to result in stronger gears.



Wider gear face widths required for straightening advanced material

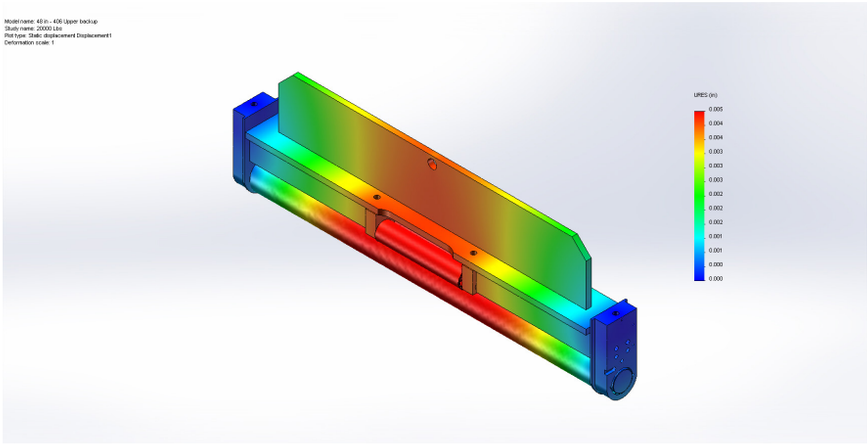
SYSTEM RIGIDITY

Backup Rollers: Given the smaller roller diameters and greater force requirements for straightening AHSS, work roll deflection becomes a much bigger concern. Excessive work roll deflection results in undesirable side effects like material edge wave, increases in journal stresses, and premature gear failures. Backup rollers are often required at the center and intermediate positions of the straightener roll to prevent work roll deflection.

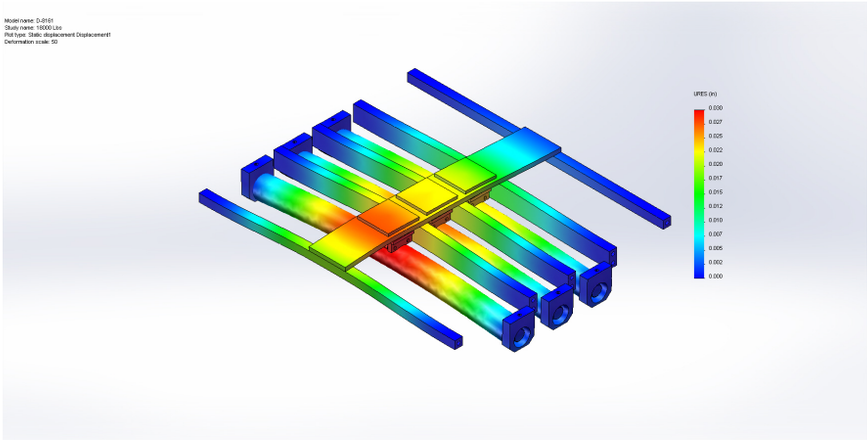
Backup Roller Support: Backup roller support is vital to ensure the effectiveness of the backup rollers and prevent work roll deflection when running AHSS. Backup roller face width and the cross section of the support structure are key to providing proper work roll support. Simply adding screw jacks to narrow cross bars will not provide the backup roller support necessary to achieve a good result.

Journal Support: As mentioned earlier, outboard support of the drive gear journals is also critical to providing the rigidity necessary to withstand the higher horsepower and torque requirements and improve the system gear ratings.

Force Delivery: Closer work roller center spacing leaves less room for the work roller force delivery mechanism. Conventional "off-the-shelf" screw jack designs cannot provide adequate force in this reduced space. COE's experience has led to the development of custom screw jack modules, which can be designed to fit the available space and deliver the higher forces required to effectively yield AHSS.



FEA of conventional straightener roll, back-ups and support bridge. Image shown with 20,000# of force applied resulting in .030" deflection



FEA of COE Series 406 straightener roll, back-ups and support bridge. Image shown with 20,000# of force applied resulting in .005" deflection.

POWER REQUIREMENTS

In general, processing of AHSS requires greater motor power and torque capability to effectively pull the material through the straightener. The higher tensile strength steels require higher horsepower to straighten the material to overcome the higher yield strengths. However, calculating the correct power is based on numerous factors, including:

- Material characteristics – thickness, width, and yield strength
- Maximum coil weight that the straightener must pull-off
- Required processing speed of the coil feed line
- Response/acceleration time of the straightener

A standard COE straightener, capable of processing a wide range of materials including AHSS.

Each application has unique considerations of the above variables and can result in an almost infinite number of outcomes based on the combinations of these variables. To effectively design the straightener for any particular application requires tools that can analyze these requirements.

LOOK FOR PROVEN EXPERIENCE

COE has been supplying straighteners for the processing of increasingly stronger steels for nearly three decades, establishing a knowledge base on the most effective methodologies. When seeking a supplier to help you process AHSS, look for proven experience in:

- Understanding the science of straightening continuous coil steel
- Designing machines capable of creating the necessary forces to process AHSS as well as the robustness to withstand the forces over the long term
- Application tools that engineers and sales people use to predict suitability of a machine design for a particular application

The bottom line – before you make a commitment to a supplier, request documentation that can demonstrate that the proposed machine is suitable for your processing needs. When in doubt, ask questions regarding the machine design using the above considerations as a guideline for the proper straightener specification for AHSS applications.

COE

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