

PANDROL Introduces New VICTOR Fastening System

By Alison Mitchell

Bridgeport, N.J.-based PANDROL USA LP is introducing its new VICTOR fastening system, which is designed to accommodate high axle loads on wood ties. The VICTOR system combines the durability of an American Railway Engineering and Maintenance of Way Association (AREMA) tieplate with the benefits of PANDROL's existing line of resilient rail fasteners.

PANDROL USA Vice President of Engineering Bob Coats said that several railroad conditions came together to create the need for a superior fastening system. In his presentation at the 2003 Railway Tie Association Convention in Charleston, S.C., Coats explained that higher locomotive horsepower, dynamic breaking, more MGTs per year, larger rail sections and tie strength variation led industry experts to consider developing a new heavy haul tieplate design.

Railroad officials developed a set of design specifications for the new heavy haul tieplate. The most critical of these specifications were maximum bearing area contact with the tie, increased bearing area asymmetry toward the field side, a clip housing that is centered on the tieplate, space for four screw spikes and two cut spikes, and, last but not least, a gain in economics over a cast plate.

PANDROL engineers in their U.S. office set to work on creating a new product that would fulfill these requirements. The result is the VICTOR system, a new rolled steel tieplate system for wood ties that uses durable, proven AREMA tieplates, which have a flat bottom with a 37 percent increase in bearing area over existing tieplates for resilient fasteners. "Previously, we had rolled steel tieplates that did not have a flat bottom and so they lost a lot of bearing area. The VICTOR system emerged to meet the needs of today's heavy haul environment," Coats said.

According to PANDROL USA Manager of Engineering Bill Geissele, the VICTOR system is flexible, as it is easily configured for different tieplate profiles and clip styles. It is also economical because it is competitive in cost to a cast ductile iron tieplate. Flat-bottomed



VICTOR tieplates, such as the one shown above, feature space for four screw spikes and two cut spikes.

AREMA tieplates provide maximum bearing area, while the use of PANDROL's fasteners provides all the advantages railroads expect from resilient fasteners: holding power, prevention of rail rollover and reduced maintenance.

Product Development

For years there has been a desire to develop a product such as the VICTOR system that couples rolled steel tieplates with resilient rail fasteners, Geissele said.



PANDROL's VICTOR system is designed to work with its existing line of resilient rail fasteners, including the eClip, above, and the FASTCLIP, right.

Yet, no company had been able to find an economical way to produce them. "The process of creating rolled steel tieplates is extremely economical, and the plates are strong and durable. However, the geometry of rolled steel tieplates must be kept very simple due to the nature of the rolling manufacturing process," Geissele said, explaining that more complicated geometry is required for tieplates utilizing resilient fasteners.

"Traditionally, if a tieplate design required a resilient fastener the only option was to cast the tieplates, usually

out of ductile iron. With a cast plate, it is easy to produce the complicated geometry necessary to mount a PANDROL clip. But, these cast tieplates cannot be as economically or efficiently produced as a rolled steel tieplate," he said. "In order for a cast tieplate to approach the cost of a rolled steel tieplate, the weight and number of cores in the casting process must be reduced. This constrains the most economical cast tieplate to a design with a significant reduction in strength and requires many hollow intrusions into the bottom of the tieplate, which lowers bearing area and increases the tendency of the tieplate to cut into the wood crosstie."

Coats explained that the size of a tieplate's bearing area is important to the overall safety of the railroad. "If a tieplate's bearing area is too small, it will wear into the tie. A plate with more bearing area will allow more tie life and will keep gage consistent by preventing rail spreading."

PANDROL engineers concluded that the solution was to take rolled steel tieplates and add the complicated geometry of the cast tieplates in the form of lightweight, cast ductile iron shoulders. "We adapted an AREMA rolled steel tieplate to the PANDROL FASTCLIP, PANDROL eClip and



Safelok III resilient rail fasteners," Geissele said. "The AREMA tieplates are a strong, proven design, and our new system is an economical way to use plates that already existed."

The cast ductile iron shoulders PANDROL attaches to the AREMA tieplates are easy to cast and only add nominal weight to the tieplate.

How The Ductile Iron Shoulders Are Attached To The Rolled Steel Tieplates

PANDROL uses a proprietary cold forging method called SWAGE to attach the cast shoulders to the rolled steel tieplates. "In the beginning design stages we evaluated the different methods to attach a shoulder to a tieplate, including bolting, welding and riveting," Geissele said. "To bolt the shoulders on we would have to drill holes, thread the holes, supply bolts, purchase the drill bits, actually bolt them on, etc., which is not economically viable. The same principle holds for welding, except that the rolled steel tieplates and the shoulders contain a lot of carbon, which makes them difficult to weld."

The SWAGE method of attaching cast shoulders to tieplates requires no extra components such as bolts, rivets or weld filler. The plate and two shoulders are placed in a large forging press where a section of the tieplate is forced under high pressure into a groove in the shoulder, locking the shoulder and tieplate together. This process is done "cold" or below the re-crystallization point of the metal. "At the steel mill, rolled tieplates come out of

the final form rolls and shear press at about 1,500 degrees Fahrenheit, then they are left to cool down and sit in storage until an opportune time for assembly," Geissele said. "The plates and shoulders are then brought to the forge press where the SWAGE process locks the shoulder and tieplate together at room temperature.

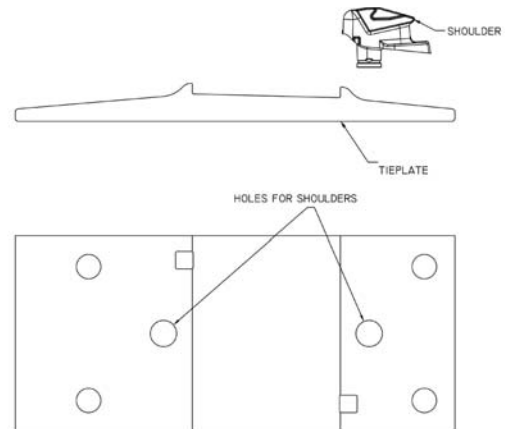
"Much research on the cold forging process was done by the Germans during World War II where they used the process to produce munitions such as artillery shell casings and machine gun barrels. Although the process is still used in certain industries, it has fallen out of favor as the investment casting process has taken over in the manufacture of many precision metal components," he said.

Geissele explained that during a cold forging operation, the applied shear stresses must exceed the yield strength of the metal. Once the yield strength is exceeded, plastic flow of the metal occurs. On a micro-scale, individual grains acquire and retain distortions corresponding to the overall distortion of the component on a macro-scale. As the distortions of individual grains increase, the resistance to deformation

also increases and the metal progressively work hardens.

"We used this behavior of metals under high pressure to our advantage in developing the SWAGE process. The steel of about .45 percent carbon used in AREMA tieplates behaves very well in the limited plastic deformation needed to lock the shoulder in place," he said.


To understand the process, Geissele suggested visualizing a tieplate with a round hole of approximately 1-inch diameter punched on the centerline of the plate just past the raised bosses next to the rail seat, as shown below.



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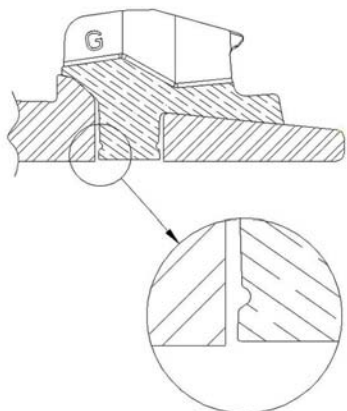
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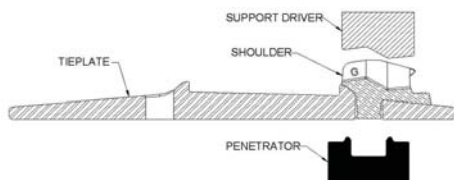


A ductile iron shoulder that has a protruding round stem is placed on top of the plate with its stem inserted into the hole, as shown below.

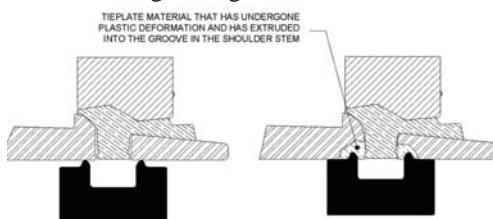


The shoulder stem has an annular groove cast into it that has a profile designed to maximize the strength of the stem near the groove in response to a load applied along the stem centerline.

The tieplate and shoulder are placed on supporting tooling in the forge press and the press is stroked to bring the tooling together (below).

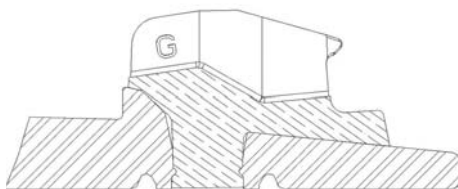


During the press stroke, a hardened steel "penetrator" is forced into the bottom of the tieplate, as shown above. The penetrator is of a hollow, circular profile that encompasses the area near the shoulder stem. As the penetrator enters the tieplate, metal is compressed until it plastically deforms and begins to press against the stem. As the metal presses against the stem, it will flow into the annular groove and exert a force on the sides of the groove, as seen below. Since the shoulder is constrained in the tieplate direction but unconstrained in the penetrator direction, the shoulder stem will slightly elongate. This elongation is very similar to the elongation produced in a bolt due to the tightening of a nut.



After the completion of the press stroke the impression of the penetrator is left in the bottom of the tieplate and the metal

displaced by the penetrator fills the groove in the shoulder stem and positively locks the shoulder in place, such as below.



Not only does the tieplate metal in the groove keep the shoulder in place but also the elongation of the stem produces a favorable compression stress at the surface where the shoulder meets the top of the tieplate. This compressive stress must first be reversed before the shoulder can be even slightly pulled from the surface of the tieplate.

According to Geissele, the VICTOR SWAGE operation will meet or exceed AREMA specifications for pullout strength on a shoulder in a concrete tie. AREMA minimum specifications for pullout strength on a shoulder in a concrete tie is 12,000 lbf, meaning that about six tons are required to pull the shoulder from a concrete tie.

"We have seen consistent pullout strengths of 23,000 pounds for a VICTOR shoulder. Not only is the joint produced by the SWAGE method stronger than a shoulder in a concrete tie, but the design of an AREMA tieplate with raised bosses along the railseat forces much of the rail lateral load into the tieplate, not on the VICTOR shoulder. In a concrete tie, the shoulder sees almost 100 percent of the lateral load," he said.

After just one stroke of the forging press, a VICTOR assembly is removed

from the tooling and is ready for installation in track. The process is fast, requires no extra components other than the tieplate and shoulder, and creates no waste.

Product Testing And Details

Having been researched, designed and developed at the Bridgeport plant, the VICTOR system is currently available for track installation. "We expect to have the system in widespread commercial use this year," Coats said.

Testing of resilient rail fastening systems has also been ongoing at the Transportation Technology Center Inc. in Pueblo, Colo. Experiments there with 39-ton axle loads have shown a five-fold decrease in gage widening when using resilient fasteners on wood ties, which gives strength and credence to the need for a system such as VICTOR.

When using the VICTOR system, railroads will be able to choose between PANDROL's FASTCLIP, eClip and Safelok III fastening systems. Additionally, VICTOR comes with a ROLLBLOCK™ option, which PANDROL has designed to eliminate rail rollover.

Currently, tieplates are being rolled at the Arkansas Steel Associates (ASA) mill in Newport, Ark. VICTOR plates are being assembled at the Southwest Steel Processing forge shop located at ASA. "We only have one mill in the United States making the tieplates at this time," Coats said. "But we'll be able to supply the North American market from this plant."

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