RailEngineer
by rail engineers for rail engineers
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CP6: Planned from the bottom up!

COMMUNICATIONS ON THE CENTRAL LINE

This month's Signalling and Telecommunications Focus includes a look at how Sella Controls and London Underground renewed the Central line's communications control system without disrupting services.

SIGNALLING & TELECOMS

SLAB TRACK AUSTRIA

PORR and ÖBB jointly developed a slab track system that could be a serious contender for applications on UK high-speed lines.

EXPLOSIVE CLAD WELDING

Used for many years in shipbuilding, fastening aluminium superstructures to steel hulls, Nobelclad's system is being used on lightweight trains.

Feature

Signalling & Telecoms

LESLEY BROWN

Explosive clad welding coming to rail now

What's in a transition joint? "More, much more, than meets the eye - when it's explosion welded," says David Gauthier, Market Specialist in Multi-material Transition Joints at NobelClad. Used in shipbuilding for decades, the railway industry is now waking up to the potential of this 'solid-state' technique for joining dissimilar metals that, due to their metallurgy, can't be welded in the traditional manner (by fusion).

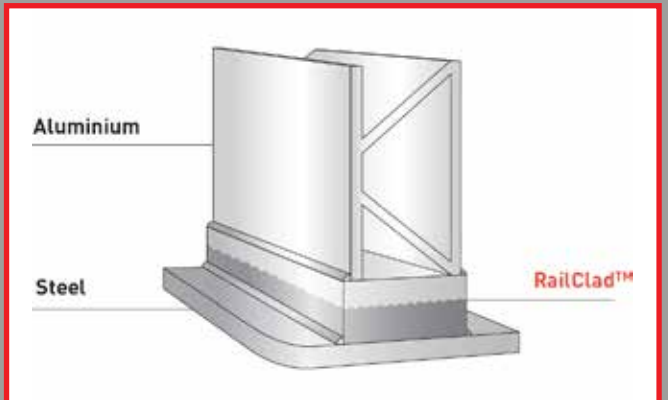
"For over 40 years, we have supplied the shipbuilding industry with these joints for assembling aluminium superstructures and steel hulls," he told Rail Engineer. "Everywhere where it's useful, or necessary, to combine aluminium and steel in the structure, explosion welding is probably the most reliable solution."

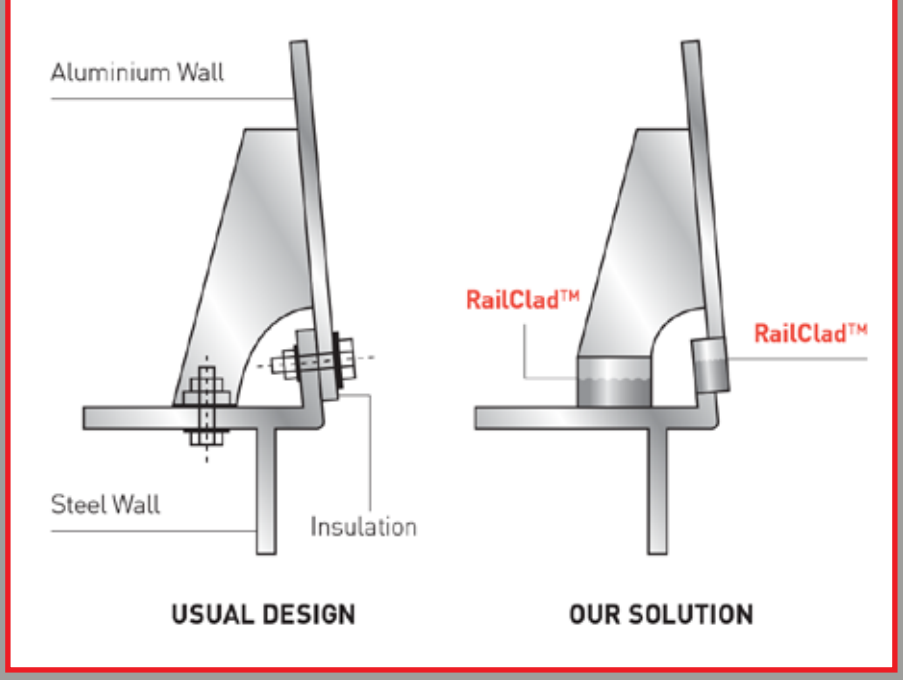
The method uses extremely high levels of energy derived from civil explosives, plus the speed of impact between the two metals, to create a solid-state weld with unique properties (more of which later). "We're not mixing or modifying the metals, yet can achieve an extremely strong metallurgical bond," David explained. "Also, you could say it's a positive process, because we are using the force of an explosive to create, rather than destroy something," he added.

NobelClad has already provided its explosion-clad transition joints (part of the company's RailClad™ range of products) for Alstom's Coradia family of intercity and regional trains, to connect aluminium train decks to the steel chassis.

"With explosion welding, we produce large steel and aluminium plates, then cut them into bars around three-metres long," David Gauthier continued. "Next, these bars are machined to remove excess materials and produce a lightweight, H-shaped profile. So, for the Coradia, half the profile is in aluminium and the other half, the other side, in steel. We call it a transition joint because the customer can then weld on elements in aluminium to steel, and vice versa."

A typical transition joint between aluminium and steel structures.





Explosion welding can replace conventional bolted joints.

NobelClad started the development process with Alstom in 2008 and deliveries in early 2010. To date, the company has supplied these transition joints for 1,000 coaches that are already in service.

Unique properties

For rail engineers, joining highly dissimilar metals such as aluminium to steel represents a challenge during assembly design. Innovative thinking and solutions are needed to join these critical components together into finished structures.

Traditional methods such as bolts, rivets or glues are always options, yet these mechanical fasteners invariably raise questions over installation and inspection costs, as well as failure rates, during the life of the train. Another pressure is the current onus on aspects such as reducing the weight of rolling stock and streamlining maintenance costs.

Explosion welding speeds up production rates, says NobelClad, since the method overcomes the time-consuming issue of assembling several hundred rivets across, say, a 10-metre expanse. The joints have also helped to build coaches with low floors, in line with accessibility regulations now in force. With previous generations of trains, the rivet-based design required a special support structure under the floor. Thanks to the explosion welds, these beams are unnecessary and there's enough room to lower the floors by about 20 to 30cm compared to previous generations.

"By using aluminium and steel together in this way, we can help both lower the floors and lighten the overall weight of the coach," said Mr Gauthier. Then there are the complex flows caused by interaction between the underfloors of coaches and tracks. With a riveted undercarriage, this flying ballast phenomenon tends to break the rivet heads, generating extra maintenance for the train operator. With explosion weld clad, which delivers a flat undercarriage, this problem is effectively eliminated.

Corrosion is another bugbear. It is likely to occur where there's riveting, but hardly likely with explosion-bonded transition joints, which have already proven their worth in shipbuilding for operation in harsh environments near salt-water splash zones. Water tight, they effectively avoid having to add insulation products between riveted plates for sealing.

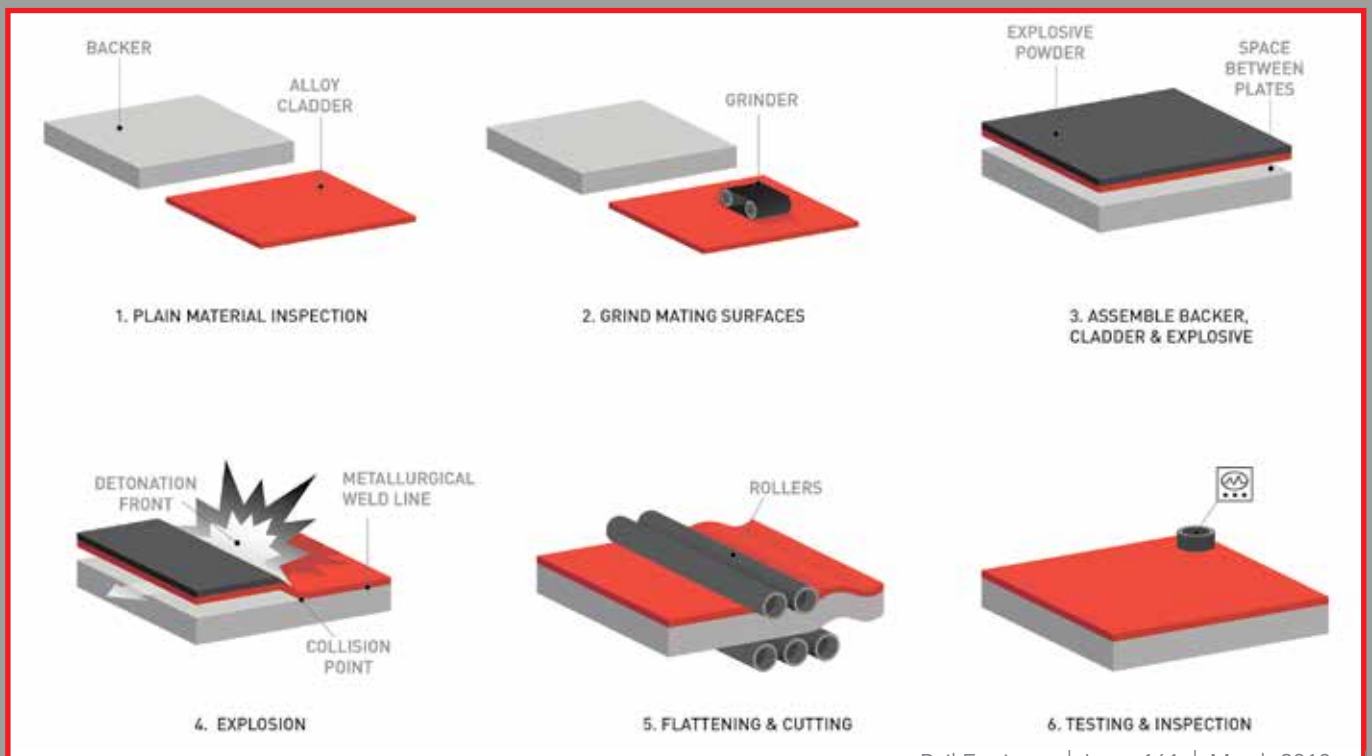
Another benefit of this type of weld is robustness in terms of mechanical resistance. As David Gauthier stated: "We supply bars with a metallurgic bond across the whole surface, which is mechanically far more robust than riveting."

Riveting still matters

Despite the adoption of new techniques such as explosion welding, train builders will continue to count on riveting for assembling similar metals where joints are unnecessary. Also, given their permanent state, explosion weld clads are not suited to parts designed to be dismantled. And then there's the cost factor.

"A handful of rivets is cheaper than one of our bars. So it makes sense that our welding technique is used »

Process for explosion-welding an aluminium-alloy cladding to a steel plate.



Alstom Coradia Liner Intercity train at Paris-Est station.

PHOTO: SHUTTERSTOCK.COM

for applications whereby the benefits justify the extra investment," David commented. At the same time, while the explosion-welded part may cost more upfront, it allows simpler and smarter design and will enable savings over the service life of the train.

Here Mike Blakely, NobelClad's Global Director of Business Development, picked up the thread. "I think a lack of awareness may give rise to the perception of explosion welding being an expensive alternative to riveting. But, once people understand the cost benefits to be gained, like faster production rates in the factory, lighter trains so less energy consumed when in service, they realise it is a viable solution over the long term."

As is obvious from the name, explosion welding is still a form of welding. The process therefore has to conform with the stringent standards governing welded parts for rolling stock. NobelClad's existing RailClad products are certified to EN 15085 'Welding of Railway Vehicles and Components (CWRVC) Class 1' and EN 3834-2:2005 'Quality requirements for fusion welding of metallic materials'.

Trending and driving forces

In 2017, NobelClad saw growing interest in its explosion-welding solution and was contacted by all the European rolling stock builders. The company believes that using hybrid aluminium-steel structures is becoming a significant trend in rail.

One of the drivers behind this innovation could be the Shift2Rail Joint Undertaking. Running from 2014-2020, this European public-private partnership is coordinating research activities with a view to driving innovation in the rail sector.

Given the pressing need to upgrade and maintain Europe's railway networks, Shift2Rail has identified reducing axle loads as one solution for extending the life of rail and track. Consequently, as train constructors explore ways and means of building ever-lighter trains, windows of opportunity (and engineering minds) are opening up to explosion-clad joints.

Efforts to reduce the weight of rolling stock are nothing new - manufacturers have been working on this challenge for years. What has changed is how they can achieve it. Taking a step back from the here and now, it is worthwhile remembering that trains were originally built in steel. Many constructors then switched to all-aluminium build around the 1980s, followed by a gradual return to steel for certain components.

Launched in 2014, Shift2Rail is a public-private partnership platform for cooperation designed to drive innovation in the years to come. Its founding members are the European Union plus eight representatives of the rail industry. Other parties have since joined the initiative.

Shift2Rail activities are organised around the following five 'Innovation Programmes':

» Cost-efficient & reliable trains, including high-capacity & -speed trains;
» Advanced traffic management & control systems;
» Cost-efficient & reliable high-capacity infrastructure;
» IT solutions for attractive railway services;
» Technologies for sustainable & attractive European freight.

SOURCE: unife.org

Explosion welded clad.

"We can produce extremely solid steel structures today that are also extremely refined," David Gauthier affirmed. "Now it's possible to join dissimilar metals through explosion welding, constructors are seeing how they can design around the resulting hybrid structures to deliver benefits like high strength and resistance, and/or to declutter."

"Rolling stock manufacturers are increasingly taking total life cycle and ownership costs into account because their clients are," added Mike Blakely. "The drive to increase the efficiency of trains over their life cycles, for example. In terms of energy consumption and maintenance, is probably working in favour of explosion welding."

NobelClad will be showcasing its hybrid transition joints at InnoTrans 2018. Members of Shift2Rail, will possibly be presenting their work for new hybrid (aluminium/steel) coach bodies at the same exhibition, a design which will include NobelClad joints.

Changing the rail engineering mindset

While NobelClad is fully confident about the performance benefits of its transition joints for rail rolling stock, it admits that a bigger challenge is encouraging a behaviour shift among engineers "to get them to include these hybrid solutions in their designs, because, at the end of the day, we are still competing with 100 per cent aluminium and 100 per cent steel structures."

If taken into consideration from the outset, explosion-welded structural transition joints allow for streamlined designs that shave off extra weight while maintaining critical strength and useful life requirements. They can also take on a wide range of shapes and sizes by sawing, water jet and machining, and be welded on both sides by any customer using conventional techniques.

"It's probably true that, compared to others like aerospace, the rail industry likes to follow the traditional path when it comes to joining different materials and structures," Mike Blakely admitted. "The mindset tends to be 'if it works use it', but not necessarily to go back to the drawing board for redesigning so that it works even better and more efficiently.

"We want to get the good creative engineers to become aware of the beneficial properties of our joints so they run with them during the design phase."

Here Shift2Rail is providing a helping hand. Given its status as a collaborative project with all of Europe's train builders on board, plus funding coming from the European Union, it has generated public attention. As a result, awareness of explosion welding in rail is growing.

"NobelClad has a great deal of experience on two fronts," Mike Blakely summed up. "In one case, standard products ready to ship for which we can share the significant amounts of data collected over the years. In addition, we are fully committed to developing custom solutions and putting them through their paces, so as to qualify the solution as appropriate for the design."

Alstom Coradia Polyvalent.