**Innovation in high speed baseplates and robotic assembly**

Pandrol is revolutionising the way in which baseplates are designed and installed, demonstrating problem solving that changes what’s possible.

For high speed train operation, accurate alignment of the track is of the utmost importance. Where the possibility of significant levels of settlement after construction exists, or where seismic activity is likely, there will be particularly demanding requirements on the range and accuracy available for vertical and lateral adjustment of the rails. When the track is a non-ballasted track form, typically all of this adjustment must be provided for in the fastening system. Given the short periods

available for maintenance, the accuracy, ease and speed with which these adjustments can be made are key attributes of the fastening system.

Pandrol has applied its design and development capabilities to reduce the time taken to make adjustments, the number of parts to be exchanged and the complexity of this important maintenance operation.

MADE FOR HIGH SPEED

The Pandrol Fastclip Baseplate is well suited to high speed. Adjustment is a fundamental requirement and there are several aspects. The range over which adjustments can be made in both vertical and lateral directions; the accuracy with which this can be done; the ease and speed of adjustment and the number and complexity of any additional or exchange parts are all important.

Adjustment may be required on curved track made up of short straight panels, as the position of the fastenings clearly needs to be offset to achieve a smooth alignment. This applies particularly to the lateral baseplate position and becomes more of an issue the tighter the curve. The fastenings must be positioned very accurately to achieve the tight tolerances on track gauge required on high speed track.

The baseplate can be tightened down and held firmly in position at the exact location required. The baseplates can also be slewed slightly relative to the axis of the slab, so that each baseplate is aligned exactly towards the centre of the curve of that the particular slab. This means that every slab can be identical and every fastening can be identically configured.

Only the exact positions of the baseplates fitted to any one slab differentiate it from other slabs in the track. So ‘spare’ slabs needed for repairs are universal and do not need to be purposely constructed with the associated difficulties and lead times. Nor are any bespoke fastening configurations required to achieve exact track alignment.

EXACT PRECISION

High speed lines built in earthquake zones such as Japan and Taiwan have in the past led to a need for relatively high levels of vertical adjustment – typically +50mm. For HS2 in London, the requirement is even greater at +70mm. The difference may not seem large, but the overturning moment that acts on the fastening is greater and any concrete upstands provided to react to lateral loads are further from the top level of prestressing or reinforcement in the base slab. Pandrol has tested the new maximum height adjustment requirement very thoroughly against the relevant European CEN requirement, running 3 million load cycles with a block configured so we could test adjacent assemblies at installation heights of 0mm and +70mm.

On slabs with inclined rail seats, as vertical adjustments are made, the lateral position of the gauge face of the rail changes too. In order to maintain close control of track gauge, vertical adjustments may mean that the components that determine lateral alignment need to be replaced unless, like the Pandrol baseplate, the position of the baseplate itself can simply be adjusted.

For HS2 for example, a +70mm height adjustment on a 1:20 rail inclination results in a 7mm change in gauge. This is much greater than the 2.5mm change that results from a +50mm maximum height adjustment on a 1:40 track, such as in China.

Speed of construction and maintenance are important and the Pandrol Fastclip Baseplate system allows machines to be used to switch the clips between the parked and installed positions to allow for rail change and de-stressing. The rates at which the clips can be applied and extracted are exceptionally high and well known in the UK. Train-mounted optical track inspection systems that allow the positions and surety of non-threaded Fastclip systems to be verified are readily available, and can operate at relatively high speeds – typically up to 160km/hr. As well as speed, these maintenance and inspection systems also help to keep workers off track and increase safety.

The global stiffness of the track controls several aspects of the behaviour of the vehicle-track system, but most track fastenings used on high speed lines incorporate at least one baseplate or steel plate, so that in principle at least two resilient layers can be introduced – one below and one above the plate. Even for a predetermined and specified global stiffness of the whole fastening, the selection of the stiffness of these two individual elements can affect overall dynamic performance.

This in turn may influence the level of wayside airborne noise, as well as the mechanical behaviour of the system in response to the loads applied to it – rail roll, dynamic gauge widening, and so on. This is a complex area where Pandrol has great understanding. But to confirm that its designs provide the best possible mitigation of airborne noise within the given constraints, Pandrol is working closely with the Institution of Sound and Vibration Research (ISVR) in Southampton to test different detailed design options.

ROBOTIC FUTURE

The combination of universal slabs with universal fastenings is an attractive proposition – but is not new. However, what is new and innovative is the way that Pandrol proposes to fit its baseplates to the slabs. Robots will be used to pick baseplates and place them in the exact positions and orientations required – transferring the expertise that the company has built up from its use in its clip manufacturing production lines.

The combinations of baseplate positions on a given slab can be selected at the touch of a button. Scanning assists and confirms the baseplate positioning and the configuration of each slab – and which end is which! This is then coded into an RFID tag that is affixed to the slab before it leaves the factory, so that the curve or transition where it is destined to be installed can be recalled at any time.

Robotic installation of baseplates is greatly facilitated by the fact that the Pandrol baseplate can be largely pre-assembled before it is installed on the slab in the factory. That’s an advantage too when

it comes to the second area where adjustment is essential. This is to maintain the track over its operating life.

A damaged baseplate could be replaced as a self-contained unit. There is no need to dismantle the fastening on track and no need to then know how to correctly reassemble it.

Lateral adjustments are particularly advantageous. The baseplate just needs to be loosened off, moved to the correct position and retightened. No additional replacement parts are required and there is no need to disassemble the fastening.

Vertical adjustments too are simple. The baseplates are loosened off, any additional shims required are slid into place and the baseplate is retightened. The height adjustment shims themselves are a very simple planar design, easily manufactured to whatever precise thicknesses are required. There is no danger associated with assembling shims of different thicknesses in the wrong order.

This robotic process increases the reliability and quality of the installation on which the ultimate quality of the track alignment depends. It also increases the rates of production and reduces the risks of delays or interruptions. Pandrol’s baseplates and robotic assembly are a great example of our future thinking approach which meets the demands and challenges of high speed rail.

