Slab Track Fasteners

Concrete slab track, has evolved considerably in recent decades, particularly in Japan and it comes in many types. Slab track is favoured due to its durability and low maintenance cost. There are a number of rail fastening options available to the slab track designer including the resilient baseplate which anchors the rail to the concrete by means of a resilient fastener.

Conventional rail fasteners use spring clips which apply load to the rail foot. There are limits to the lowest vertical stiffness that can be provided using this method. The vibration performance of the fastener is directly dependent on low vertical stiffness. Therefore spring clip fasteners are useful to a point, but for improved vibration performance, alternative track support products must be used.

Typically the Japanese standard Direct 8 fastening system has a vertical static secant stiffness of around 20 to 30 kN/mm. In order to significantly improve the vibration performance of such a fastener, a significant reduction in that value of vertical stiffness is required.

Pandrol Vanguard

It was on recognising the limit of conventional baseplate technology during the 1990s that Pandrol developed the Pandrol Vanguard system for control of rail vibrations. Pandrol Vanguard works on a quite different principle to conventional baseplates, by suspending the rail at the web and under its head rather than clamping the rail foot. Wedge-shaped elastomeric elements are held in compression against the rail, so that as well as being supported, the rail is secured to the track foundation. This clamping force also provides adequate resistance to contain longitudinal loads in the rail. The principal advantage of Pandrol Vanguard over more conventional rail fastenings is that it allows much greater vertical deflections under traffic without excessive rail roll. The low track stiffness leads to improved attenuation in the dynamic forces generated at the wheel-rail interface, thus reducing the level of dynamic forces transmitted through the fastening and into the track foundation and beyond.

The rubber wedge supporting elements deflect in the shear mode, rather than in compression. Natural rubber, known for its outstanding dynamic performance is the elastomer chosen for the wedge. Pandrol Vanguard delivers a vertical static stiffness of 5 kN/mm and a dynamic stiffness of around 7 kN/mm in a safe manner whilst restricting rail roll and maintaining track geometry.

Pandrol Vanguard delivers high levels of vibration attenuation, but at a much lower installed cost than floating slab track. The exceptional vibration attenuating performance of
Pandrol Vanguard has been measured in numerous locations and documented in published technical papers and journals globally.

Since successful early trials on London Underground Victoria Line in the year 2000, Pandrol Vanguard has been installed in more than 14 countries in at least 80 locations. There are more than 70 track kilometres of Pandrol Vanguard in operation worldwide, most of it in Asia.

Against intense competition Pandrol Vanguard was selected for use throughout the St. Pancras high speed rail terminus in London, UK. It was also selected for use in the high speed rail terminus at Kowloon in Hong Kong.

### Pandrol Vanguard in Japan

A retrofit version of Pandrol Vanguard was developed by Pandrol for Japan that directly fits onto the T-bolt anchoring system occupied by standard Direct 8 baseplates on J-slab track. The tight bolt spacing and low rail height presented a challenge to Pandrol’s designers, since these two geometrical constraints have to remain constant for a successful Pandrol Vanguard retrofit. A version of Pandrol Vanguard that fits onto 50N rail was successfully developed.

In March 2013 Pandrol Vanguard baseplates were retrofitted in place of existing Direct 8 baseplates on a 100m section of viaduct track between Otori and Hagoromo stations on West Japan Railways’ suburban lines in Osaka.

Under live traffic loading Pandrol Vanguard deflects vertically by up to 4mm, which is about three or four times greater than a Direct 8 fastener. Special Pandrol Vanguard “stiffness transitions” were introduced at either end of the 100m trial section where the rail support changes back to standard fasteners.

The viaduct was formed of J-slab on tangent track. Fastener spacing was 625mm, rail inclination 1:40, rail section 50N and the average track speed approximately 60km/h.

The rolling stock was a three car shuttle train that travels between the two stations about five times each hour. The original track was installed in 1973 and little work or maintenance had been necessary since then. The rail was original and there were few signs of excessive or unusual wear.

The switch from regular to Pandrol Vanguard fastener was conducted during night closures of the track. This ensured that there was no disruption to regular operating services.

Planning work by West Japan Railways was excellent and each operator knew their function well. Training sessions had previously been held, which meant that despite some unfamiliarity with the Pandrol Vanguard assembly there were no unforeseen problems.

Existing Direct 8 baseplates were completely removed, but the bolts were left in situ for anchoring the new Pandrol Vanguard assemblies.

A team of 10 operators worked on the first night installation, a number that was reduced to five for subsequent nights (the extra workers were initially needed for unloading baseplates from the works locomotive). Over a period of four nights a total of 324 Pandrol Vanguard assemblies were fitted into the entire 100m trial section of the track.

West Japan Railways (WJR) had undertaken wayside noise measurements several days prior to installation. These measurements were taken in three locations – (i) adjacent to the track at about rail height (ii) under the viaduct and (iii) approximately 12.5 metres away from the viaduct. Further noise measurements were taken once the Pandrol Vanguard installation was complete. Track deflection figures as well as vibration readings inside the driver’s cab of the shuttle train were also recorded.

WJR are conducting a full investigation into the noise levels emitted by the viaduct and they will publish a full report in due course. The findings of that report are expected to confirm the preliminary recordings made shortly after traffic started running over the trial section of track. Sound readings immediately under the viaduct give the insertion loss for the switch over to Pandrol Vanguard. They record structurally radiated noise and are thus a direct measure of the vibration efficiency of the track support. Data supplied by WJR shows that there have been noise level reductions of between 6dB(A) and 8dB(A) measured for traffic travelling in both the up and down directions. Total noise levels for a single train pass event under the viaduct have been reduced down to around 70dB(A).

As well as noise levels, WJR continue to monitor the track and rail condition at regular intervals. This gives assurance that all aspects of normal operations remain unaltered. The only noticeable change in track performance to date is the reduced vibration and structural noise that Pandrol Vanguard delivers. This provides a real benefit for nearby residents.