Development of the Prestressed Ballast Track

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A great deal of labour is required for ballast maintenance work on important lines in Japan including the Shinkansen to ensure that they remain fit for high-speed and high-density train operation. One measure to solve this problem is to replace ballast tracks with directly fastened (ballastless) tracks to eliminate ballast repair work, the aim being to achieve a significant reduction in maintenance costs. If the substructure supporting the track has deformed, however, ballastless track necessitates large-scale repair work due to the difficulty of reconstruction thereby potentially increasing the costs of track maintenance. Furthermore, ballast track is far superior to ballastless track in terms of the time and cost required for reconstruction, should the soil structure be damaged to a large extent by a major earthquake or for any other reason. In the circumstances, therefore, the author is now developing the Prestressed Ballast Track (hereinafter referred to as "PSB Track") as a track structure that allows reconstruction to be carried out easily and with significantly less track settlement than that exhibited by ballast track.

PSB Track has a structure to connect the sleepers and an anchor buried in the track bed with tie rods to provide the required tension and to continuously apply confining pressure on the ballast (Fig. 1). Granular materials, such as ballast, tend to increase in rigidity and strength when placed under confining pressure. According to the results of previous research, it is known that track settlement dramatically decreases when confining pressure equivalent to about 30% of train loads is applied constantly on the ballast. Figure 2 illustrates the results of a repeated loading test of a full-size PSB Track model conducted by RTRI, which proves that track settlement is much less than that of ordinary ballast track. PSB Track also exhibits excellent earthquake resistance because its horizontal resistance is far greater than that of normal ballast track as the sleepers are pressed onto the ballast all the time. Figure 3 shows the results of a test to measure the horizontal resistance (per/sleeper) of a section of PSB Track in the direction perpendicular to the track axis. It also indicates that PSB Track exerts horizontal resistance at least four times greater than that of normal ballast track.

Furthermore, PSB Track allows repair by tie tampers as the need arises. At the same time reconstruction can be carried out easily even when the soil structure has become greatly deformed. In other words, PSB Track is an ideal track structure to rival ballastless track in terms of earthquake resistance and ability to reduce maintenance work, while also enabling reconstruction to be carried out as easily as with ballast track.

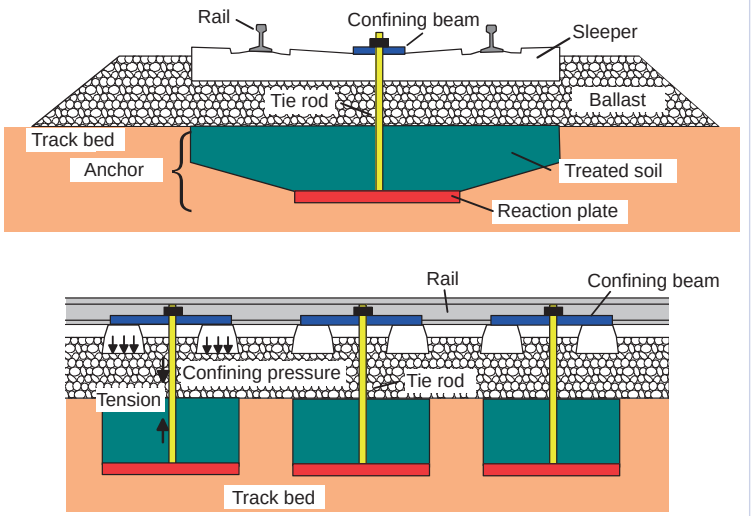

Fig. 1 Basic structure of the Prestressed Ballast Track

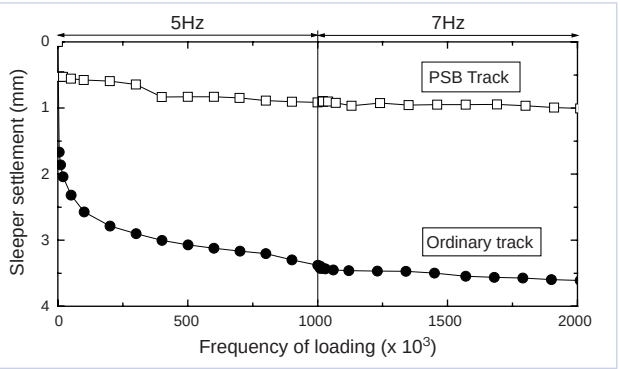

Fig. 2 Results of a repeated loading test on PSB Track (axle load 160 kN)

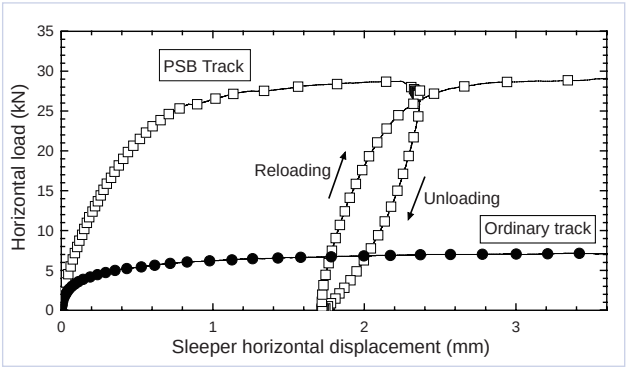

Fig. 3 Results of a horizontal resistance test with PSB Track