Track Stiffness and Impact

The effects of wheel defects on wheel/rail impact loadings have been addressed in a prior *Tracking R&D* article (*RT&S*, September 1986). Previously though, the main thrust in this column has been the consequences of surface anomalies or "defects" (wheel tread or the rail head) and the effects these have on the dynamic wheel/rail loading.

Another closely related item, however, that has come under recent scrutiny, is the contribution of the track structure itself, and particularly its relative stiffness to the same wheel/rail impact forces. With growing attention being paid to concrete ties, and the corresponding increase in stiffness (or track modulus) these bring to track, the effect of this increased stiffness on the dynamic wheel/rail forces has also taken on greater importance.

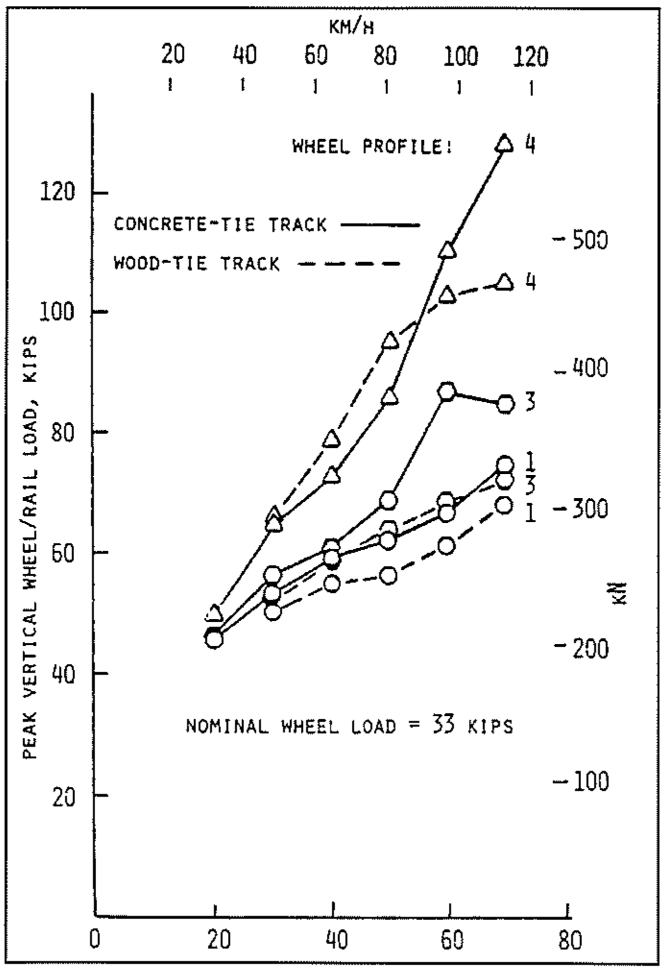

Figure 1 — Peak vertical impact load on concrete-tie track versus good wood-tie track

Track stiffness or vertical track modulus is defined as the load per unit length of rail required to depress the rail by one unit.[1] Tests at FAST have shown that for similar track structures (on very similar subgrades), concrete tie track has modulus values that are more than twice that of comparable wood tie track.[2]

Increase good, but . . .

In general, a relatively high track modulus is beneficial, since it results in decreased track deflection under

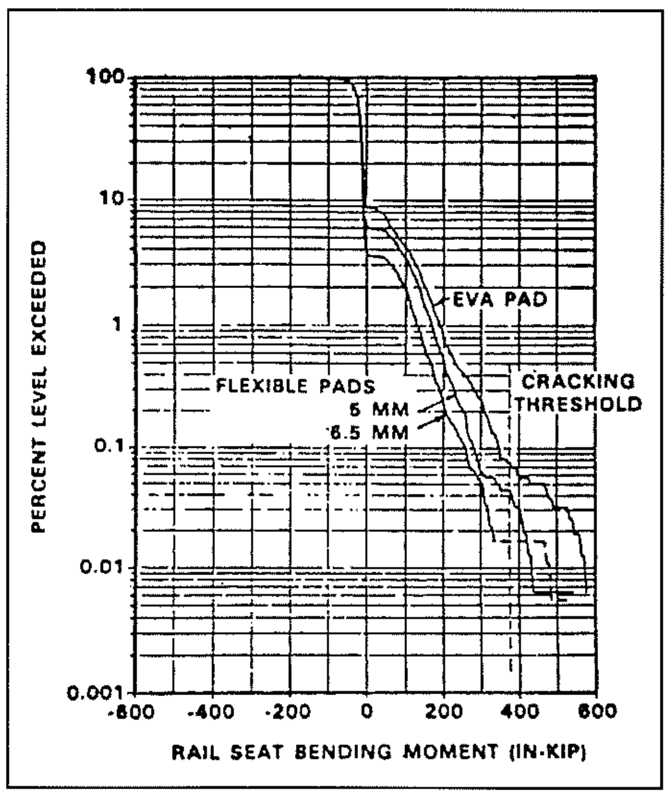

Figure 2 — Statistical comparison of rail seat bending moment under three different pads on NEC track

wheel loadings, and correspondingly reduces track deterioration. However, in the presence of rail or wheel anomalies that cause dynamic wheel/rail impacts, increased track stiffness or modulus can lead to a direct increase in the dynamic wheel/rail forces.

An analysis of the dynamic wheel/ rail forces under known wheel imperfections was carried out recently for wood tie and for concrete tie track.[3] The test employed actual measured wheel tread profiles for various wheel "flat" or "out-of-round" conditions. Dynamic wheel/rail forces were then analyzed as a function of train speed and track structure, that is wood vs. concrete tie track. The results are shown in Figure 1. It can be seen that the more resilient wood tie track, with its correspondingly lower track modulus, has generally lower dynamic wheel/rail impact forces than concrete tie track subjected to the same wheel conditions and speeds.

Figure 1 depicts also that three different wheel anomalies were evaluated: wheel profiles 1, 3, and 4. In two cases, 1 and 3, the concrete tie track always produced higher peak loads. In one case, profile 4, the concrete tie track produced higher loads in the higher speed ranges.

Pads important

In order to minimize loads in concrete tie track, softer rail pads (rubber or comparable) are installed to attenuate high wheel/rail impact loadings. The pads also reduce overall track stiffness.[3] The results of using softer and more flexible rail pads is illustrated in Figure 2. It demonstrates a significant (statistical) reduction in track response in concrete tie track using the flexible rail pads.

It thus would appear that a trade-off must be considered in addressing allowable levels of wheel and rail anomalies as well as overall track resiliency when making the decision to upgrade the track structure.

References:

1. Hay, W. W., Railroad Engineering, Second Addition, John Wiley and Sons, N.Y., 1982.
2. Kish, A., et al, "Track Structures Performance, Comparative Analysis of Specific Systems and Components Performance," Dept. of Transportation Report FRA/ORD-77/29, September 1977.
3. Harrison H.D. and Ahlbeck, D.R., "Railroad Track Structure Performance Under Wheel Impact Loading," Transportation Research Board, 66th Annual Meeting, January 1987.