What is Track Quality

The importance of proper support of the track structure is obvious to track engineers. However, the 'art' of determining the adequacy of this support — specifically the definition of the conditions of ballast, sub-ballast, and subgrade — has historically been vague and subjective. In fact, the determination of the quality of track support is extremely difficult, and it usually results in various interpretations of track support conditions.

The degradation of the track surface geometry, which is a result of track support variation, is often used as the monitor for this track support condition. This is particularly true with the increasing use of track geometry cars, because of the relative ease of monitoring surface degradation. However, the approach is one of looking at effect rather than cause.

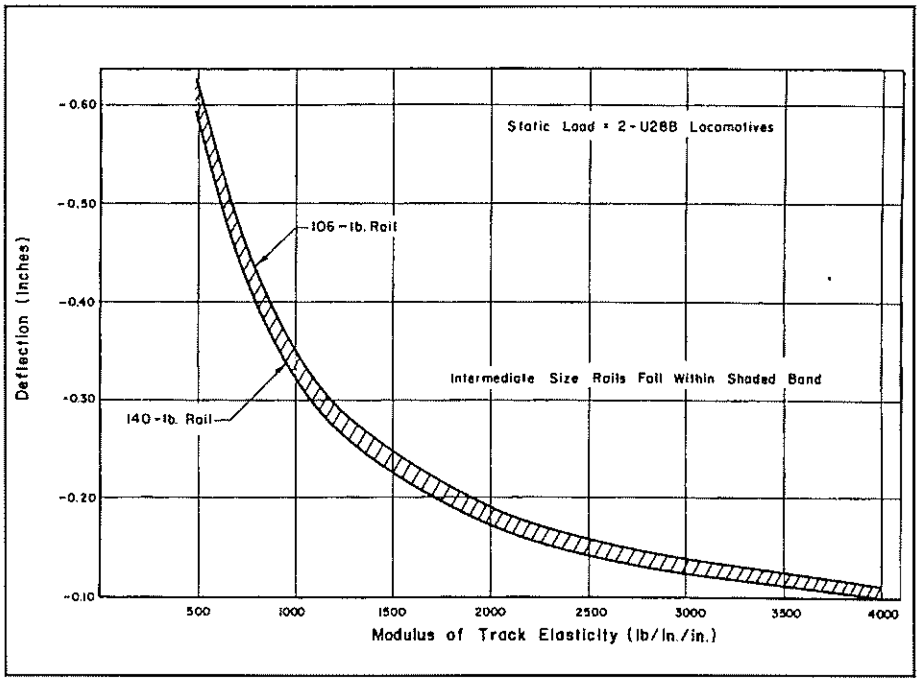

Figure 1 — Effect of track modulus on deflection for various rail sizes

A useful, old definition

One definition of track support condition has, in fact, been in existence for over 100 years. It is a theoretical model which assumes that track behaves like a continuously supported beam, the rail resting on a uniform layer of springs spaced continuously along the track. This is often referred to as the "beam on elastic foundation" theory. It was proposed by Winkler in 1867, and made known widely in North America by Professor A. N. Talbot and his ASCE-AREA "Special Committee on Stresses in Railroad Track."[1] The model introduces a term *u*, the vertical track modulus or "modulus of elasticity of rail support." In reality, *u* is a measure of the vertical stiffness (or elasticity) of rail support. Such *support* includes the ties, ballast, subballast, and subgrade layers of the track structure. In fact, *u* is a term which relates the deflection of the track under loading, and is relatively independent of the rail section. This can be seen in Figure 1, which shows the relationship between track modulus and vertical track deflection.

Numerous tests carried out by the Talbot Committee (and subsequent researchers) have developed relationships between track configurations and track modulus values. They provide insight into the value track modulus has in defining quantitatively the support condition of the track structure. There are other collections of modulus data, based on static field tests for different track configurations. (For one, see Reference 2 given below.)

As can readily be seen from the table the lower the track modulus the poorer the track support condition. Consequently, the lower the track modulus the larger the track deflection under load (Figure 1[3]).

Subsequent research and testing have shown that highly desirable track will have modulus values of 2500 lb./in./in. or more. Modulus values of 7000 lb./in./in. and higher have been measured for concrete tie track. However, wheel-rail dynamic effects must also be addressed at the higher modulus values.

Dynamic interpretation

While the track modulus value has been a useful means of defining track support, it has always been obtained through static (stationary) testing. While several alternative ways have been developed to calculate modulus, they have always required static test data.

More recent research, though has been directed towards determining track modulus under a moving vehicle. At least one of these activities[4] has reported high correlations between observed variations in track stiffness signatures and the actual conditions of track structures and subgrade. Other independent research activities seem to confirm the potential viability of obtaining track modulus values from moving vehicles.

This approach offers the *potential* of obtaining quite valuable measurements of the quality of track support in an effective and efficient manner, such as off of a high-speed track measurement vehicle like the track geometry car.

References:

1. Talbot, et al., "Stresses in Railroad Track-The Talbot Reports", American Railway Engineering Association, 1980.
2. Hay, W. W., "Railroad Engineering-Volume One", John Wiley and Sons, 1953.
3. Butler A. B., "An Analysis of Bending Stresses and Deflections in Railway Rails", Master's Thesis, Dept. of Civil Engineering, University of Illinois, Urbana, Illinois, 1969.
4. Hayes, G. et al., "Track Stiffness Measurement System Evaluation Program", Federal Railroad Administration Report FRA/ORD-79/30. December 1979.