Identifying Vibration-Sensitive Work Zones

Compaction is an essential and integral process in hot mix asphalt (HMA) pavement construction. Compaction reduces airvoids and enables HMA to achieve the desired level of density . A combination of static and vibratory rollers typically are used for compaction, although vibratory rollers are preferred because of their efficiency. However, vibratory rollers cause greater ground motion than static rollers, and may damage adjacent infrastructure particularly in densely populated urban areas when the vibrations exceed threshold values. Examples of such damage include the separation of masonry blocks or cracks developing in foundations.

The Florida Department of Transportation (FDOT) has developed a methodology and analysis software to identify areas where vibratory compaction is not recommended during construction of Hot Mix Asphalt (HMA) pavements. Implemented in 2007, this methodology helps pavement engineers reduce the risk of structural damage and human annoyance by predicting areas sensitive to vibrations. The methdology uses Falling Weight Deflectometer(FWD) data to predict ground motion induced by vibratory compaction. Both the vibratory roller and the FWD apply dynamic impulse loads to a pavement surface, and most of the currently used FWDs are capable of collecting load-deflection time histories. Using this information, FDOT engineers have determined that FWD data collected during pre-design testing can be utilized to predict vibration-induced ground motion.

Various federal, state, and foreign agencies have proposed criteria to limit the impact of man-made vibrations to structuresand humans. Two of these criteria (U.S. Office of Surface Mines Blasting Level Criteria for Major and Minor Structural Damage, and German DIN 4150 Standard Level for Human Annoyance) were selected to guide FDOT's recommended practice (Figure 1) for limiting vibratory compaction in critical work zones. FDOT engineers used these criteria to differentiate on a plot three distinct zones of peak particle velocity versus vibratory roller frequency.

The vibration analysis methodology in Figure 2 provides a method of quantifying vibration-sensitive portions of resurfacing projects during routine pre-design testing without a detailed knowledge of the pavement structure or the geology of the surrounding site. When a project is identified as potentially vibration-sensitive, full FWD displacement time histories are recorded, and a plot of peak velocity versus scaled range is developed. The plot provides an upper bound predictor of ground motion at the site. By knowing (or assuming) a frequency of the vibratory roller used during construction, the user determines the peak particle velocity to identify locations where vibratory compaction should be avoided.

Since implementation, FDOT has collected FWD time histories on all pre-design projects during routine testing to evaluate vibratory impact and to determine appropriate vibratory roller usage. The methodology has enabled FDOT engineers to reduce incidental damage to adjacent infrastructure and decrease human annoyance complaints.

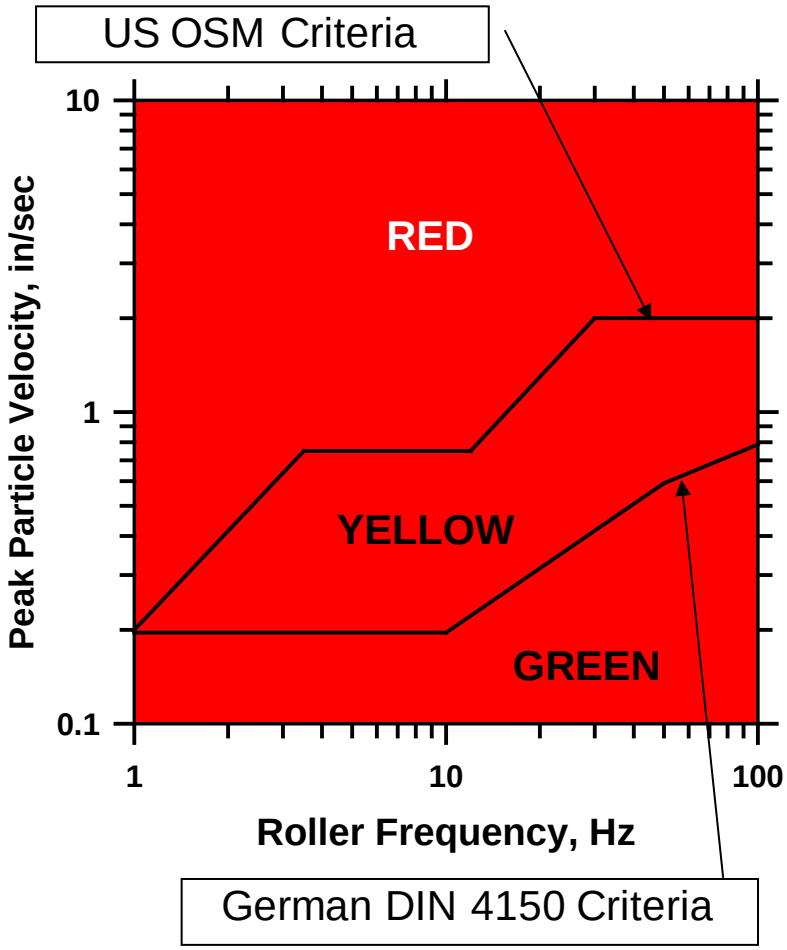

Figure 1 FDOT Adopted Vibration Threshold Criteria

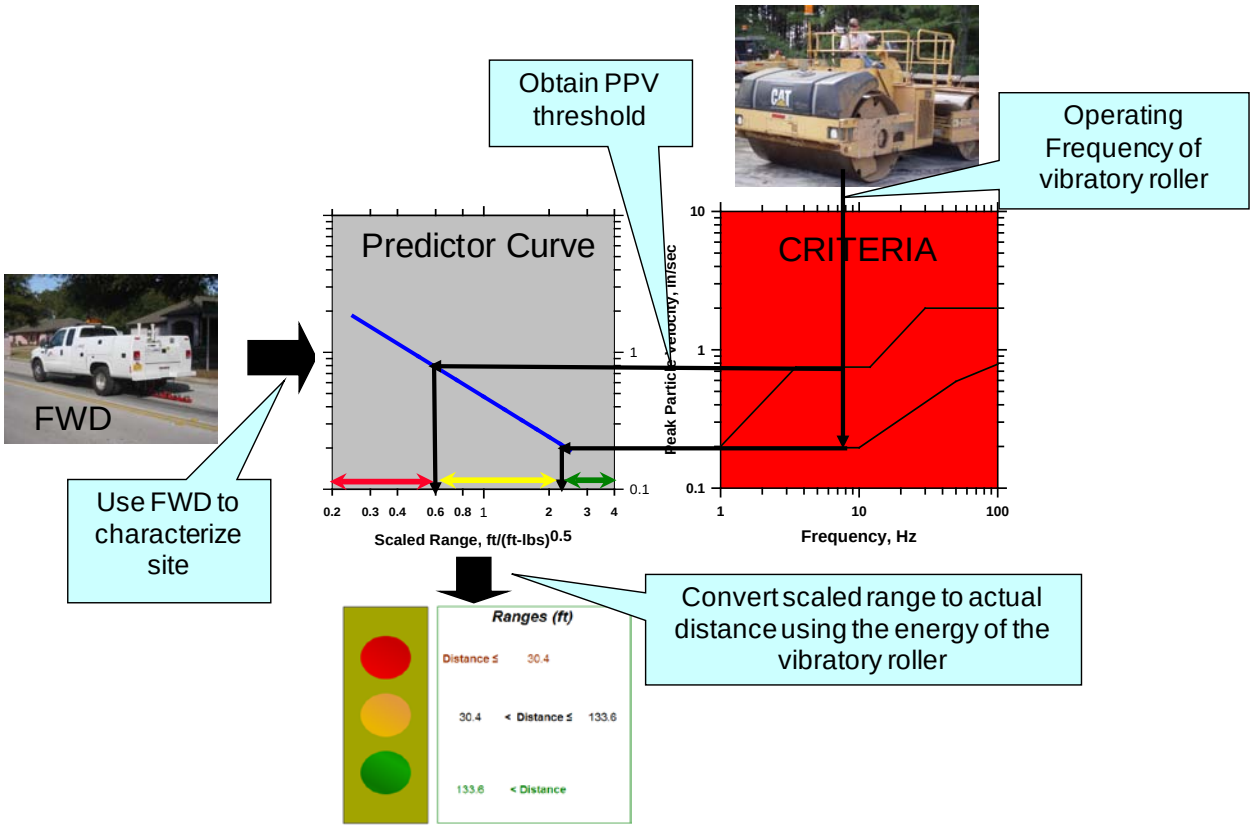

Figure 2 Overall Vibration Analysis Procedure