RMRC Project 41: Determination of Moisture Damage (Stripping) Potential of HMA With Recycled Materials Using Accelerated Loading Equipment

Introduction

Across the United States, recycled materials, most notably the Recycled Asphalt Pavement (RAP) are used widely as an alternative source of pavement material for construction. Most state agencies allow the use of at least 10%-15% RAP in their mixtures. To develop a performance based mix design procedure with RAP, it is important to monitor the performance the HMA mixes with RAP under repeated traffic loads and environmental conditions. One of the important performance indicators is the resistance of the mix against moisture damage or stripping. Stripping occurs when the cohesive bond between asphalt film and aggregate is lost due to the simultaneous action of existing moisture in the pavement and traffic load. At the plant, the RAP is mixed with preheated virgin aggregates before the virgin asphalt is added. In the lab, as performed by NH DOT and contractors, RAP is preheated for 2 hours before mixing with virgin aggregates and virgin asphalt. Both of these processes and the underlying design procedure assume that complete blending between virgin asphalt and asphalt already present in RAP occurs. It has been reported in various studies that complete blending does not occur and addition of RAP to a HMA mix changes the mechanical properties of the mix which includes the volumetric properties and stiffness. In many situations the field RAP particles contain moisture. The incomplete blending of binders and change of mechanical properties can cause any moisture trapped inside the pores or on the surface of the RAP aggregates to induce more damage under loading than it would have caused without RAP. Therefore, there is a need to investigate the effect of RAP on the resistance of HMA against moisture damage.

Materials and Methods

This project involved testing of various HMA mixes with an accelerated loading device, the third-scale Model Mobile Load Simulator (MMLS3). The MMLS3 was used for testing control samples containing all virgin materials as well as samples containing RAP. The samples were tested in the dry and wet conditions and the rut depths were measured at increasing load cycles. The rut depths were then analyzed to evaluate the rutting resistance of samples containing RAP.

Six different mixes were tested; four control mixes containing all virgin materials and two mixes containing RAP. The first mix contained 19mm Nominal Maximum Size Aggregate (NMSA) Continental fractured stone with 5.0% AC. The second mix was a 12.5mm NMSA Continental fractured stone mix with 5.5% AC. The third mix contained 19mm NMSA Ossipee gravel stone with 5.0% AC. The fourth mix contained 12.5mm NMSA Ossipee gravel stone with 5.6% AC. The first RAP mix was a 12.5mm NMSA Farmington gravel stone mix with 14.4% RAP and 5.5% total AC. The second RAP mix was a 12.5mm NMSA Hooksett fractured rock mix with 14.5% RAP and 5.5% total AC. All six mixes used PG64-28 virgin binder. The six mixes are summarized in Table 1 and the RAP mix characteristics are summarized in Table 2.

Table 1: Mix Characteristics

Mix Name	Aggregate	NMSA	%AC	%RAP
Continental 19mm	Continental fractured stone	19mm	5.0	0
Continental 12.5mm	Continental fractured stone	12.5mm	5.5	0
Ossipee 19mm	Ossipee gravel stone	19mm	5.0	0
Ossipee 12.5mm	Ossipee gravel stone	12.5mm	5.6	0
Farmington 12.5mm	Farmington gravel stone	12.5mm	5.5	14.4
Hooksett 12.5mm	Hooksett fractured rock	12.5mm	5.5	14.5

Table 2: RAP Mix Characteristics

Mix Name	RAP NMSA	% RAP	%AC Total	%AC Virgin	RAP %AC
Farmington 12.5mm	11.1mm	14.4	5.5	4.92	4.0
Hooksett 12.5mm	11.1mm	14.5	5.5	4.92	3.6

With the exception of the two Ossipee mixes, samples from each mix were tested in both the wet and dry loading conditions. The Ossipee mixes were tested in the dry condition only. Wet tests were conducted at a target temperature of 50°C and dry tests were conducted at a target temperature of 60°C. During the tests, pavement temperatures were recorded using thermocouples. Because the wet and dry tests are run at different target test temperatures, the rut depth data was normalized to a single test temperature, 50°C. Normalization of the test data also eliminates any uncontrollable fluctuations in test temperature. With the data normalized to a single temperature the rutting resistance is more accurately compared and evaluated.

Results

Average rut depths for each mix were calculated from the seven samples in each test. The average rut depths for each of the tests are compared in Figure 1. Dry tests are shown as dashed lines while wet tests are shown as solid lines. The RAP mixes did not demonstrate rutting that was significantly different from the control mixes. Both the Farmington and Hooksett mixes tested in the wet condition showed rutting that was on average less than all other mixes. When tested in the wet condition, the Farmington RAP mix rutted at least 1mm less than the control samples while the Hooksett RAP mix rutted at least 1.3mm less than the control samples. This can be seen in the wet test comparison shown in Figure 2. When tested in the dry condition the Farmington and Hooksett RAP mixes rutted less than three of the four control mixes. This can be seen in the dry test comparison in Figure 3. The Farmington and Hooksett RAP mixes rutted a maximum of 3.2mm and 2.6mm respectively, while other control mixes rutted between 2.2mm maximum and 5.6mm maximum. Figures 4 through 7 show the Continental 12.5mm, Continental 19mm, Farmington, and Hooksett individual wet and dry test comparisons.

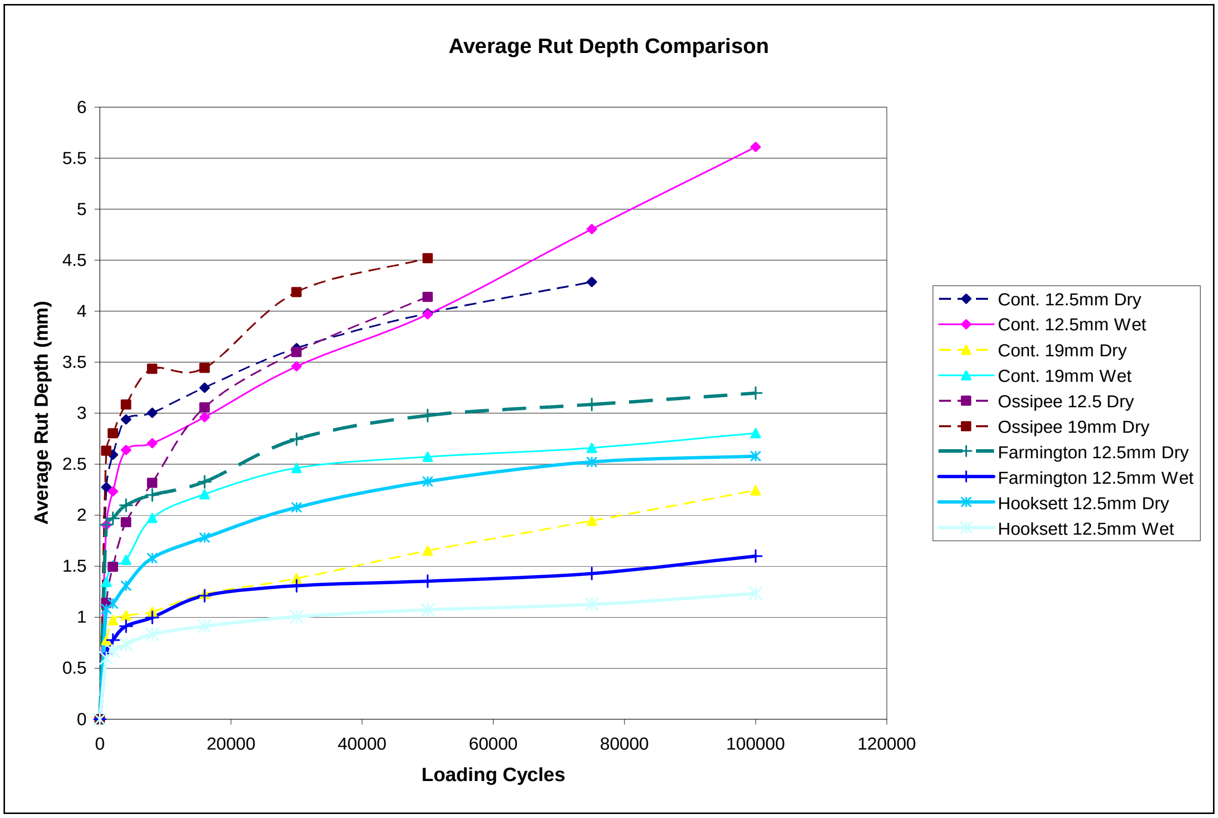

Figure 1: Wet and Dry Test Comparison

Figure 2: Wet Test Comparison

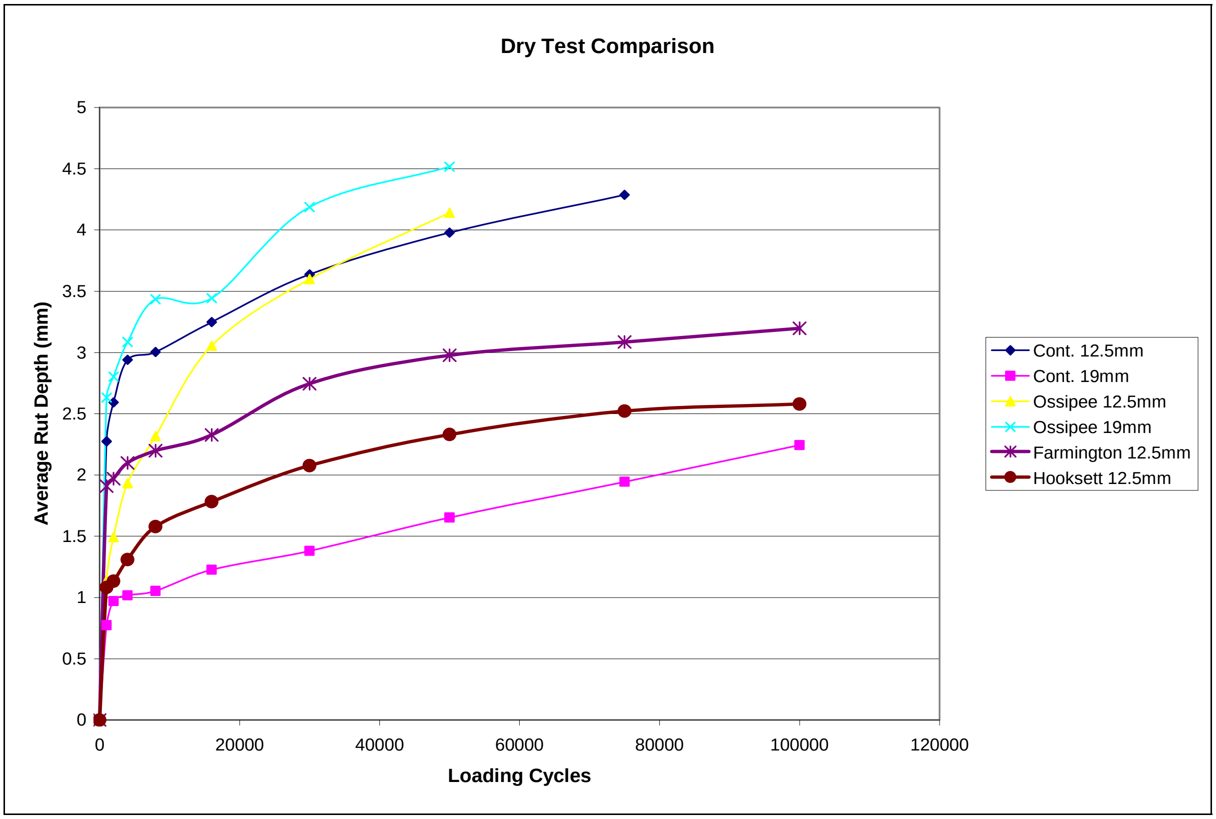

Figure 3: Dry Test Comparison

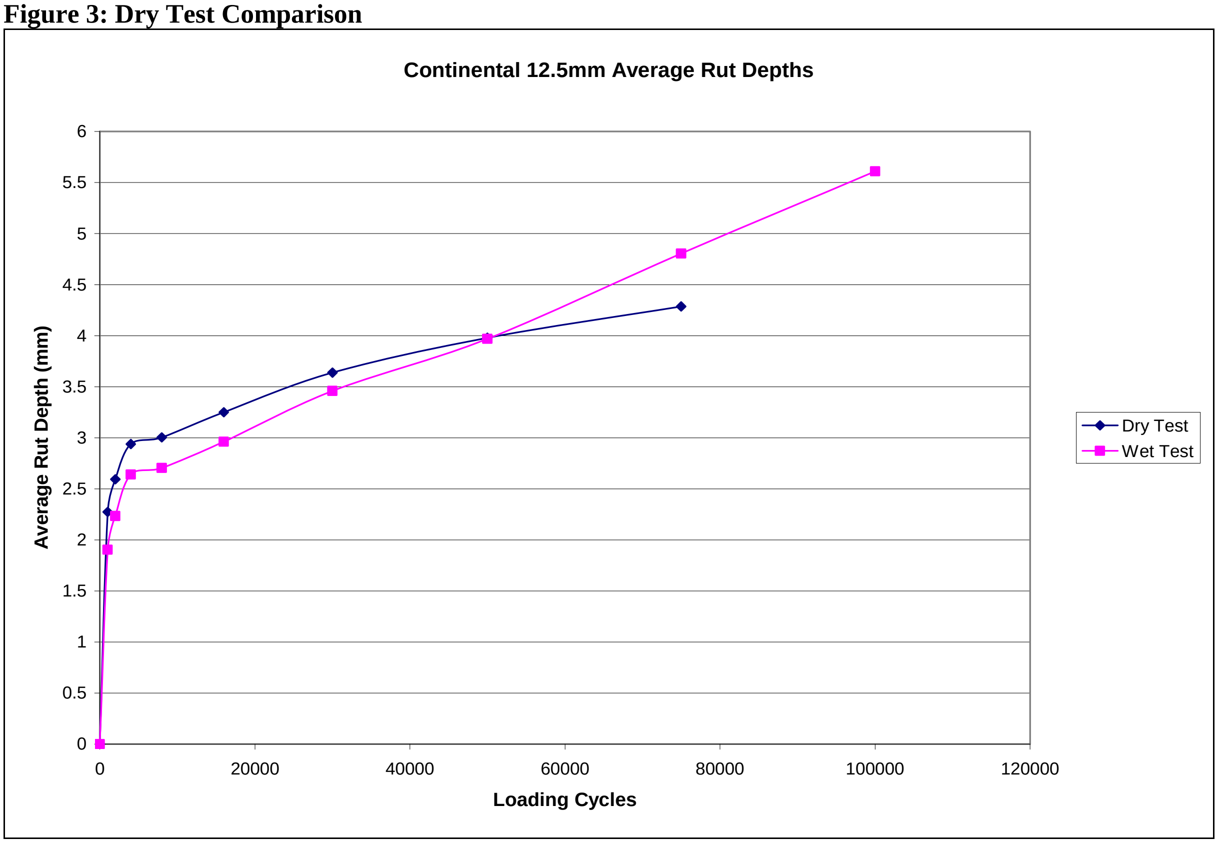

Figure 4: Continental 12.5mm Wet vs. Dry Rut Depths

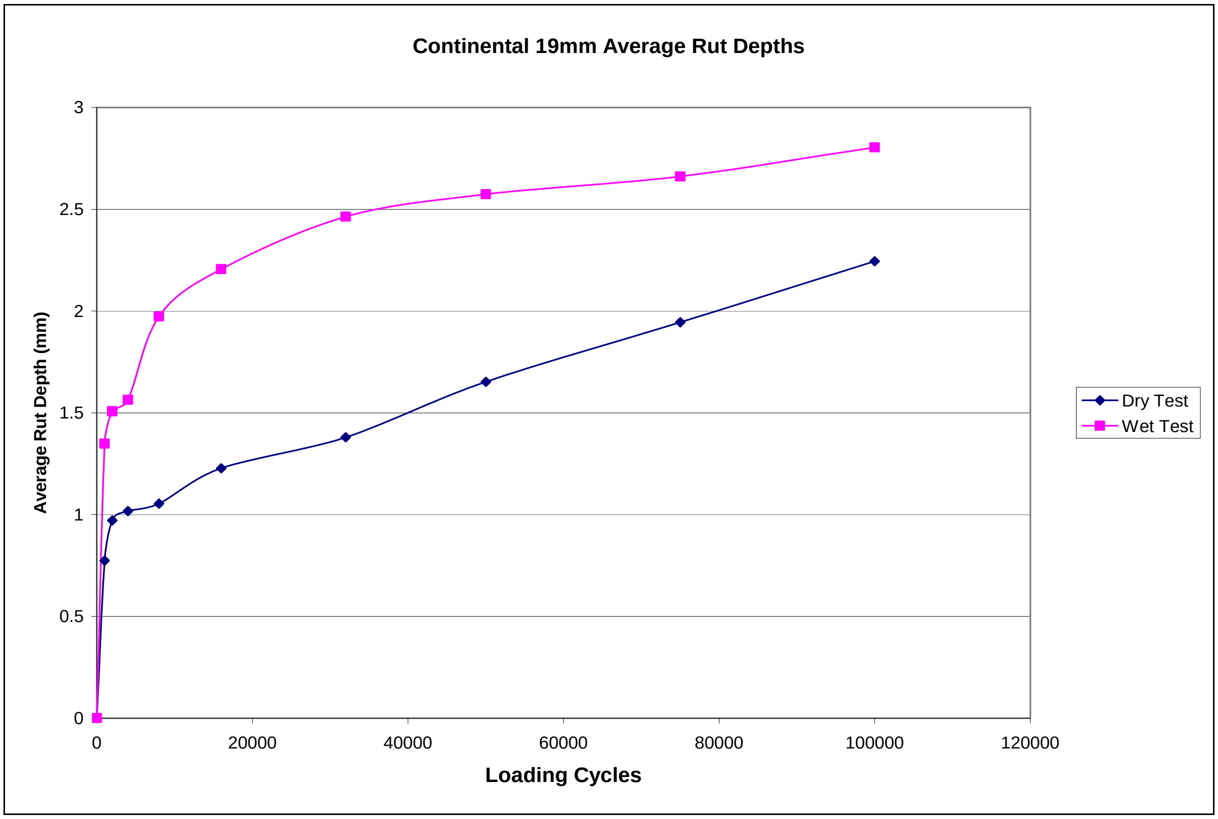

Figure 5: Continental 19mm Wet vs. Dry Rut Depths

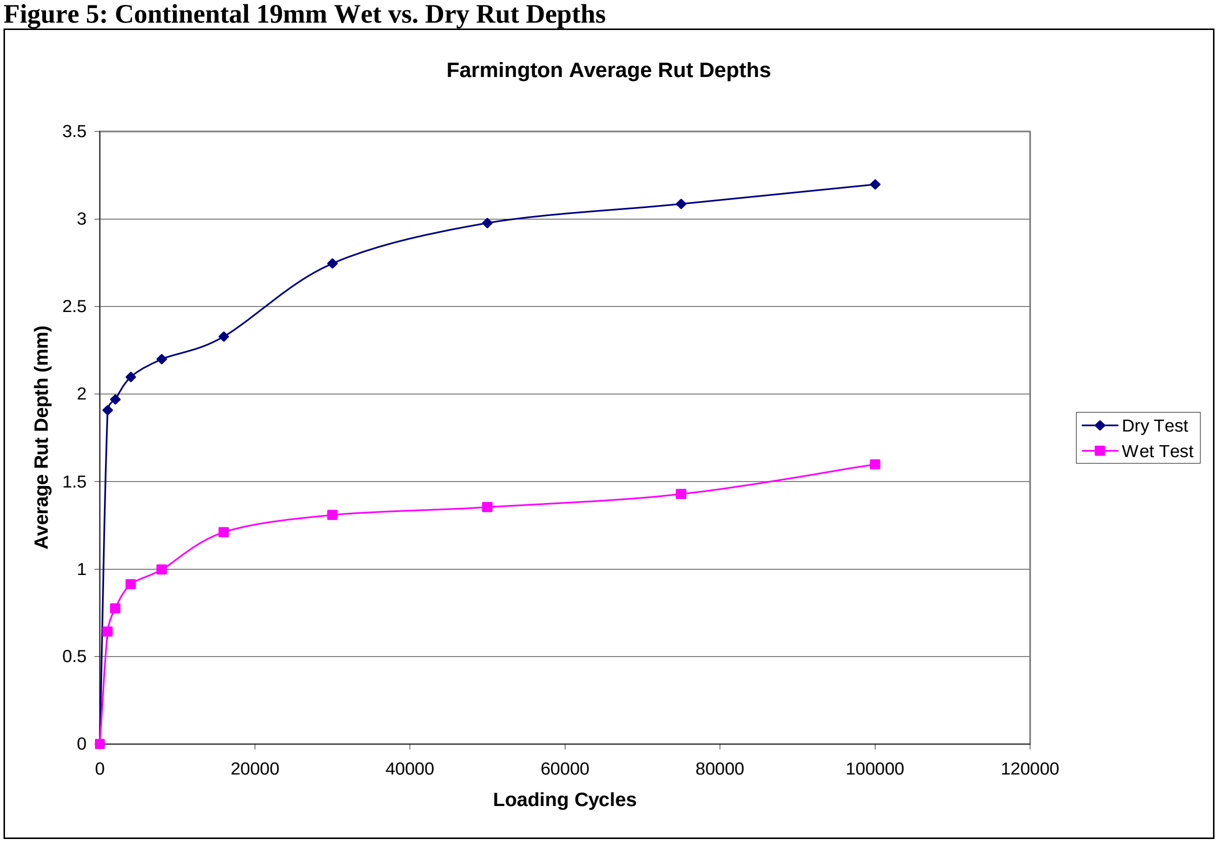

Figure 6: Farmington Wet vs. Dry Rut Depths

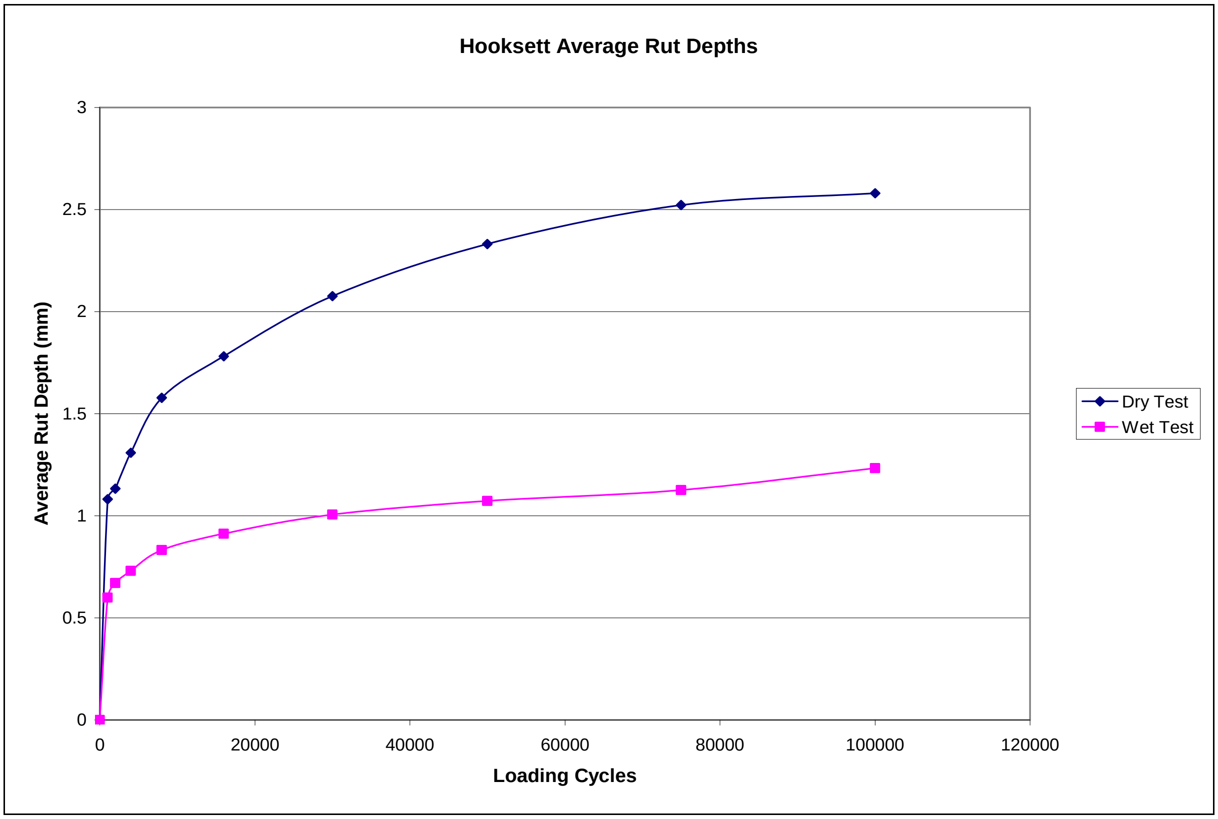

Figure 7: Hooksett Wet vs. Dry Rut Depths