Evaluation of Stripping Potential Tests for Bituminous Concrete

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Background

Aggregates in Hot Mix Asphalt (HMA) disintegrates over time due to loss of adhesion/binding between asphalt binder and aggregate in presence of moisture. This phenomenon, referred to as "stripping", and in broader terms is addressed as moisture-induced damage in HMA. Some of the common moisture damage observed in HMA are shown in Fig. 1.

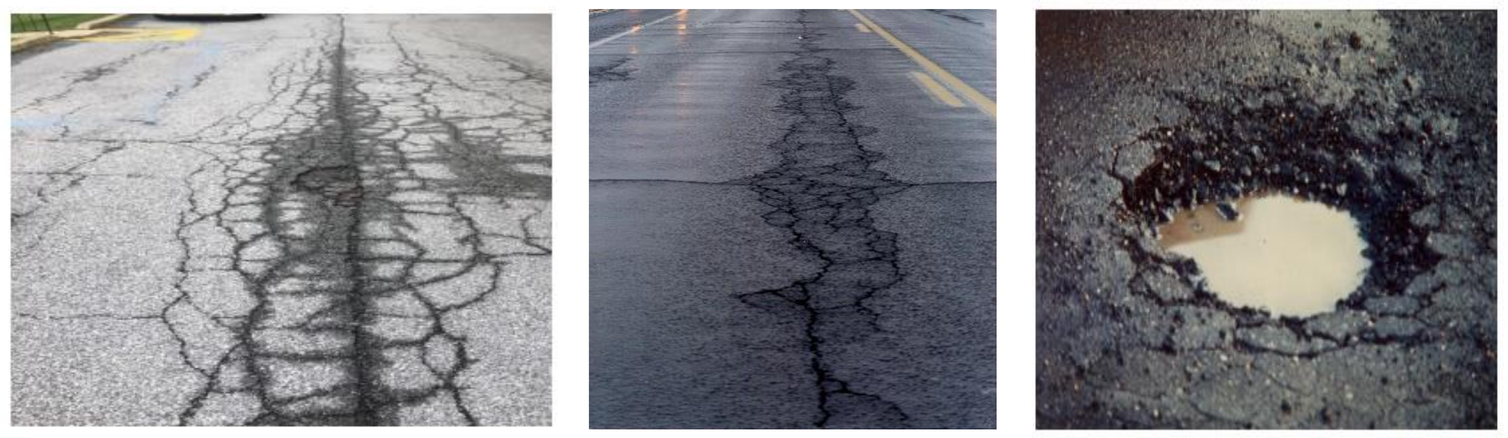

Figure 1: Photos of some typical moisture induced damages (a) longitudinal cracks (source: Veeraragavan, 2020), (b) stripping (source: Pavement Interactive, 2022), (c) potholes (source: Williams, 2010)

Moisture Susceptibility Tests

Moisture susceptibility tests can be divided into two broad categories: (i) Qualitative, and (ii) Quantitative tests. There are different varieties of tests in practice. This study is focused to investigate the effectiveness of Boiling Water Test (ASTM D3625; Qualitative) and Modified Lottman Test (AASHTO T283; Quantitative) to identify the moisture susceptibility of HMA mixtures. We also explored quick and simple measures to quantify the outcome of ASTM D3625 and effect of one extra cycle of lottman conditioning on moisture susceptibility of HMA.

Methods

Boiling water test follows standard test procedure ASTM D3625. In a Boiling Water Test, ~250 g of HMA is boiled in water at 100 ºC for 10 minutes and the percentage of loss in asphalt binder is visually evaluated after the sample dries out (Fig 3(a)). Modified Lottmat test (AASHTO T283) involves subgrouping six cores into two subgroups each containing three cores. Then one subgroup is subjected to wet conditioning (i.e. freeze-thaw cycle) and the other subgroup is tested dry (Fig 3(b) – (d)). Finally, indirect tensile strength of each core is measured, and the ratio of average tensile strength of the subgroups is used as an indication of stripping potential of the HMA (Fig 3(e) & (f). The flow chart to conduct Modified Lottman Test is shown in Fig 4.

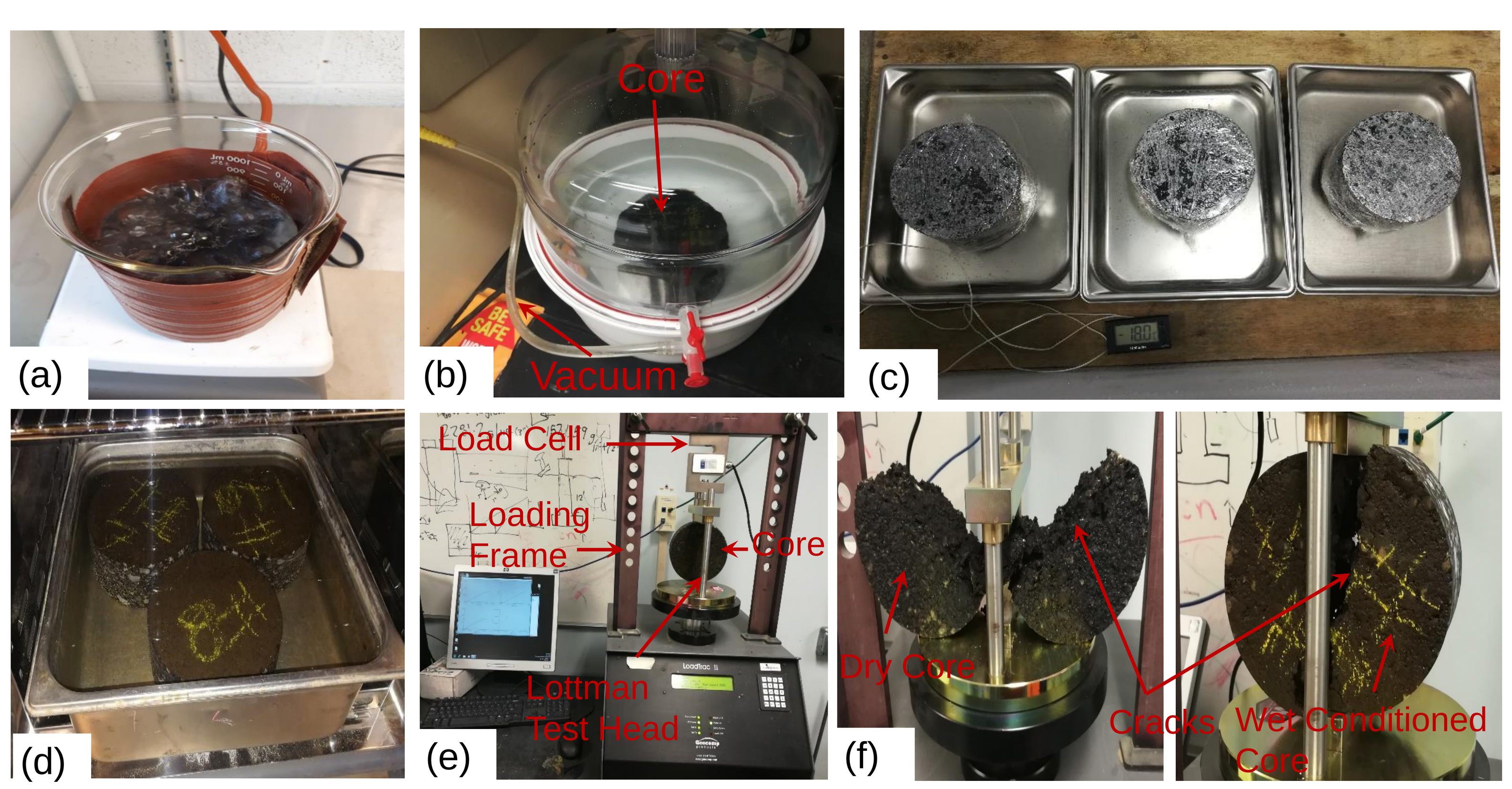

Figure 3: Photos of (a) Boiling Water Test (b) Vacuum saturation of core (c) cores frozen at -18 ºC (d) Core under water bath at 60 ºC (e) Indirect tensile strength test and (f) Post-test cores

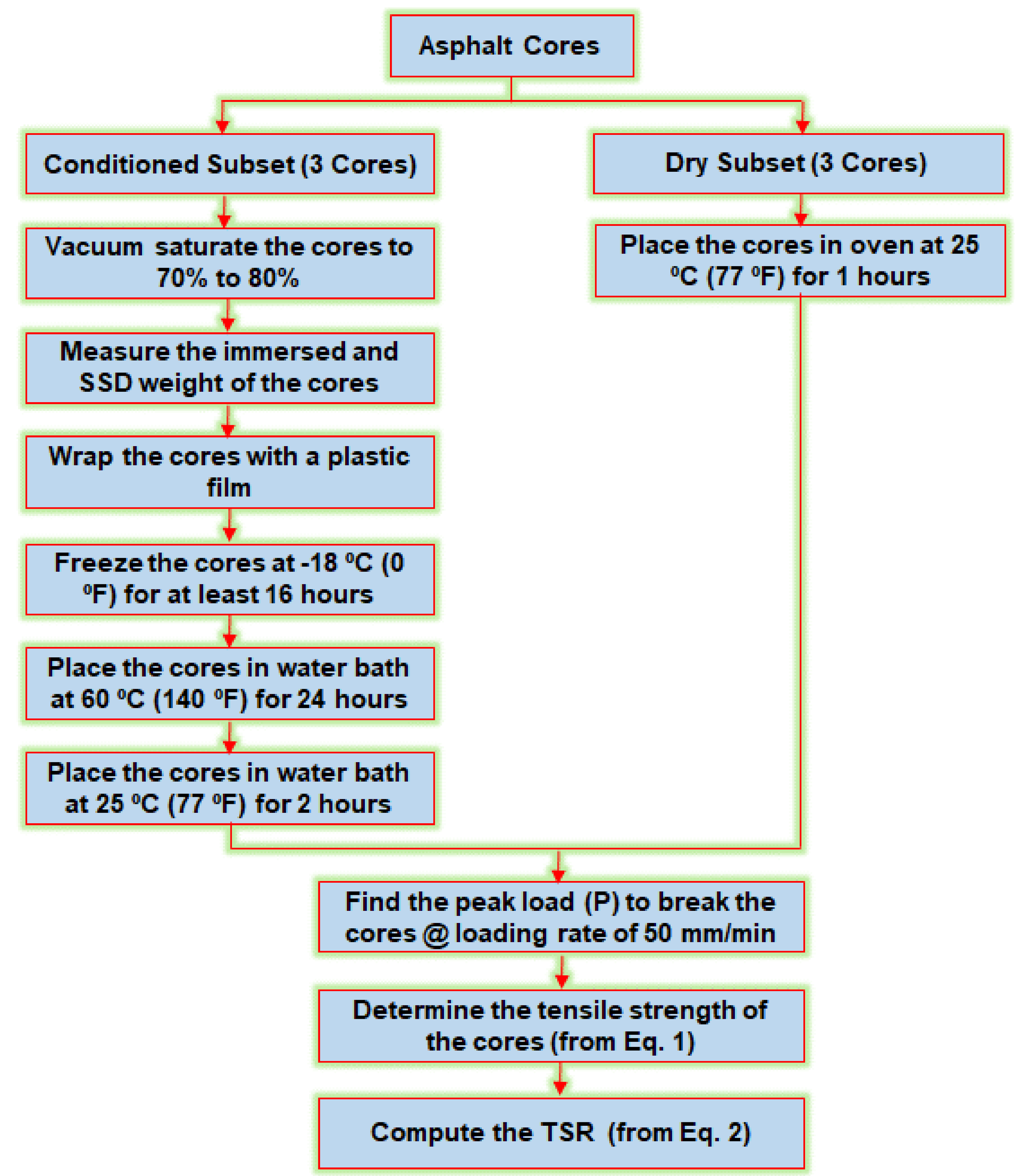

Figure 4: Flow chart of Modified Lottman Test Procedure (AASHTO T283)

Results

Boiling water test on the HMA used in Londonderry-Chester project and Burlington STP projects retained 90-100% of asphalt binder coating based on Texas Rating Board. Fig. 5 shows the photo of different HMA samples after boiling for 10 minutes.

Boiling water test on HMA containing 10% additional (i.e up to 30%) Reclaimed Asphalt Pavement (RAP) showed same level of asphalt binder retainment as HMA with 20% RAP (Fig 6).

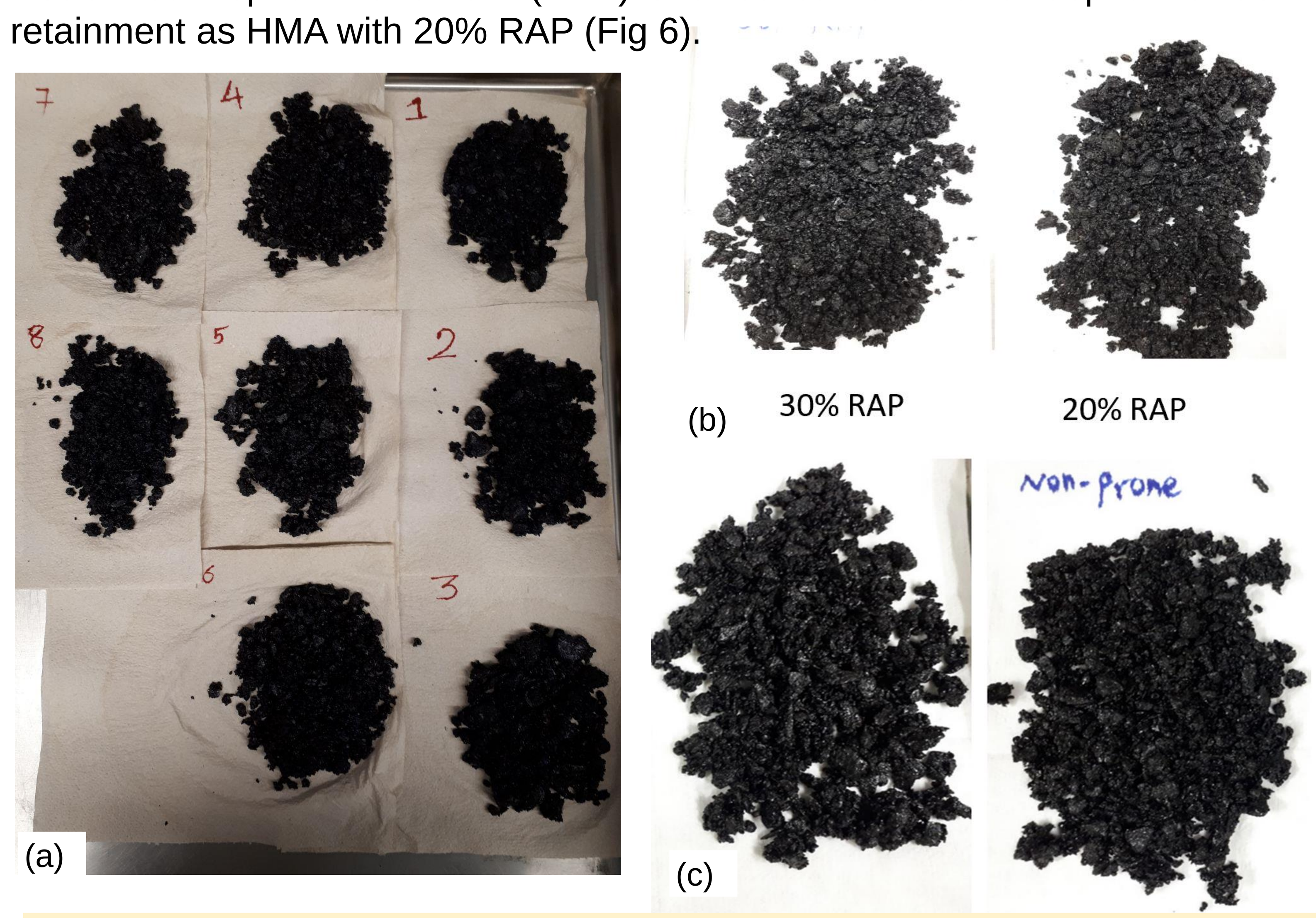

Figure 5 : Photos of post boiled HMA (a) HMA retrieved from field (b) HMA with RAP and (c) HMA with stripping-prone aggregate in presence of liquid anti-stripping agent

The Tensile Strength Ratio (TSR) values for majorities of the field retrieved asphalt cores were higher than 0.8 for both one cycle of wet vs dry conditioning and extended cycle of wet vs one cycle of wet conditioning. This indicates that one extra cycle of wet conditioning was not able to induce additional damage to the cores compared to only one cycle of wet conditioning. The average tensile strength and the TSR of the cores retrieved from four different projects in Vermont are shown in Fig. 6.

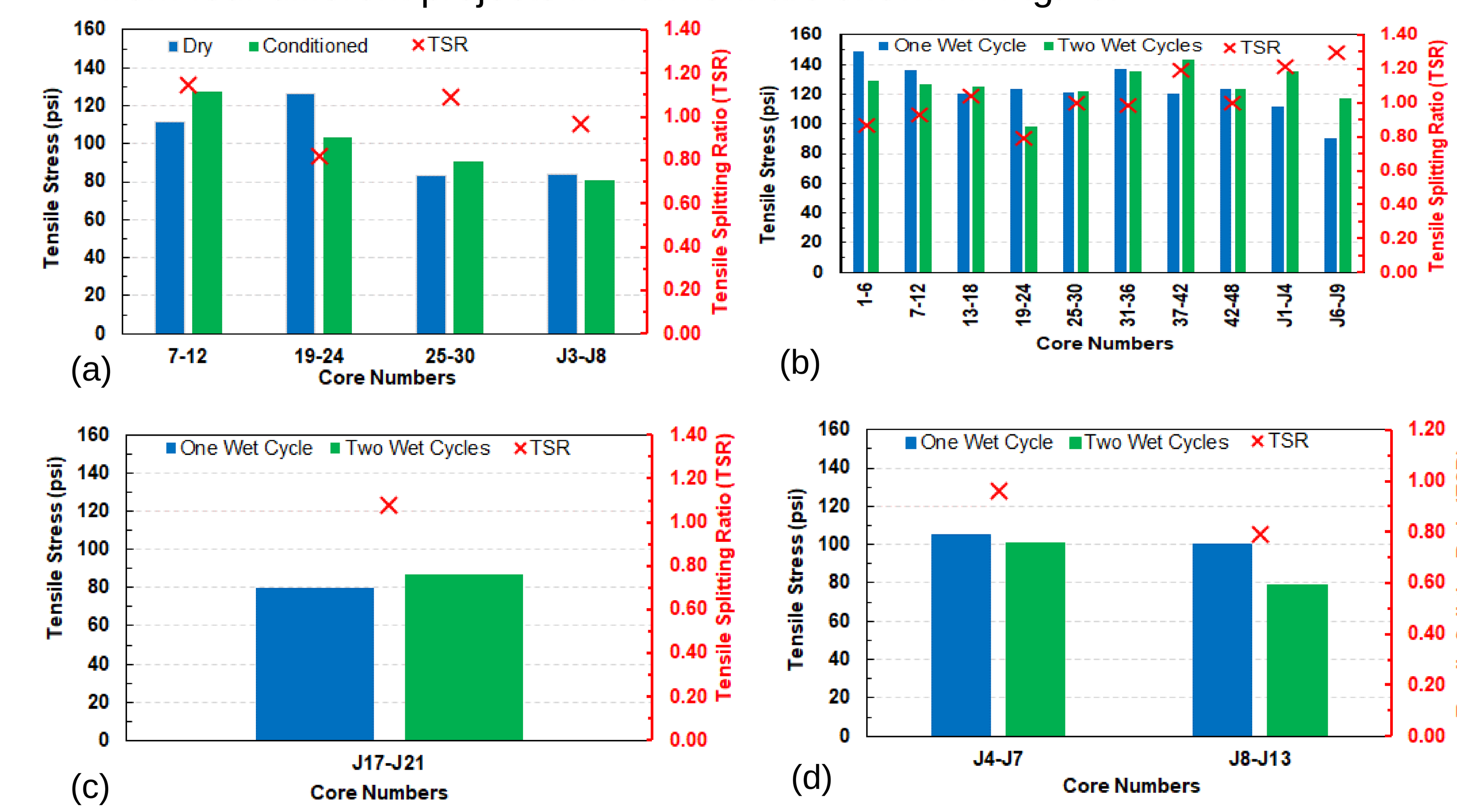

Figure 6: Result of Modified Lottman Test on cores retrieved from (a) Groton-Newberry STO PS19(2) Project (b) Richford-Jay STP 2914(1) Project (c) Johnson-Morristown STP 2919(1) Project and (d) Cavendish-Weathersfield ER STP 0146(14) Project

The result of indirect tensile strength test indicates joint cores exhibited less tensile strength due to less compactive effort along the joints. Fig. 7 shows the relationship between tensile strength and percent compaction for all the regular and joint cores.

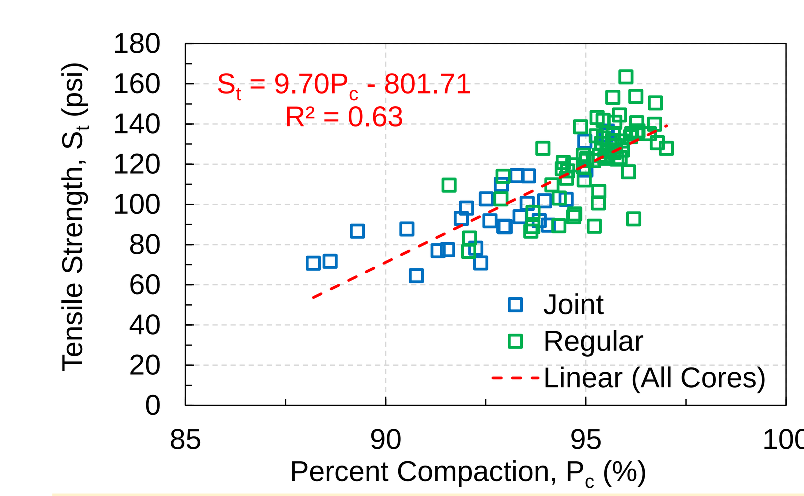

Figure 7: Effect of compaction on the tensile strength

Table 1: Result of two-tailed t-test between regular and joint cores

Parameters	Joint Cores	Regular Cores	P-value
Avg. compaction (%)	92.65	95.16	1.1×10^{-5}
Avg. Indirect Tensile Strength (psi)	95.67	121.71	5.2×10^{-5}
TSR	1.05	0.99	0.41

Conclusions

1. Both boiling water test and modified Lottman test indicated the HMA used in different projects passed the requirement.
2. Boiling water test did not show any additional moisture damage on adding extra 10% RAP.
3. Field cores subjected to two cycles of Lottman conditioning showed same level of moisture damage compared to one cycle of conditioning.
4. Joint cores exhibited lower compaction and hence the tensile strength.

Acknowledgement

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