# Experimental validation of crystallizing & non-crystallizing models of rubber fatigue behavior

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**ABSTRACT**. The orientation of cracks initiating under cyclic loading in rubber may depend not only on maximizing the energy release rate, but also – in the case of a strain crystallizing rubber – on minimizing the life-lengthening effect of strain-crystallization associated with nonrelaxing loads. Crack orientations in a series of fully relaxing and nonrelaxing fatigue tests were computed with Endurica's critical plane analysis, and compared with cracks developed in experiments on strain-crystallizing Natural Rubber, and amorphous Styrene Butadiene Rubber. The specimen used for experimentation was a rectangular flat dumbbell prepared according to the ASTM D4482 Standard. Five strain histories were tested, two fully relaxing (0-80% and 0-100%), and three nonrelaxing (20-120%, 50%-150%, and 50%-170%). Critical plane analysis was performed with Endurica CL. As predicted, all fully relaxing tests, for both NR and SBR, developed cracks on the plane perpendicular to the maximum principal stress (90 degrees). Also as predicted, all nonrelaxing tests for the amorphous SBR develop in the same 90 degree plane. Finally, nonrelaxing tests for the crystallizing NR develop on specific planes that were accurately predicted by minimizing the fatigue life with respect to crack orientation.

**Keywords**: Fatigue, Strain Crystallization, Durability, Natural Rubber, Damage

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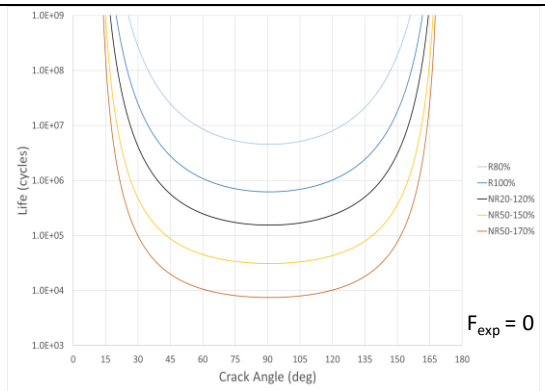
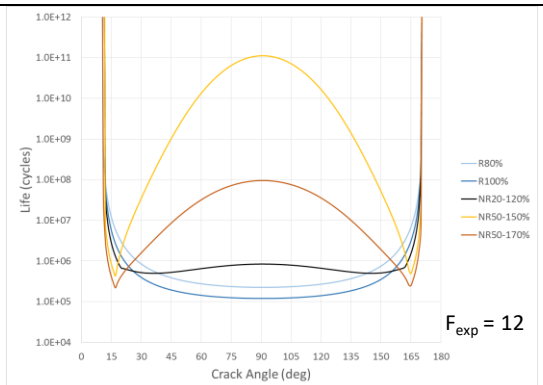
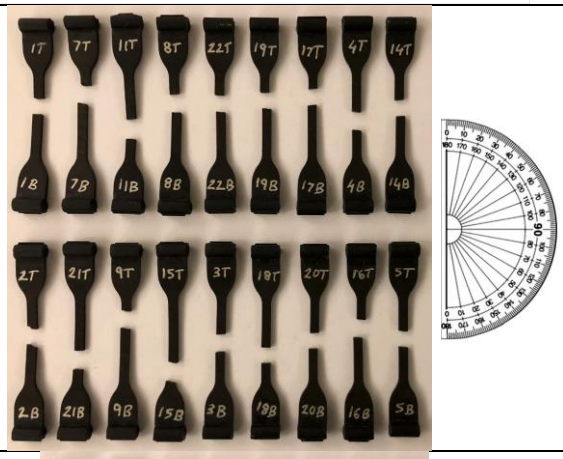
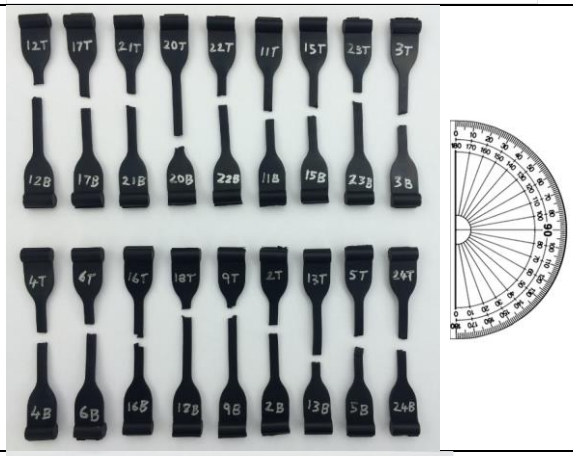
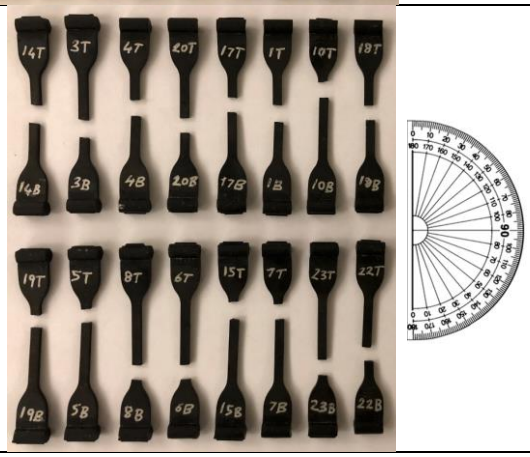
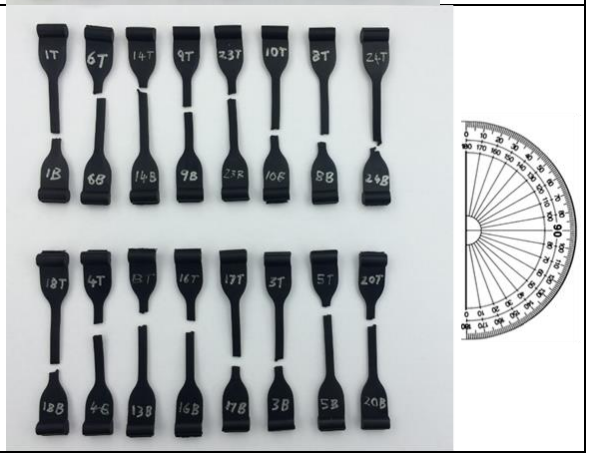
| | Styrene-Butadiene Rubber (amorphous) | Natural Rubber (Strain-crystallizing) |
|---|---|---|
| Critical Plane Analysis |  |  |
| 0-80% |  |  |
| 0-100% |  |  |

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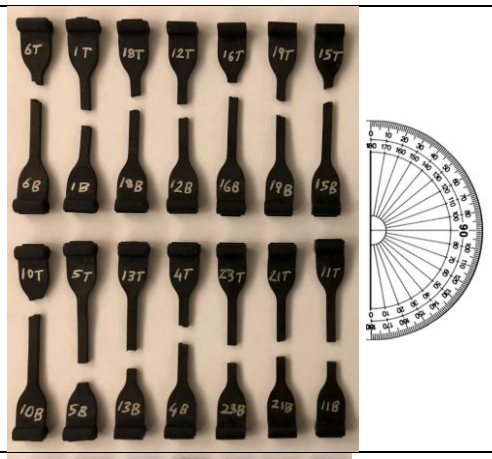
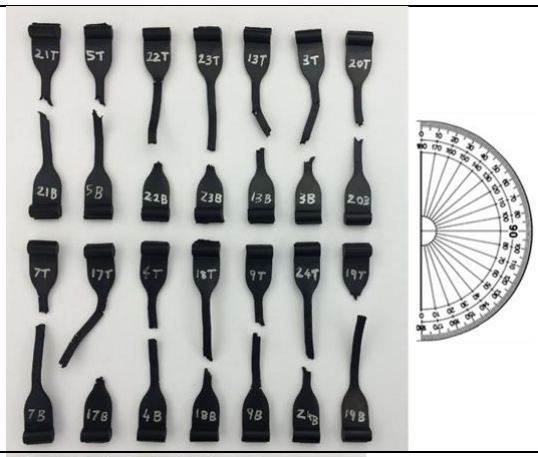
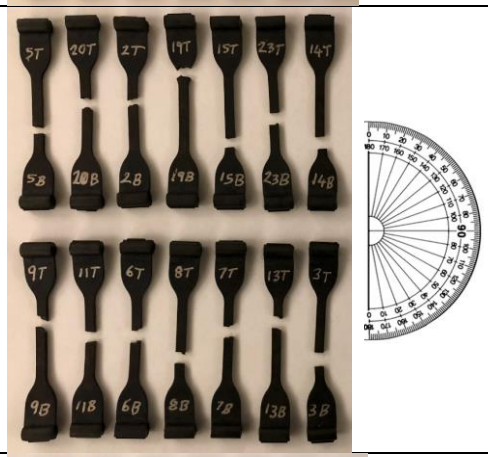
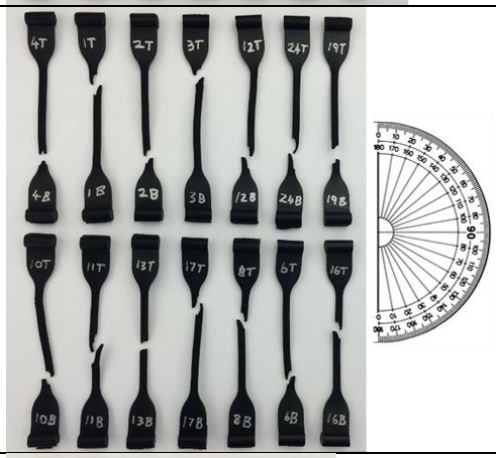
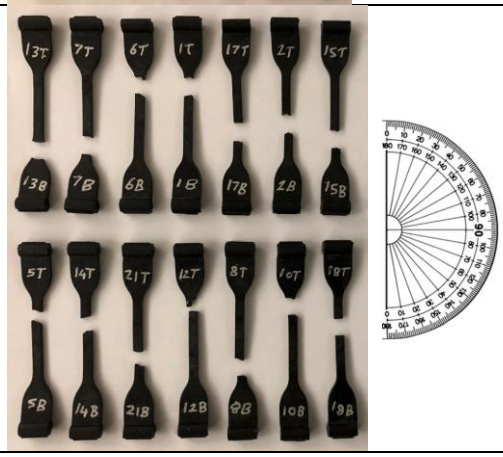
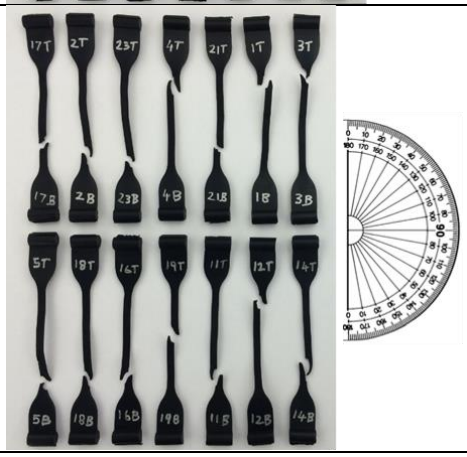
|---|---|---|
| 20%-120% |  |  |
| 50%-150% |  |  |
| 50%-170% |  |  |

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