The Mills model is used to characterize the wear of materials under multiple loading conditions and is suitable for complex wear scenarios by considering the microscopic changes in the material surface and its elastic recovery properties.

In the case of stairs, which are used under stable conditions (e.g., constant flow of people and gait characteristics), the friction process is dominated by sliding wear due to the low sliding velocities. In this case, the contact state of the stair surface (including pressure and temperature distribution) remains stable during the friction process. Based on this assumption, the amount of wear W is usually linearly related to the nth power of the sliding velocity V, where n is the velocity factor, which is related to the material properties and contact conditions[2].

On this basis, to more accurately analyze the wear behavior of staircase materials (e.g., stone or wood), we will modify the classical Mills model and develop a mathematical model suitable for staircase wear analysis.

First, the normal load F acting on the surface of the staircase material is calculated with the following expression:

Where FG is the average value of normal pressure, ¥ represents the adjustment coefficient, and μ represents the coefficient of kinetic friction.The F obtained by Eq. n is used as an independent variable in the wear volume model to further calculate the material wear volume V:

Where V represents the average sliding velocity of the contact producing friction, and K and H are the wear coefficient and hardness of the staircase material, respectively.