To study stair wear due to friction when a person walks, we assume that a person walks on stairs with a walkway width that is at least equal to the average shoulder width (disregarding extreme crowding) and does not walk tightly against the edges of the stairs.

On this basis, we divide the plane of the staircase into several walkways, each with a width approximately equal to the average shoulder width. Multiple walks cover almost the entire width of the stairs, with the excess width evenly distributed between the left and right sides of the stairs in the direction of travel.

**Delineation of the target area of the stairs**

Combining the actual walking pattern, the force of human walking on stairs can be classified into the following four patterns:

（图）

To analyze the effect of walking patterns on the stairs more accurately, the actual stepping area at the intersection of each step of the stairs and the walkway is defined as the target area. In the plan view of the stairs, the target areas are divided into four sub-areas, numbered 1, 2, 3, and 4, based on the functional characteristics of walking patterns(shown in Fig. n).

（图）

Sub-areas 1, 2, and 3: These areas correspond to the combined effects of different walking patterns, and their wears need to be analyzed separately according to the force characteristics of different patterns.

Sub-area 4: Located at the edge of the staircase, its influence is ignored in this study due to the large and rather small area affected by accidental factors.

With the above division, we clarify the force characteristics of different sub-regions by combining the four walking modes. Next, the force on each sub-region is quantitatively calculated using the relevant formulas:

\begin{align}

X\_1 &= K\_A \cdot A\_{35 \to 38} - \alpha \\

X\_2 &= K\_A \cdot A\_{24 \to 24} + K\_B \cdot B\_{24 \to 34} - \alpha \\

X\_3^\* &= K\_A \cdot A\_{12 \to 23} + K\_C \cdot C\_{12 \to 23} + K\_D \cdot D\_{12 \to 23} - \alpha \\

X\_3^\*\* &= K\_A \cdot A\_{6 \to 11} + K\_B \cdot B\_{6 \to 11} + K\_C \cdot C\_{6 \to 11} + K\_D \cdot D\_{6 \to 11} - \alpha \\

X\_3^\*\*\* &= K\_A \cdot A\_{3 \to 5} + K\_B \cdot B\_{3 \to 5} + K\_C \cdot C\_{3 \to 5} + K\_D \cdot D\_{3 \to 5} - \alpha

\end{align}

Where $X\_i$ represents the total depth of wear due to friction in sub-area i; $k$ refers to the number of people; $A\_{i \to j}$ refers to the depth of friction due to friction at a time corresponding to the range of distance from the edge of the staircase from i to j; and $\alpha$ is the amount of wear in the target area due to environmental factors (e.g., temperature changes, humidity fluctuations, extreme weather, etc.).

The formulae for subregions 1, and 2 have been given above, and since there is no direct function to calculate X\_3 for subregion 3, we design our own algorithm to calculate the total depth of wear due to friction. The pseudo code is as follows: