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Assessment of the safe evacuation of people walking through flooding staircases based on numerical simulation

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Background

The underground spaces are usually at a high risk of flooding intrusion when those urban flooding events occur.



Objective

To evaluate the possibility of people walking in a flooding flow on a staircase with rest platforms.

Major method and results

Commercial software was used and validated by experimental data for flows on staircases and stepped spillways. The effects of the rest platform, the staircase slope and the staircase pattern on the flooding flow characteristics are discussed.

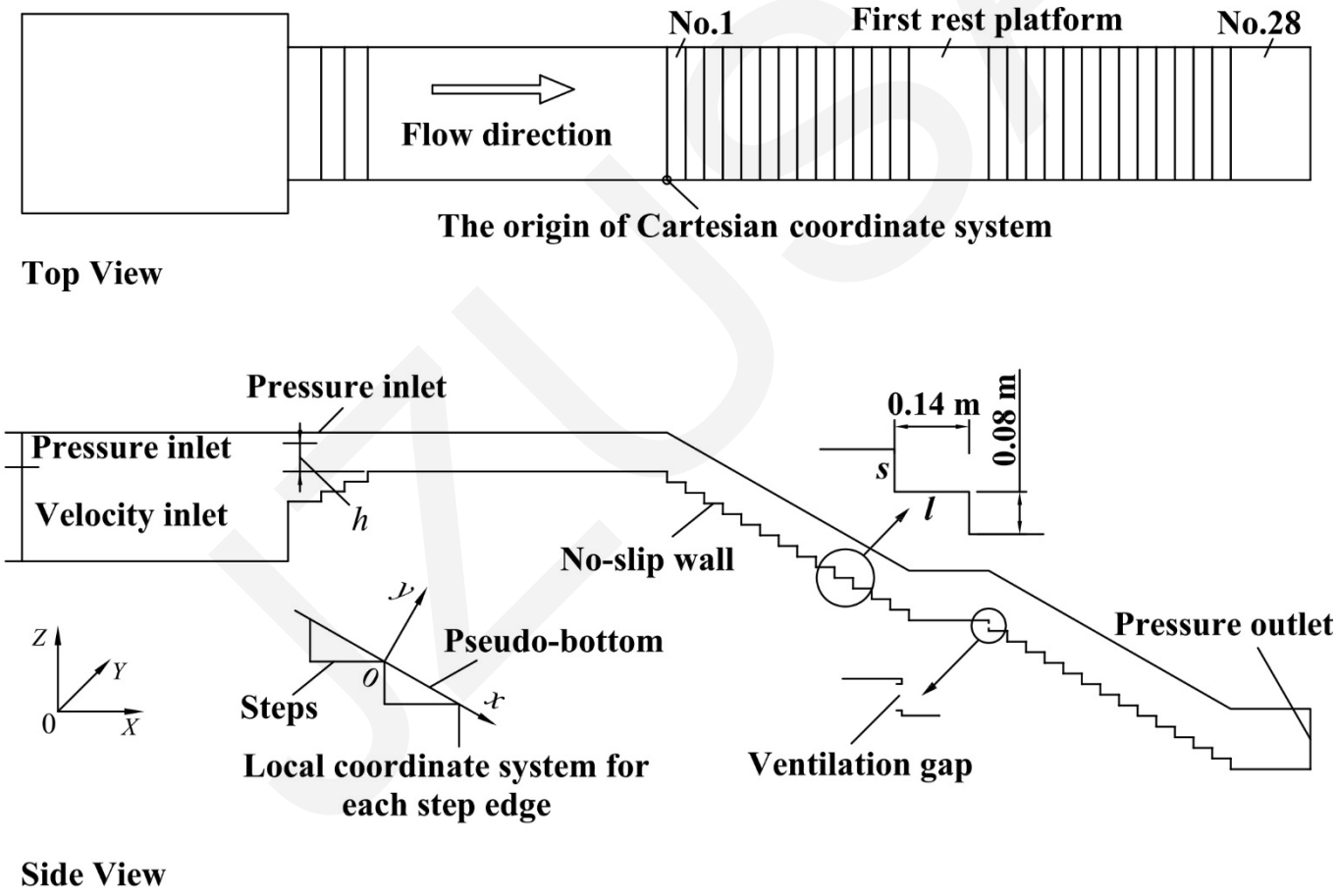

Fig. 1 Computational domain and boundary conditions of staircase

Major method and results

The existence of rest platforms between staircase segments can greatly change the flow characteristics on the rest platform and the steps downstream.

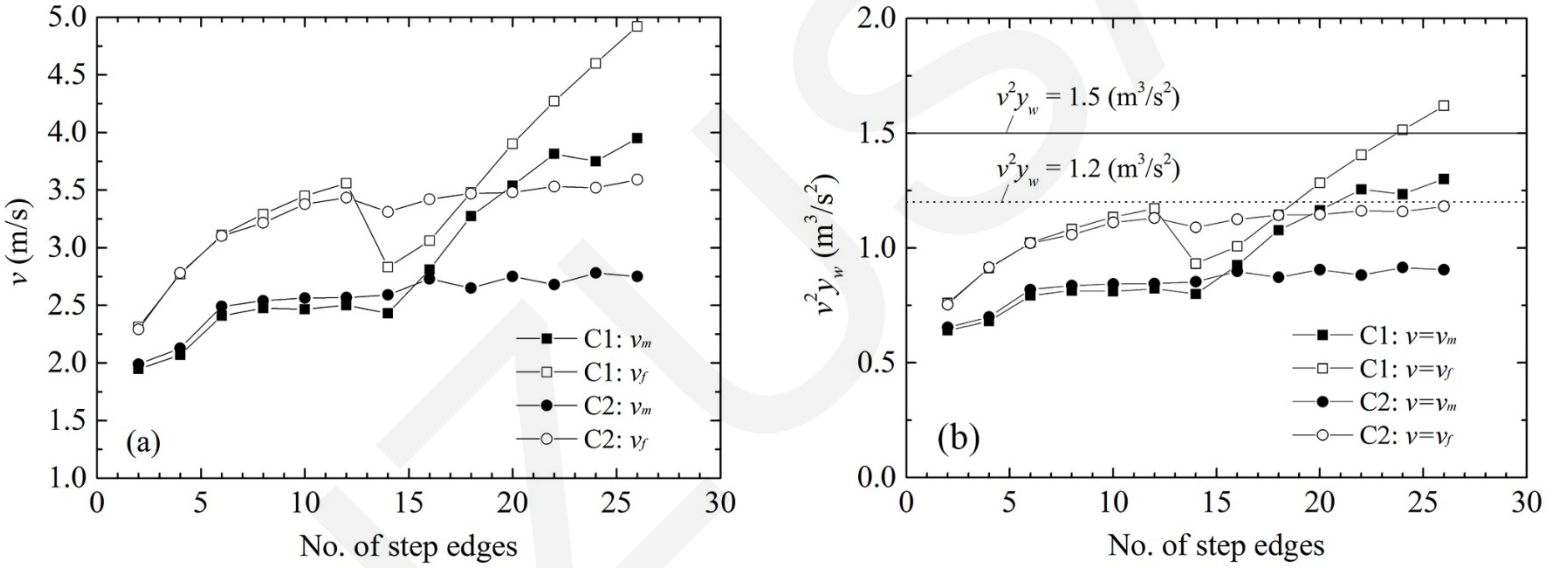

Fig. 2 Effect of the rest platform on (a) the air-water mixture velocity and (b) the value of $F(v, y_w)$ along the symmetric longitudinal plane above the pseudo-bottom

Major method and results

The slope of a straight-run staircase has little effect on evacuation due to the small range in the slope of staircases.

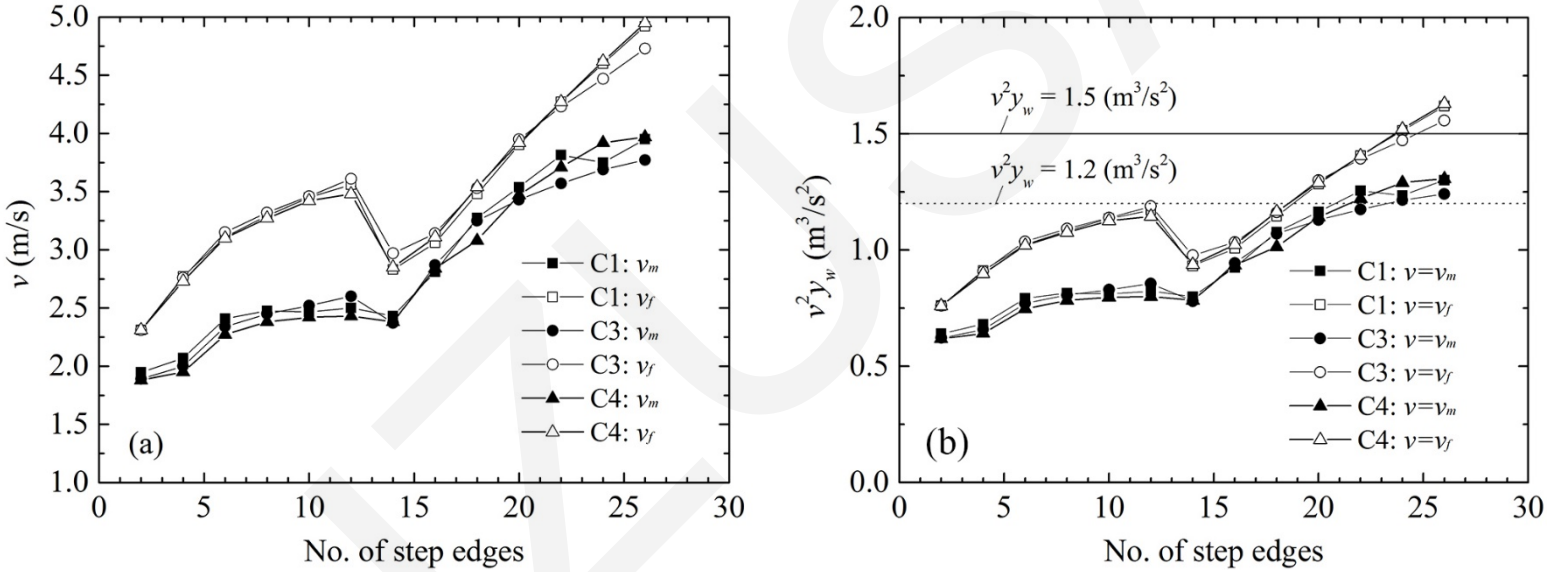

Fig.3 Effect of staircase slope on (a) the air-water mixture velocity and (b) the value of $F(v, y)$ along the symmetric longitudinal plane above the pseudo-bottom

Major method and results

The L-shaped type would be the first choice for people evacuation. People going upstairs should walk in the middle or on the left of the lower segment of an L-shaped staircase, and in the middle or on the right of the lower segment of a U-shaped staircase.

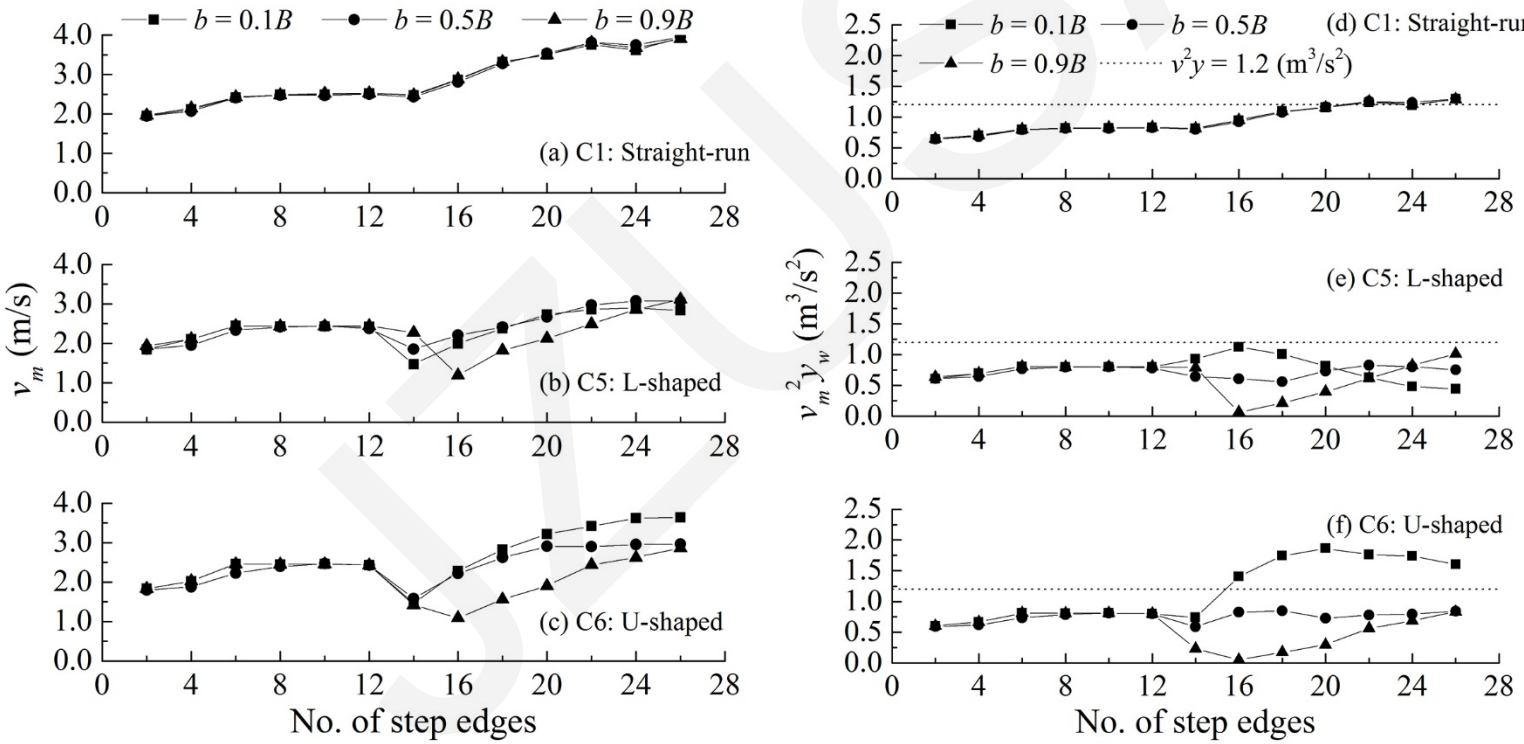

Fig. 4 Value of the mean air-water mixture velocity and $F(v, y_w)$ along the stepped chutes of three types of staircase