

Experimental Study the Impact of Visibility on Individual Ascent Speed in Stair

Evacuation Case Studies and Evacuation Data

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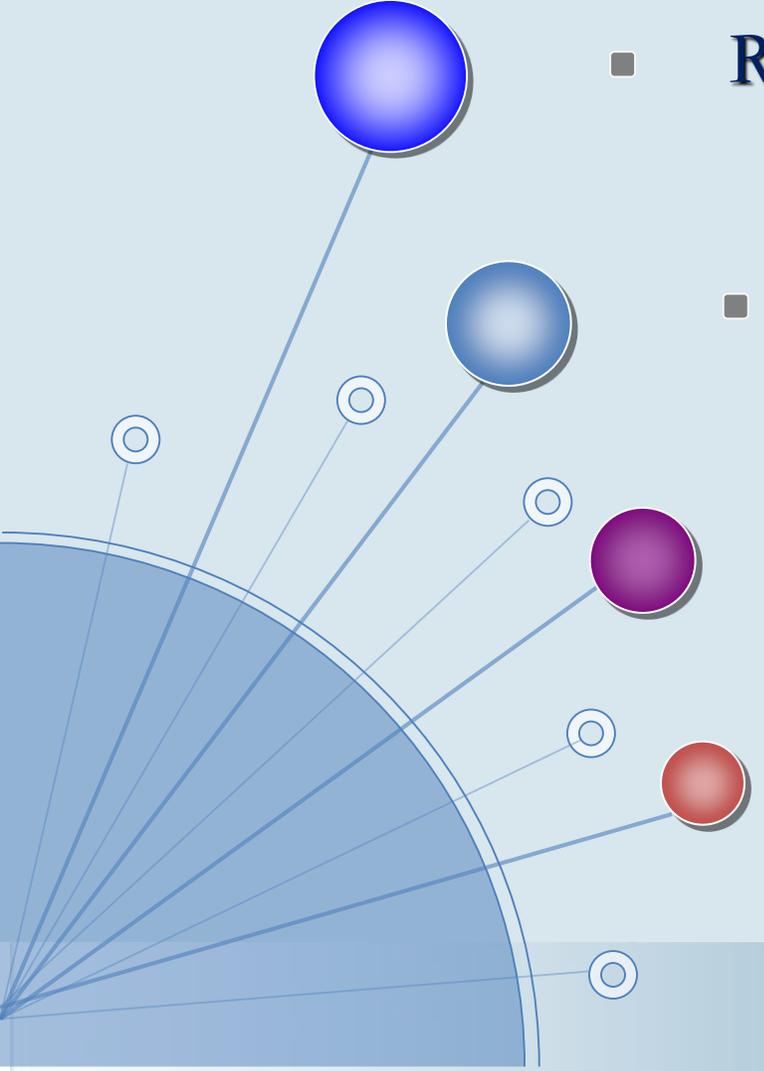
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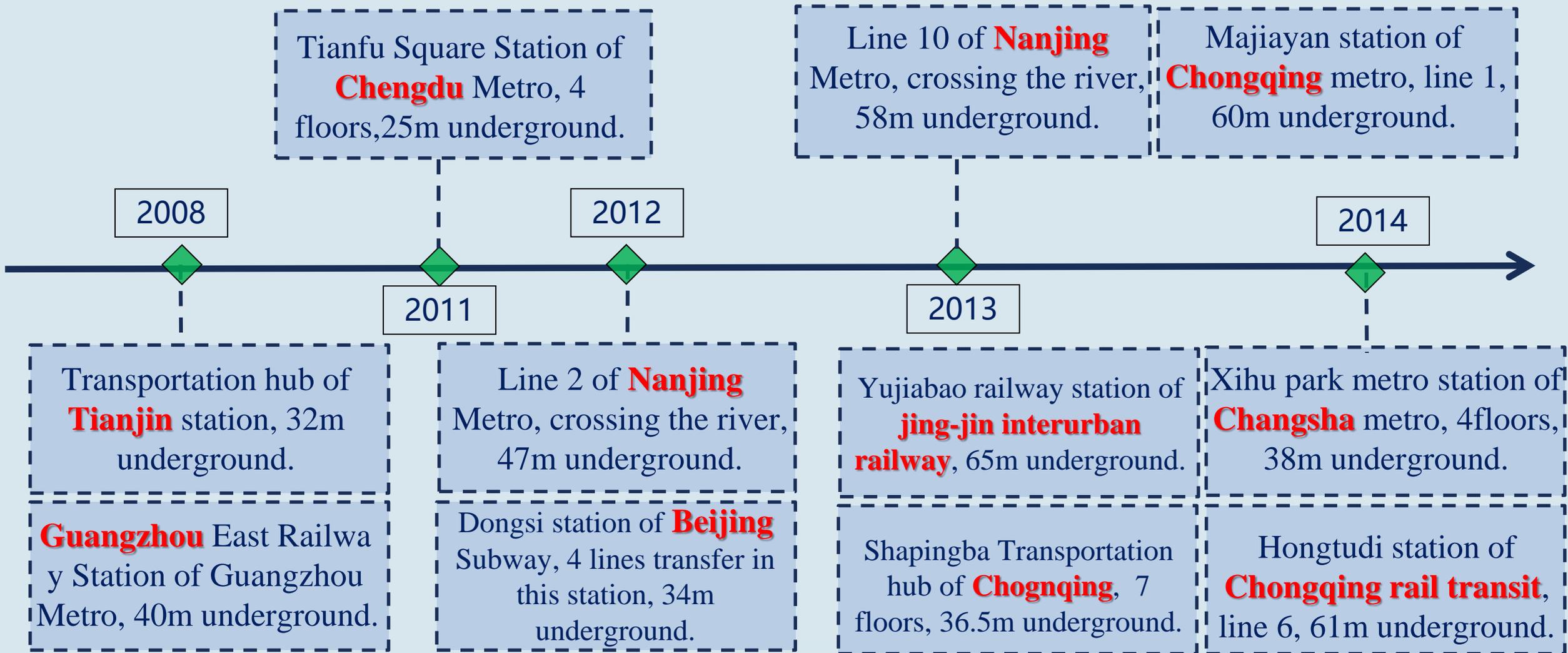


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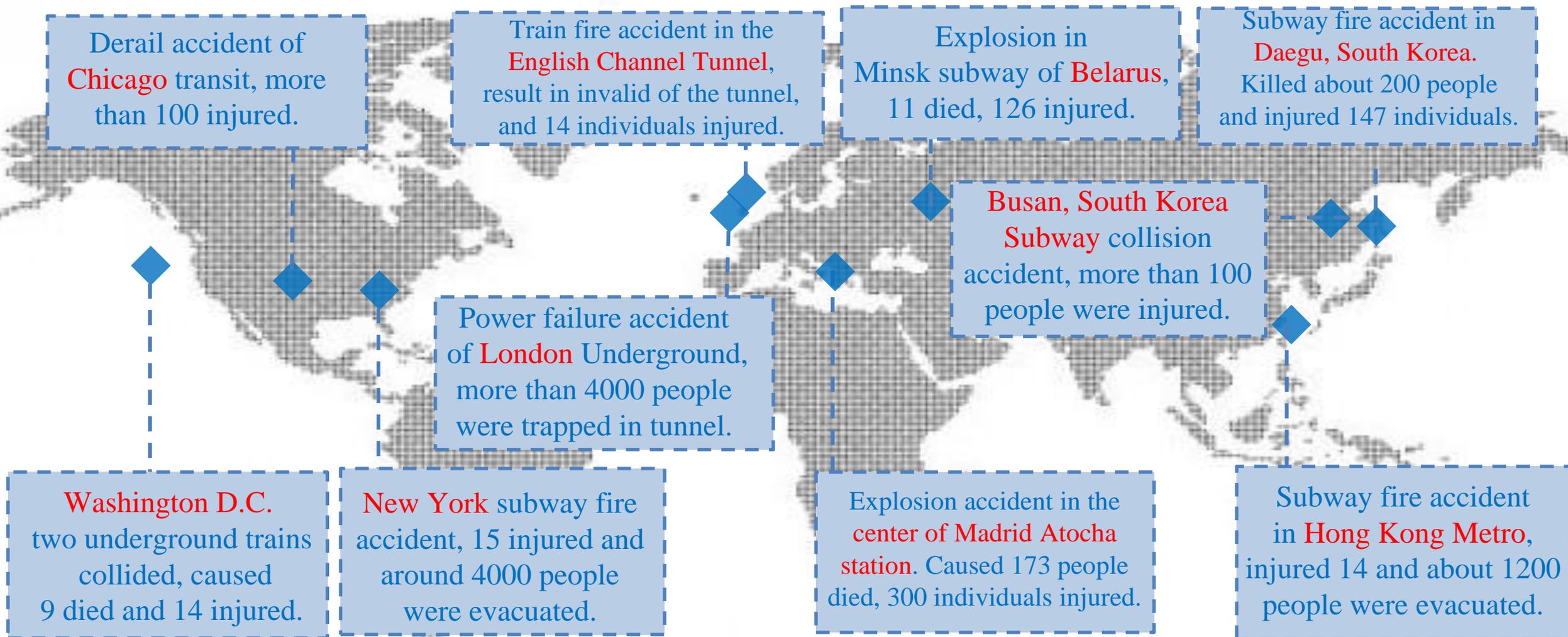
CONTENT

- 
- Research background and significance
 - Experiment and analysis method
 - The Results and Discussion
 - Conclusion

1. Research background and significance

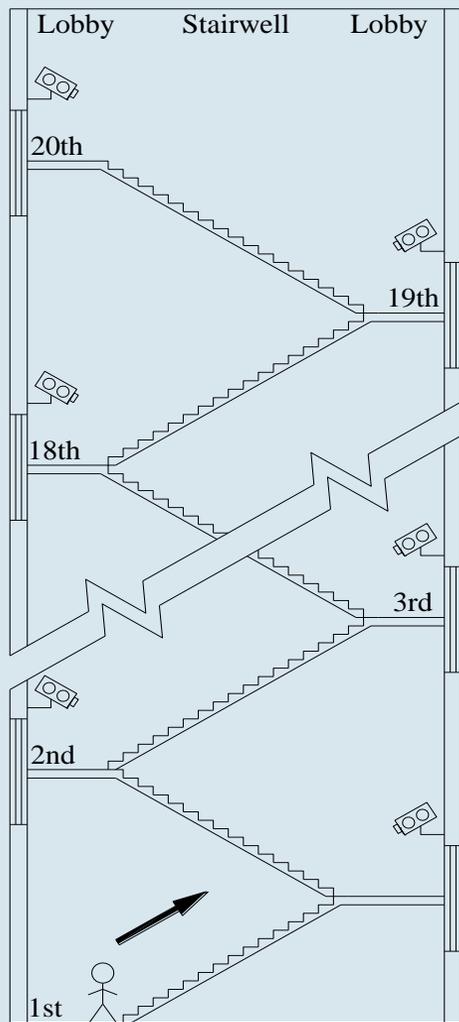


1. Research background and significance

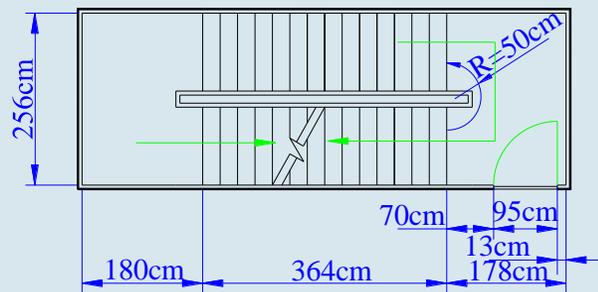


2. Experiment and analysis method

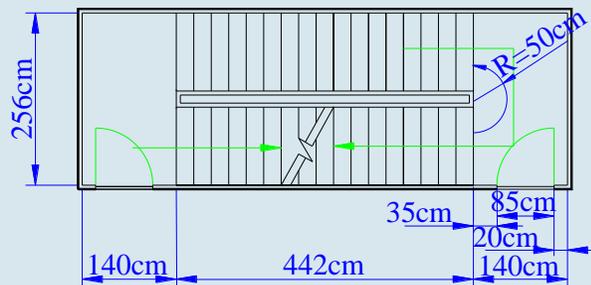
◆ Experiment settings



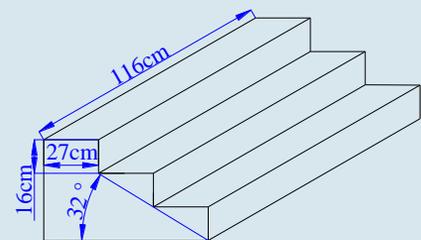
(a) Section diagrammatic of stairwell;



(b) Plan of stairwell 1-2 (Unit: cm);



(c) Plan of stairwell 1-2 (Unit: cm);



(d) Size diagrammatic of step (Unit: cm)

Figure1. The dimension of the staircase in the study



(a)



(b)

Figure2. The view of the staircase in lighting-out condition: a on the inside of the stair; b on the outside of the stair.

2. Experiment and analysis method

◆ Visibility Parameters

◆ Based on Lambert-Beer law, when the light of wavelength λ goes through the smoke:

$$I_{\lambda} = I_{\lambda 0} \exp(-C_s L) \quad T[\%] = \frac{I_{\lambda}}{I_{\lambda 0}} \times 100 = 100 \times \exp(-C_s L)$$



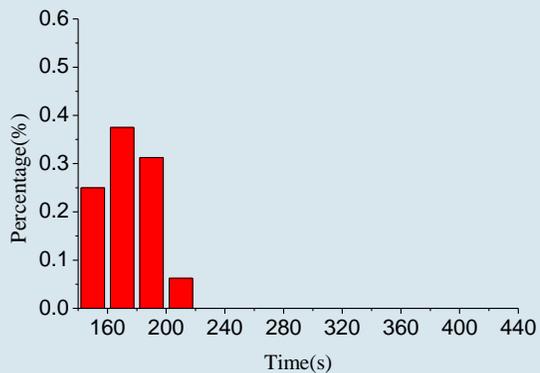
Figure 3. People putting on the eye-patch.

Table 1. Terms of the evacuation experiment.

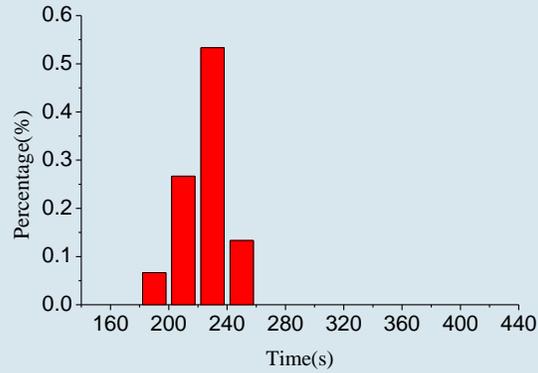
Experiment condition	Condition of lighting system	Condition of eye shield	smoke density	visibility	Male	Female
1	On	-	-	>20m	15	15
2	Off	-	-	—	15	15
3	On	27%	0.13-0.26m ⁻¹	5-10m	15	15
4	On	16%	0.26-0.60m ⁻¹	3-7m	15	15

3. The Results and Discussion

◆ The Probability Distribution of Evacuation Time

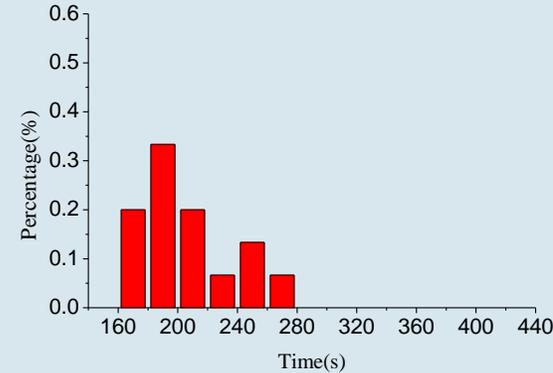


(a)

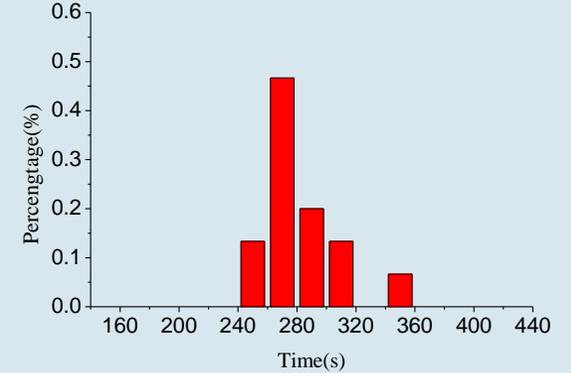


(b)

Figure3. Condition 1:a Male; b female.

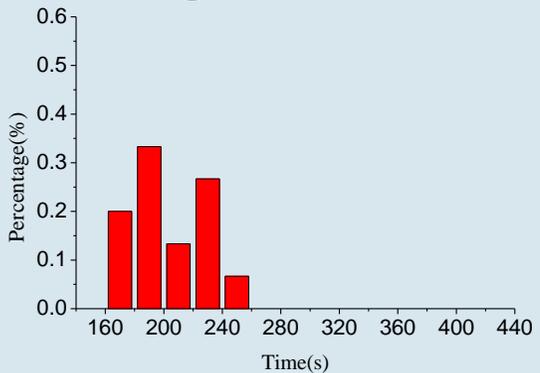


(a)

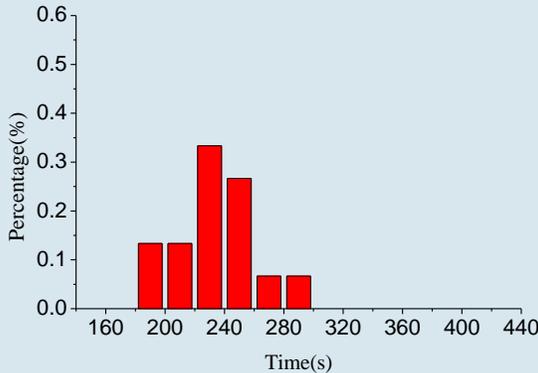


(b)

Figure5. Condition 3:a Male; b female.

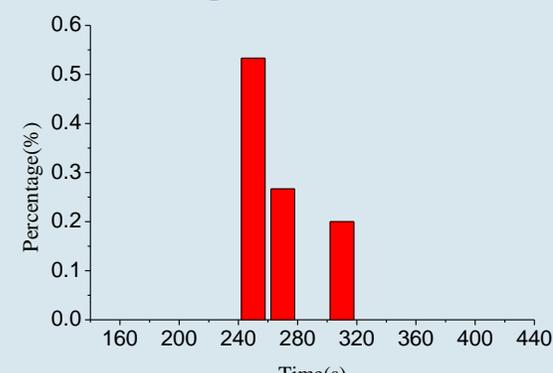


(a)

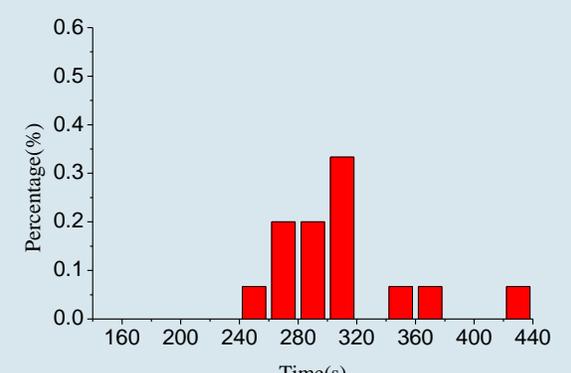


(b)

Figure4. Condition 2:a Male; b female.



(a)



(b)

Figure6. Condition 4:a Male; b female.

3. The Results and Discussion

◆ The Ascent Speed

Table2. Experimental result in Condition 1.

Gender	Max velocity	Min velocity
Male	1.28m/s	0.63m/s
Female	0.97m/s	0.53m/s
Jeon	1.34m/s-1.69m/s	

Table3. Experimental result in Condition 2.

Gender	Max evacuation speed	Min evacuation speed
Male	0.97m/s	0.60m/s
Female	0.82m/s	0.51m/s
Jeon	1.23m/s-1.61m/s	

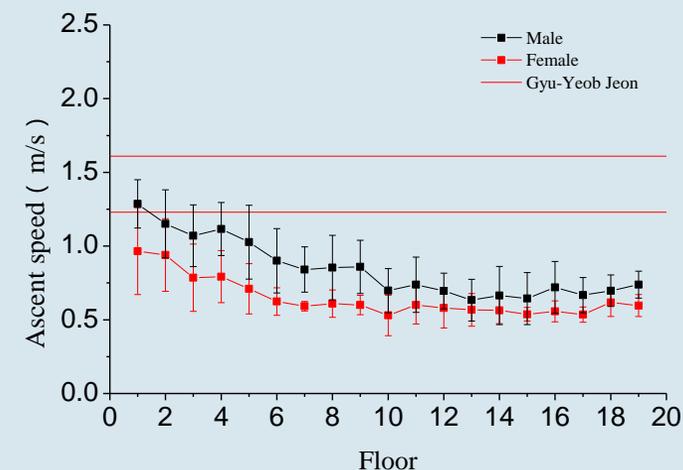


Figure7. Condition 1

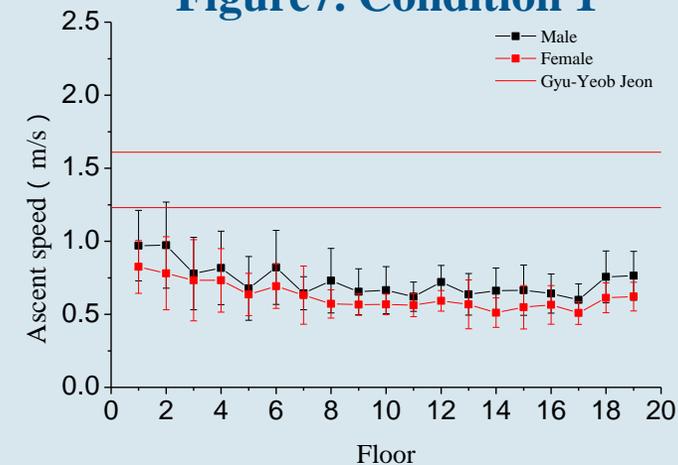


Figure8. Condition 2

3. The Results and Discussion

◆ The Ascent Speed

Table4. Experimental result in Condition 3.

Gender	Max velocity	Min velocity
Male	0.84m/s	0.57m/s
Female	0.55m/s	0.45m/s
Jeon	0.62m/s-0.64m/s	

Table5. Experimental result in Condition 4.

Gender	Max velocity	Min velocity
Male	0.62m/s	0.48m/s
Female	0.55m/s	0.44m/s
Jeon	0.51m/s-0.61m/s	

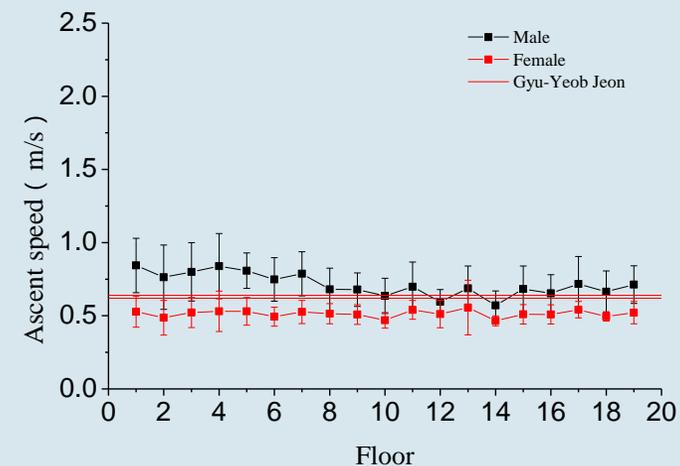


Figure9. Condition 3

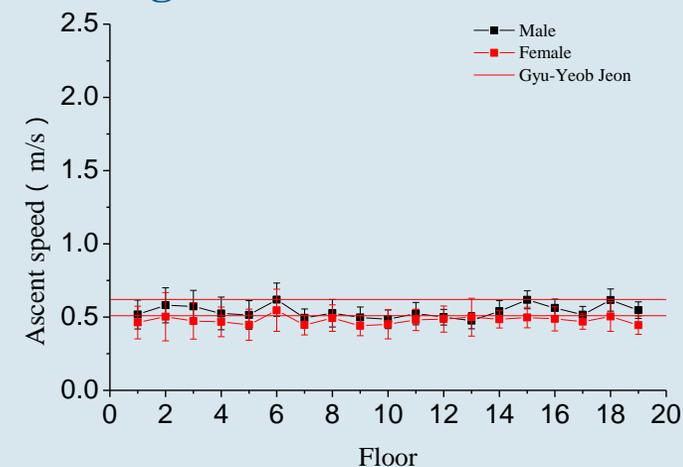


Figure10. Condition 4

3. The Results and Discussion

◆ The Cumulative Average speeds

Table6. Experimental result in Condition 1.

Gender	Max velocity	Min velocity	The difference
Male	1.28m/s	0.79m/s	0.39m/s
Female	0.97m/s	0.62m/s	0.36m/s
Choi	0.75m/s for males and 0.53m/s for females		

Table7. Experimental result in Condition 2.

Gender	Max velocity	Min velocity	The difference
Male	0.97m/s	0.70m/s	0.27m/s
Female	0.83m/s	0.60m/s </tr	

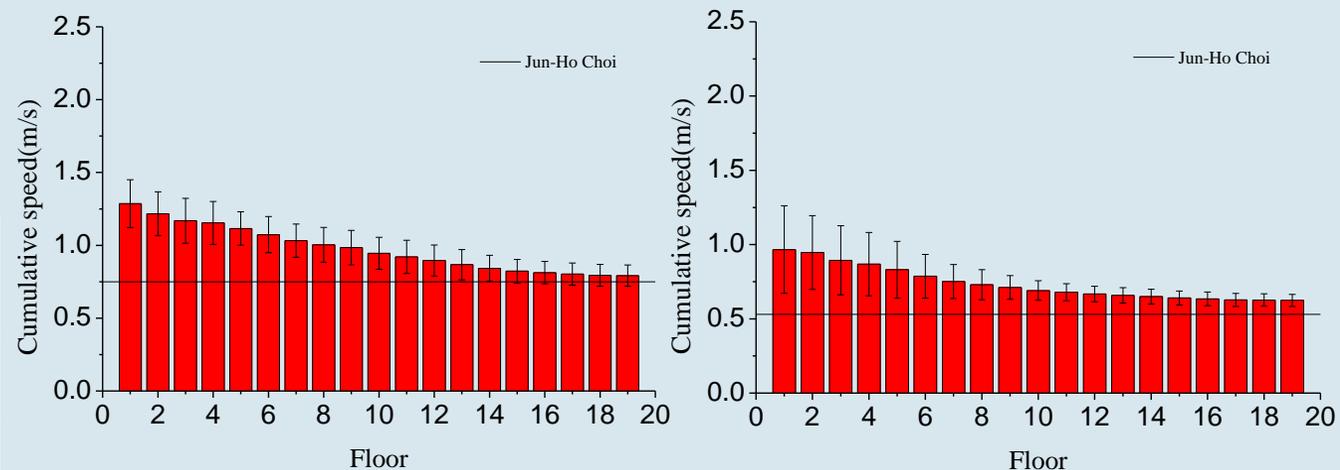


Figure11. Condition 1: a Male; b Female.

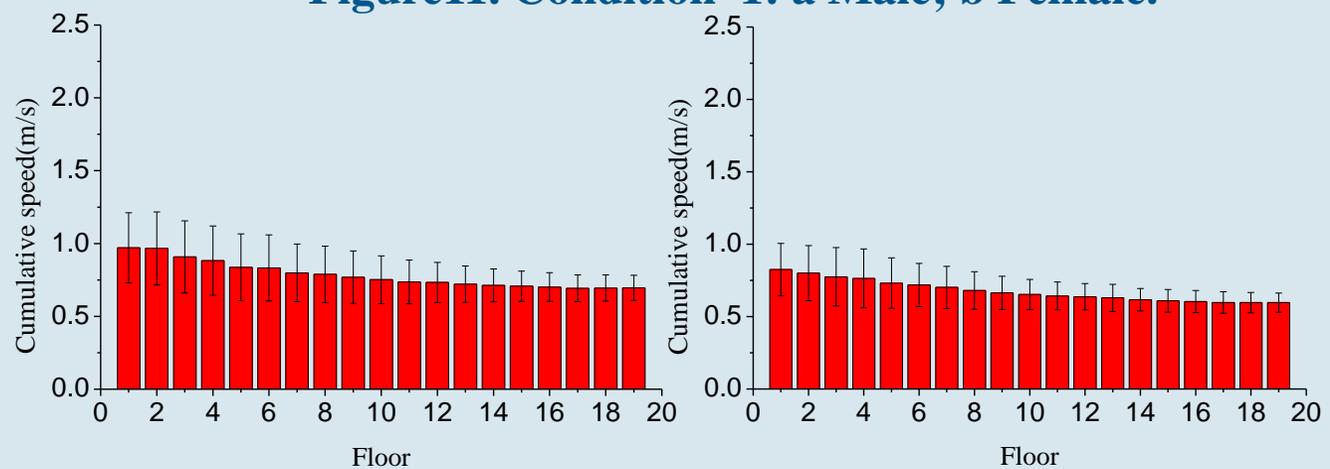


Figure12. Condition 2: a Male; b Female.

3. The Results and Discussion

◆ The Cumulative Average speeds

Table8. Experimental result in Condition 3.

Gender	Max velocity	Min velocity	The difference
Male	0.84m/s	0.69m/s	0.15m/s
Female	0.55m/s	0.46m/s	0.06m/s

Table9. Experimental result in Condition 4.

Gender	Max velocity	Min velocity	The difference
Male	0.55m/s	0.52m/s	0.03m/s
Female	0.47m/s	0.46m/s	0.01m/s

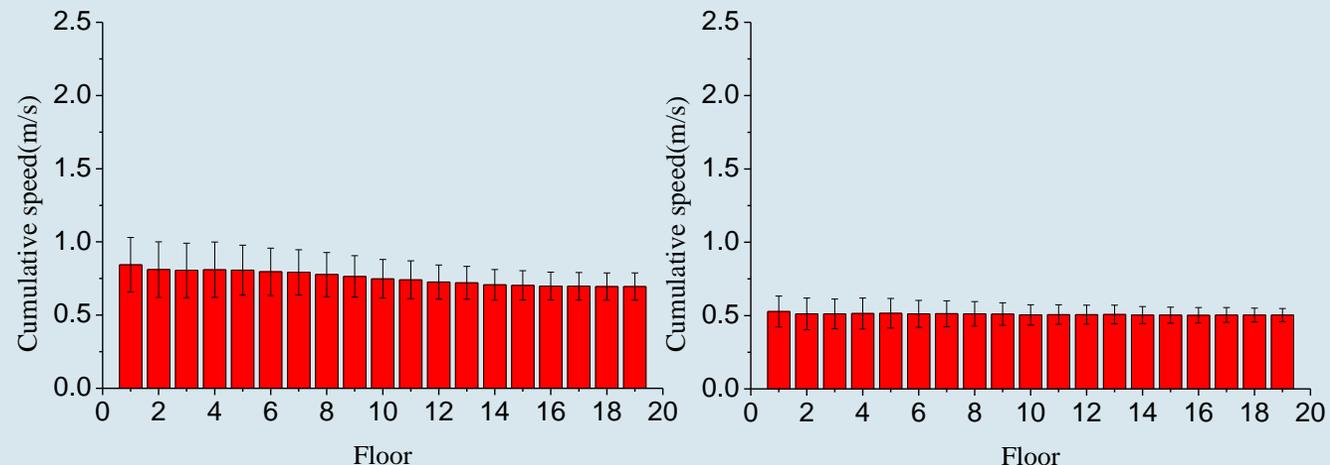


Figure13. Condition 3: a Male; b Female.

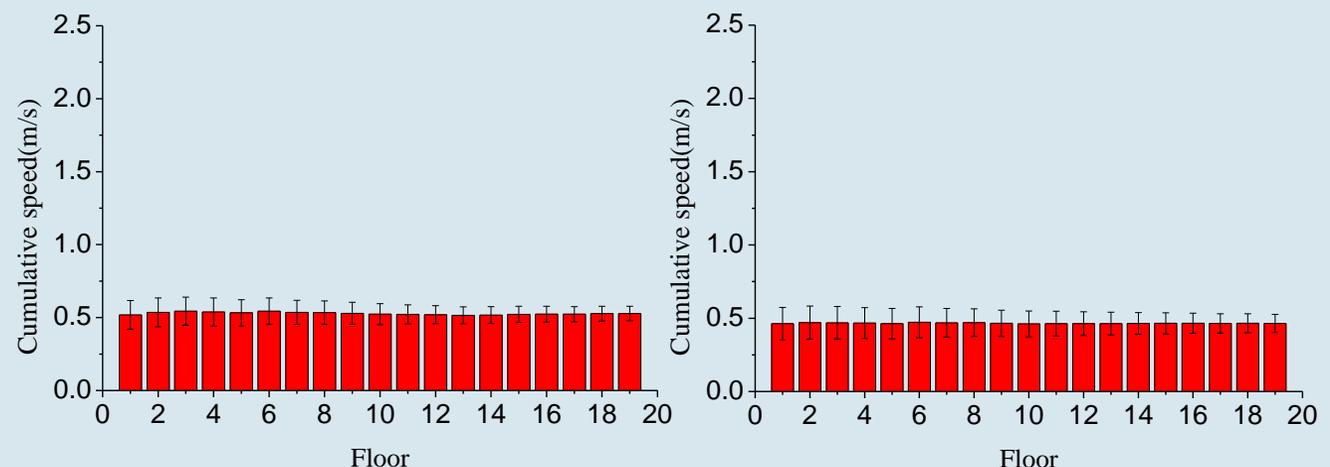


Figure14. Condition 4: a Male; b Female.

3. The Results and Discussion

◆ The Ratio of Handrail Utilization

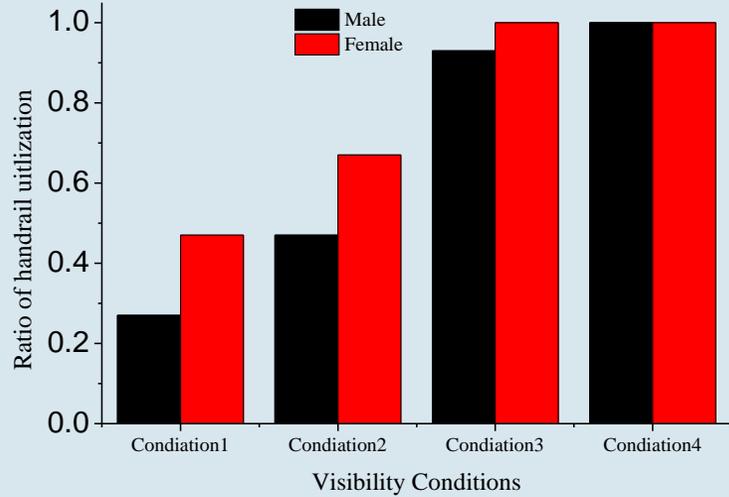


Figure15. The ration of handrail utilization

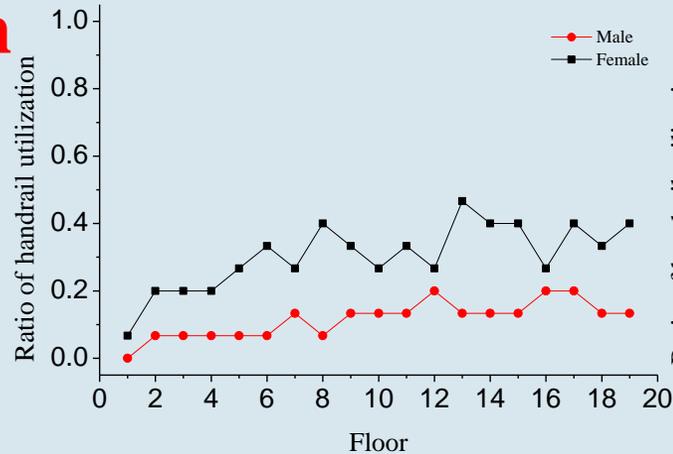


Figure16. Condition 1

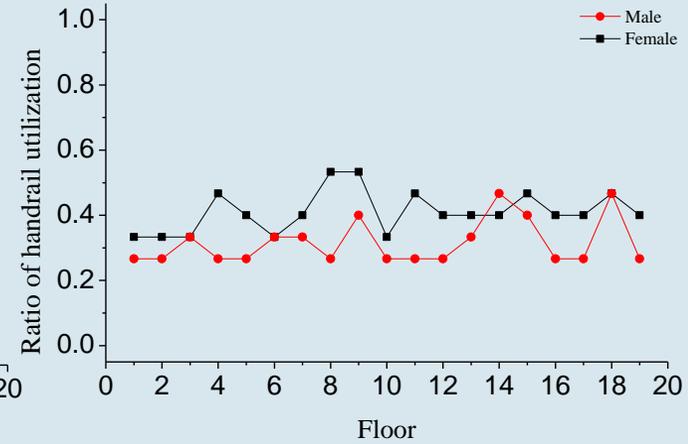


Figure17. Condition 2

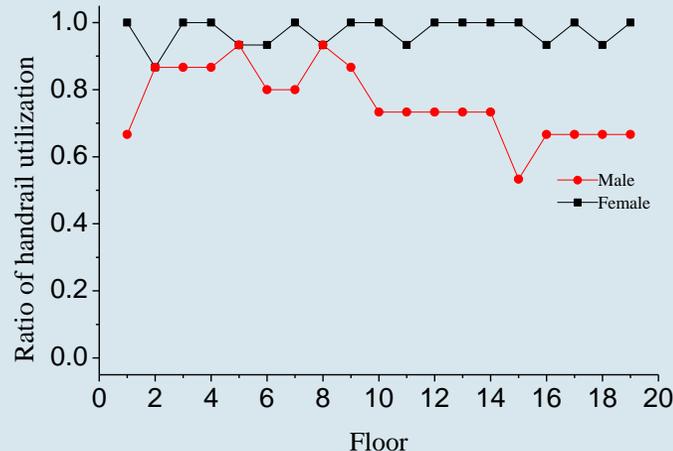


Figure18. Condition 3

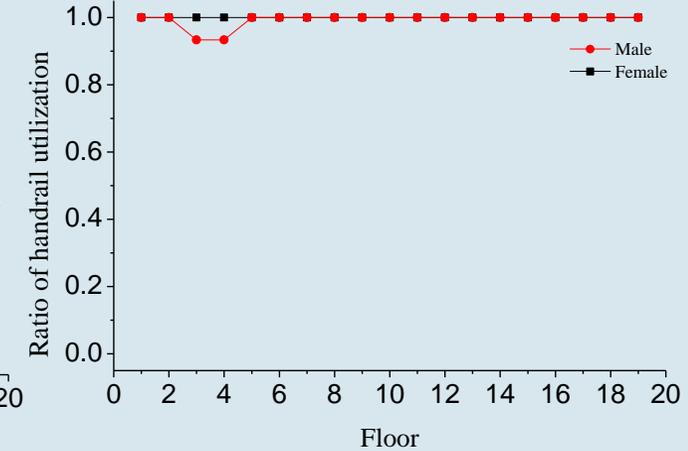


Figure19. Condition 4

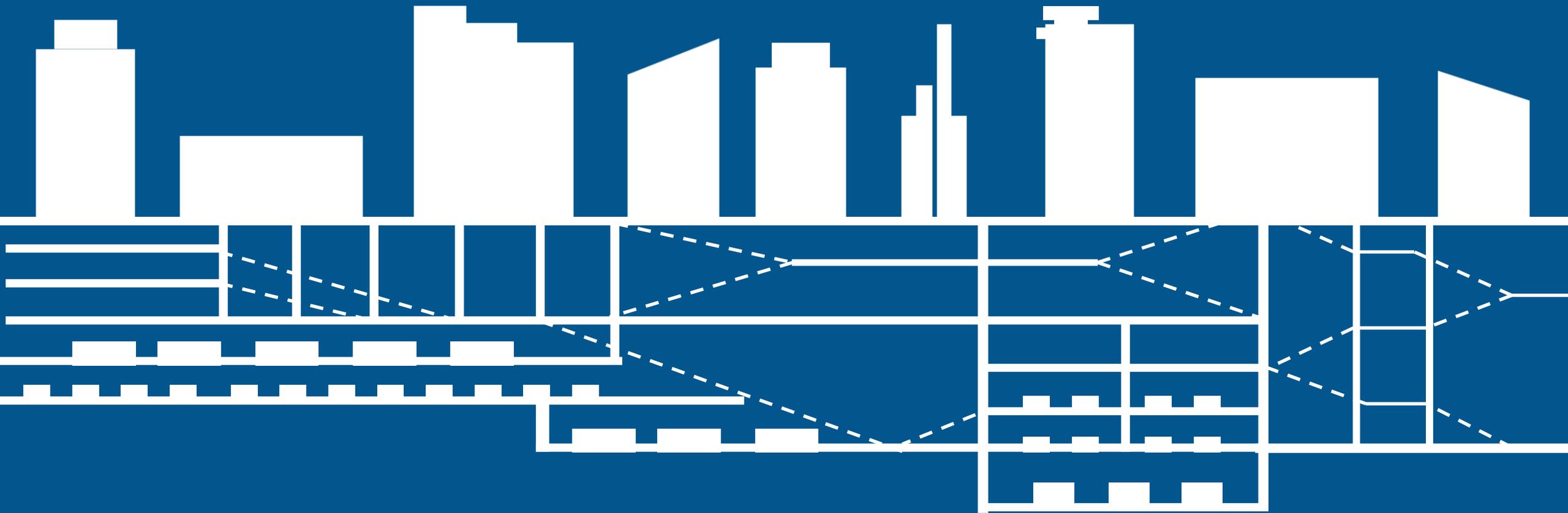
4. Conclusions



- ◆ In the condition of **changes in visibility by indoor ordinary lights**, males' and females' ascent speeds **showed a steady trend after the first decrease**. In the condition of **changes in visibility by smoke**, males' and females' ascent speeds **showed no obvious changes with the ascending floors**.

- ◆ Participates were **likely to use the handrail throughout the upward movement**. In Condition 1 and Condition 2, participants used the handrail in upward movement **process as physical exertion**. In Condition 3 and Condition 4, participants used handrail to **identify the direction of movement**.

- ◆ Females were likely more affected by the visibility of the stairs than males, and males' ability to adapt to the environment were superior to females'.



Thank You !