THE CROWD CONTROL AND THE MAKING SAFE SPACE FOR PEDESTRIAN AT THE TIME OF BIG EVENT

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1. Introduction.

Large international events such as the Olympic Games and international expositions attract large numbers of spectators. The spectators form a crowd, a group of pedestrians, forming a crowd flow in a certain direction. If this flow is not understood and controlled, crowd accidents will occur. It is an important issue to accurately guide people in normal times and in times of crisis during events, such as dealing with concentrations of spectators and guiding evacuations in the event of sudden events.

2. Problems with pedestrian traffic methods in the facility

(1) Methods of pedestrian passage are not clear

One problem with regard to pedestrian traffic is that there is no defined way for pedestrians to pass through walking spaces such as footpaths and internal walkways.

(2) Mechanisms of crowd accidents in panic situations

In order to prevent crowd accidents due to a concentration of spectators and accidents during evacuation in a panic state in the event of an earthquake or terrorist attack, it is important to know the mechanisms of crowd accidents and accidents involving panicked spectators under what conditions they occur and to take corresponding countermeasures. The tendency of the empirical results so far are in Table-1.

Table-1: Behavioral characteristics of crowds during panic.

Left-hand traffic	Crowd flows spontaneously form one lane and pass on the left hand of the road, in Japan.
Shortcut behavior	The behavior of choosing a straight route to reduce energy and time consumption as much as possible.
Buffalo behavior	Blind rush to entrances and exits in a panic.
Rushing behavior	Rushing into arenas, etc. at the height of an event.
Inertial behavior	Inertial behavior in which the behavior pattern in normal times follows the same pattern in emergencies.
Following behavior	In a panic, independent judgement diminishes and people follow the person in front of them.
Phototaxis behavior	Light-tracking behavior.
Slalom phenomenon	A meandering phenomenon in which the gait trajectory does not follow a straight line but turns to the left or right.
Arching	Traffic jams occur at bottlenecks such as exits, causing pedestrians to arch.
Clogging phenomenon	A phenomenon in which people clog each other at bottlenecks.
Stop-and-go phenomenon	Stop-and-go occurs when the distance between pedestrians is less than 1 m.
Turbulence phenomenon	When the crowd density becomes higher under the stop-and-go phenomenon, turbulence occurs and the possibility of tipping over is very high.
Pressure concentration phenomenon	A phenomenon in which pressure is concentrated due to the combined mechanical interactions of a crowded crowd.

3 Measures for Crowd Accidents at Emergency

It is important to consider both the hard and soft aspects from the design stage of the facility, taking into account evacuation in case of accidents or emergencies. Points are human flow control and avoidance of human flow concentration.

(1) Human Flow Control

- Creating a walking space based on lefthand traffic.
- Double-tracking. and disperse the flow lines.
- Do not create lines of flow where crowds bump into each other
- Do not create darkness.
- Prepare emergency evacuation routes in the event of an emergency.

(2) Avoidance of Human Flow Concentration

- Do not create a line of flow that creates pressure at a single point.
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- Floor levels should be sloped to prevent falls.
- Ensuring the strength of handrails and fences.
- Enforcement of designated passage ways.
- Prevention of shortcut behavior.
- Prohibition of standing still.
- Preliminarily limit the number of crowds to avoid concentration.
- Crowd segmentation.
- Disperse exiting party at the end of the event.
- Provide appropriate and sufficient information to avoid panic.
- Emergency response preparedness and training.

4, Conclusion

To make safe spaces and to prevent accidents at crowded places, it is important to take two types of measures: hard measures for facilities and roads, and soft measures to control the flow of people and prevent confusion.