Human Engineering to Reduce Damage on Passengers at Train Collision

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Railway Technical Research Institute is only one organization in Japan, where human engineering researches have been promoted to reduce the damage on passengers at train collision, with its research results on the accidents occurring with long-seat type commuter trains unparalleled in the world as outlined below.

SURVEY OF INJURIES

The author and co-researchers surveyed the accidents of long-seat type commuter trains and clarified the features of passenger injuries at accidents that the chest injuries are outstanding with seated passengers (accounting for 48% of the total injuries) and injuries on the head are with standing passengers (20%) (Fig. 1). In terms of assailant articles, 64% of the injuries taking place to seated passengers are caused by hand-rails and 80% of those to standing passengers are by the floor, columns, and other passengers (Fig. 2). As injury patterns specific to long-seat train accidents, passengers seated beside a pipe hand-rail are injured on the chest by lateral pipes, and those standing in front of a long seat collide with the floor to injure the head.

ANALYSIS OF BEHAVIORS AND COUNTERMEASURES AGAINST SEATED PASSENGERS

The author performed simulation analysis of the above-mentioned chest injury pattern of seated passengers (Fig. 3) and estimated the passenger behaviors as well as chest injury indices (to indicate the possibility of serious damage on the chest), which is significantly high for passengers seated beside a hand-rail. Against this fact, the author proposed a mechanism of releasing the hand-rail fixing point when hit by a passenger, which reduces the index by about 30%.

ANALYSIS OF BEHAVIORS AND COUNTERMEASURES AGAINST STANDING PASSENGERS

The author also performed similar simulation analysis on the head injury pattern of standing passengers as described earlier, discussed countermeasures, and proposed a squatting posture on the floor as shown in Fig. 4 to ensure safety at accidents in which passengers have several seconds leeway until the accident occurs after noticing that it is unavoidable. Calculations have verified that the index to seriously damage the head (Head Injury Criterion, HIC) is decreased by 38% when passengers are standing while gripping a hand strap from that when taking the standard standing posture (without gripping a hand strap). It was furthermore estimated that the HIC is decreased by 98% when passengers take the proposed posture (Fig. 5).

The hand strap arrangement to reduce the head injury index is also being examined. The author will perform simulation analysis to study more effective measures against the aforementioned injury patterns and discuss other injury patterns from now on.

ACKNOWLEDGEMENT

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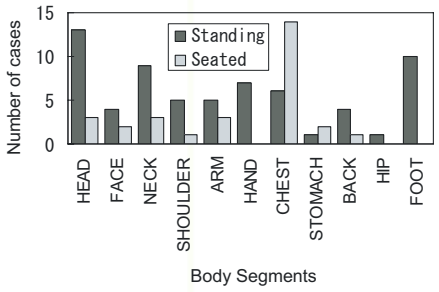

Figure 1. Body segments injured at a train collision.

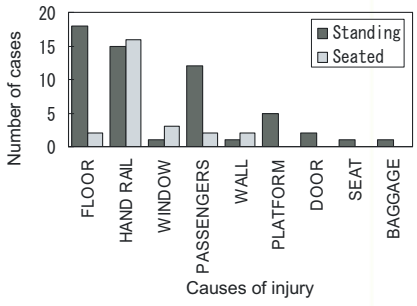

Figure 2. Causes of injury.

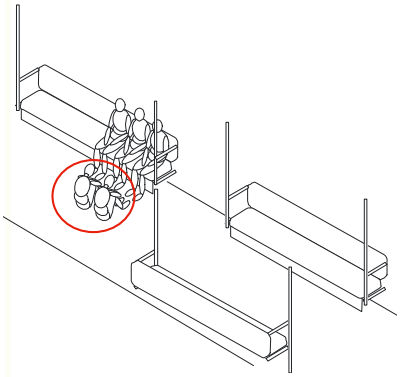

Figure 4. A safe position for standing passengers.

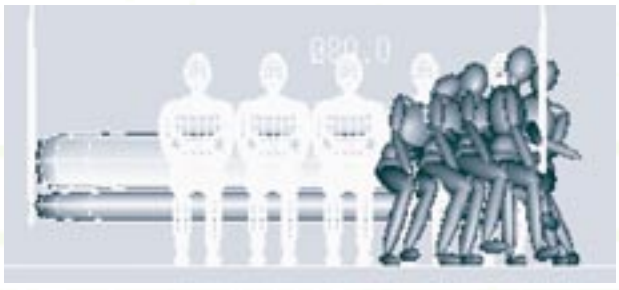

Figure 3. A computer simulation of passengers sitting on a long seat. Passengers are simulated by white wire frame bodies before the impact and by dark bodies 0.8 s thereafter.

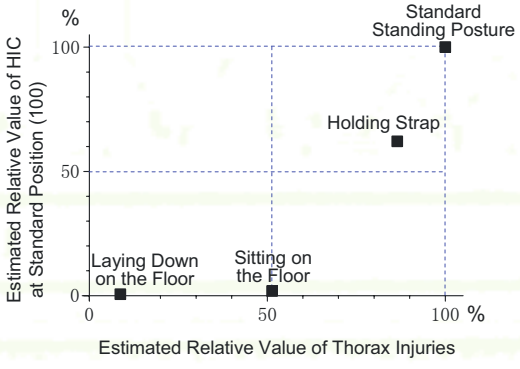

Figure 5. Positions of passengers on board and injury percentages.