

Submitted by the expert from Japan

Informal document GRSP-76-29

(76<sup>th</sup> GRSP, 2-6 December 2024

agenda item26(a))

# **Guidelines for the Safety of Express Buses with Full-Flat Seats**

November 2024

Vehicle Safety Measures Study Group

Logistics and Road Transport Bureau, Ministry of Land,  
Infrastructure, Transport and Tourism

## **I. Introduction**

Currently, international standards for the safety of occupants of vehicles in the event of collision assume that they are sitting in their seats. Specifically, safety requirements such as strength tests and collision tests are based on a seat back angle of 25 degrees. As a result, there is no internationally established safety evaluation method for seats that are deeply reclined, which cause the occupant to sit in a semi-seated posture, or for full-flat seats, which cause the occupant to lie on their back when fully reclined.

On the other hand, with the spread of automated driving, it is expected that occupants will adopt a variety of riding postures in the future, and discussions are beginning to take place at international forums such as the Working Party on Passive Safety (GRSP) under the United Nations World Forum for Harmonization of Vehicle Regulations (WP.29) regarding the safety of occupants in a variety of riding postures. Further, it has been confirmed that some long-distance buses in other countries are equipped with bed-type seating for occupant comfort, while some long-distance buses in Japan have seats that recline deeply to improve passenger comfort during travel and some manufactures have announced the introduction of full-flat seats.

In this context, the present guidelines summarize the safety measures that should be taken for full-flat seats that can be reclined fully based on the results of collision tests on the effect on the occupant of different safety measures. For deeply reclined seats other than full-flat seats, their effect on the occupant seems to vary with the reclining angle, so we will continue studying the matter for those seats.

## **II. Basic Approach**

International discussions are underway on the safety of various riding postures, but even pending the establishment of international standards, it is expected that research and development of full-flat seats and the like by automobile and other manufacturers will progress and that such seats will be introduced into the market and used by users.

For this reason, these guidelines aim to maintain an environment in which users can use vehicles with peace of mind, while also creating an environment in which automobile manufacturers can engage in advanced research and development. Based on the findings of collision tests and other research, the guidelines summarize the safety measures that should be taken.

## **III. Scope of the Guidelines**

The guidelines apply to those of the seats installed in vehicles exclusively used for passenger transport with a seating capacity of eleven or more and a gross vehicle weight of five tons or more which conform to international regulations (UNR 80<sup>1</sup>) and are designed for use while the seat is fully reclined to a full-flat position while the vehicle is traveling. The specific approach is described in sections 1. and 2. below.

Further, these guidelines do not apply to seats that are arranged so that the occupant's side faces the direction of travel (facing sideways), because they do not ensure the safety of the occupant in such a posture and are not permitted under the current international regulations, except for low-speed vehicles such as route buses.

### **1. Current regulation's approach to ensuring safety**

As a general rule, UNR 80 requires the manufacturer to prevent the occupant from being injured by, when the angle of the seat back is 25 degrees, securing their hips and shoulders, the strongest parts of the body, using a three-point seat belt to the seat with

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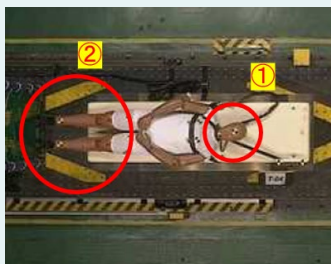


<sup>1</sup> United Nations Regulation No. 80 "Uniform provisions concerning the approval of seats of large passenger vehicles and of these vehicles with regard to the strength of the seats and their anchorages"

a waist belt and a shoulder belt, respectively, to prevent the occupant from moving forward in the event of a collision, etc., and to prevent the upper body from leaning excessively forward. However, if there is no risk of the occupant coming into contact with the seat in front or other objects in the event of a collision, or if the seat in front or other objects that may come into contact with the occupant conform to the impact absorption standards, a two-point seat belt that secures the occupant’s waist to the seat using a waist belt is also acceptable.

## 2. Collision test results for full-flat seats

(1) Results of tests where the occupant was seated with their feet facing the direction of travel (facing forward)

- It was confirmed that the occupant’s body would bounce in the direction opposite to the direction of travel upon a collision.
- It was confirmed that, when the occupant was secured with only a seat belt, they were restrained, but the legs would fly out of the seat.
- When the seat did not have any seat belt but had a fall prevention plate and protective components instead, it was confirmed that the fall prevention plate and protective components were damaged, but, if their strength was enhanced, could keep the occupant in the seat.

	Three-point belt	Two-point belt	No belt + Fall prevention plate + Protective components
Upon the simulated collision			
Evaluation	<ul style="list-style-type: none"> <li>(i) The shoulder belt caught the occupant’s neck</li> <li>(ii) The occupant’s legs protruded from the bed</li> </ul>	<ul style="list-style-type: none"> <li>(i) No injury to the occupant due to the belt</li> <li>(ii) The occupant’s legs protruded from the bed</li> </ul>	<ul style="list-style-type: none"> <li>(i) The fall prevention plate retained the occupant in the seat</li> <li>(ii) The fall prevention plate and protective components were damaged</li> </ul>

(2) Results of tests where the occupant's head was positioned facing the direction of travel (facing backwards)

- When the occupant's head was positioned facing the direction of travel (facing backwards), injuries to the head and neck that could lead directly to death or serious injury were confirmed.

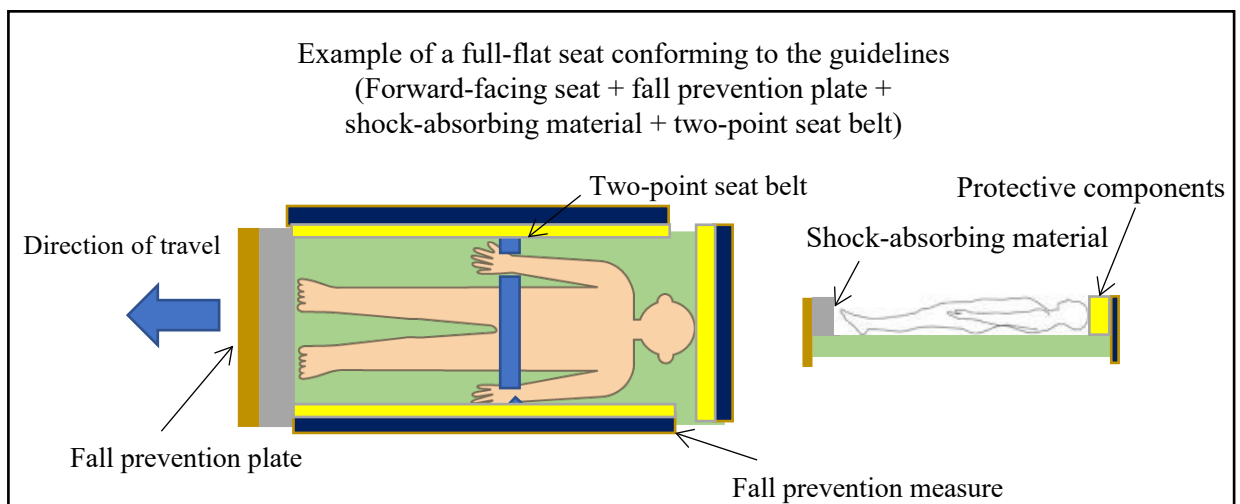
(3) Results of tests where the occupant's side faces the direction of travel (facing sideways)

- It was confirmed that it is possible to hold the occupant in their seat using belts and fall prevention plates, etc.

#### IV. Safety Measures To Be Taken for Full-flat Seats

In these guidelines, we have examined the safety measures that should be taken for full-flat seats that can be reclined fully based on the results of collision tests on the effect on the occupant of different safety measures.

##### 1. Safety measures to be taken for full-flat seats



(1) The seat should be arranged so that the occupant's legs face the direction of travel (facing forward).

Reason: While it is important to minimize the impact on the occupant of a frontal collision, which generally poses the greatest risk of injury for them, it has been confirmed that the risk of injury to the head and neck, which is directly linked to death and serious injury, is low in the case of forward-facing seats.

- (2) The leg area of the seat should be covered with a fall prevention plate and shock-absorbing material that can withstand the impact.

Specifically, it is desirable that the seat can withstand the impact of a dynamic test simulating a frontal collision at 30 km/h as specified in UNR 80. In this case, the fall prevention plate and shock-absorbing material, etc., designed to withstand a force of 900 kgf, shall satisfy this requirement.

Reason: While it is important to prevent the occupant from being ejected or falling out of the seat upon a collision or sudden deceleration and to reduce the risk of injury to them and other occupants, it has been confirmed that it is possible to keep the occupant in their seat by covering the leg area of the seat with a shock-resistant fall prevention plate and a shock-absorbing material.

- (3) In the head and side areas of the seat, measures should be taken to prevent the occupant from falling out of the seat and protective components should be installed. Specifically, measures should be taken to prevent the occupant from falling out of their seat while the vehicle is turning, etc. In this case, fall prevention measures and protective components made of pipe materials, etc. arranged to prevent the occupant from falling out of their seat and covered with materials with a Shore A hardness of less than 50 shall satisfy this requirement.

Reason: While it is important to prevent the occupant from falling out of their seat upon a collision or while the vehicle is turning, etc., and to reduce the risk of injury to them and other occupants, it has been confirmed that it is possible to prevent the occupant from falling out of their seat by covering the head and side areas of the seat with fall prevention parts and protective components.

- (4) The seat must be equipped with a two-point seat belt or other device to restrain the occupant's waist to the seat. However, three-point seat belts should not be used on a full-flat seat, as the shoulder belt may put pressure on the occupant's neck, which can lead to death or serious injury.

Reason: While it is important to prevent the occupant from being thrown out of the vehicle, etc. in the event of a rollover and to reduce the risk of injury to them and other occupants, it has been confirmed that it is possible to restrain the occupant using a two-point seat belt.

## **2. Other safety measures**

(1) Safety measures by automobile manufacturers, etc.

a. There must be a clear path for entering and exiting the vehicle and for emergency exits. If there are seats near the emergency exit that may prevent escape in an emergency, their structure should be designed to be easily removable or foldable.

Reason: Because it is possible that access from the seats to the aisles will be more difficult than with a normal seating arrangement, such as with double-level full-flat seats where the occupant gets down from the upper level when getting on and off the vehicle, or because it is possible that some of the seats will be in the line of movement for the emergency exit or the aisle leading to the emergency exit.

b. Passengers must be informed of escape routes and procedures by displaying them in easily visible locations in the vehicle. In this case, appropriate lighting should be provided so that the displayed content can be read even at night.

Reason: It is assumed that full-flat seats will affect the ease of escape in an emergency.

(2) Safety measures by the passenger transport operator using full-flat seats

a. To ensure that occupants do not place their baggage in locations that block the aisles and emergency exits as well as the lines of movement leading to these areas, the boarding space should be expanded to provide a baggage storage area, and occupants should be informed of this.

Reason: Since the full-flat seat arrangement may make the occupants' baggage storage space smaller than in the case of a normal seating arrangement, it is assumed that the ability to escape in an emergency may be affected depending on where occupants place their baggage.

b. If passengers need assistance from others when getting on and off the vehicle or in an emergency, explain to them at the time of reservation, etc. that the seats have a different structure from normal seats, how to use them, how to handle them in an emergency, etc.

Reason: Because it is assumed that occupants' understanding will affect their ability to escape in an emergency.

## **V. Important Notice**

Automobile manufacturers, etc. and users of full-flat seats, to which these guidelines apply, should aim from now on to develop and use seats that incorporate the safety measures stipulated in IV.

It should also be noted that it has been confirmed that in the case of seats that recline deeply, the waist belt may press against soft, vulnerable parts of the occupant's body, such as the abdomen, in the event of a collision. While the safety measures that should be taken for seats that have been confirmed to show such behavior will be a matter for future study, it is desirable that automobile manufacturers, etc. continue making sure in the design stage that the seats can be used safely as they have done so far, and that they thoroughly inform users of the proper way to use the seats, the safety performance of which has been confirmed as specified, and that users create an environment in which the seats are used in the proper way. Finally, the safety measures that should be taken for full-flat seats should be reviewed as necessary in response to future developments in safety technology, progress in international discussions, and the actual circumstances of accidents.