2nd report of vehicle perfomance investigation and Japanese proposal

AEBS-HDV-03

21．22th September 2021

Japan

Outline of the test and test vehicles

Outline：

- The performance of vehicle to Pedestrian and Vehicle to Vehicle were investigated by the actual vehicle tests.
- The vehicles of two categories (N2, N3) were tested.
- The tests were carried out in accordance with R152 (AEBS tests for M1/N1).
- Test speed was 10, 15, 20, 25, 30, 35, (40, 45, 50, 60) km/h (with a tolerance of +0/-2 km/h).

N2（Hydraulic brake）
Sensing device：Stereo camera

N3（Air brake）
Sensing devices：Camera + mmWave radar

Weight of vehicles	Unladen *1	Laden *2
N2（Hydraulic brake）	3255 kg	7770 kg
N3（Air brake）	11080 kg	—— *3

*1 Unladen means the mass of a vehicle in running order with an additional mass (125kg)
*2 Laden means the maximum mass
*3 The test of Laden condition of N3 was omitted, because the loads to make the vehicle laden condition (almost 25000kg) could not be prepared.

Pedestrian target

Pedestrian target：ISO 19206-2:2018

Same as R152, a child soft target in accordance with ISO 19206-2 was used. Additionally, an adult soft target in accordance with ISO 19206-2 was used in the particular test speed.

Non-articulated (fixed legs) soft targets were used, because there was concern of bigger damage of legs of the soft targets by collisions with large truck.

ISO 19206-2:2018
（Child）

ISO 19206-2:2018
（Adult）

Testing scenario	Moving speed	Collision offset
Stationary（Child）	0 km/h	50 %
Crossing（Child）	5 km/h	50 %
Stationary（Adult）	0 km/h	50 %
Crossing（Adult）	5 km/h	50 %

Stationary vehicle target

Passenger vehicle 3D target：ISO 19206-3

- Ssme as R152, a passenger vehicle 3D type soft target in accordance with ISO 19206-3 was used as a stationary vehicle target.
- N2 vehicle with Laden condition was used for the test vehicle.
- Centreline offset between the test vehicle and the stationary vehicle target was not more than 0.2 m in each test.

Overview of tests

N3(Air), Crossing (child)

N3(Air), Stationary (child)

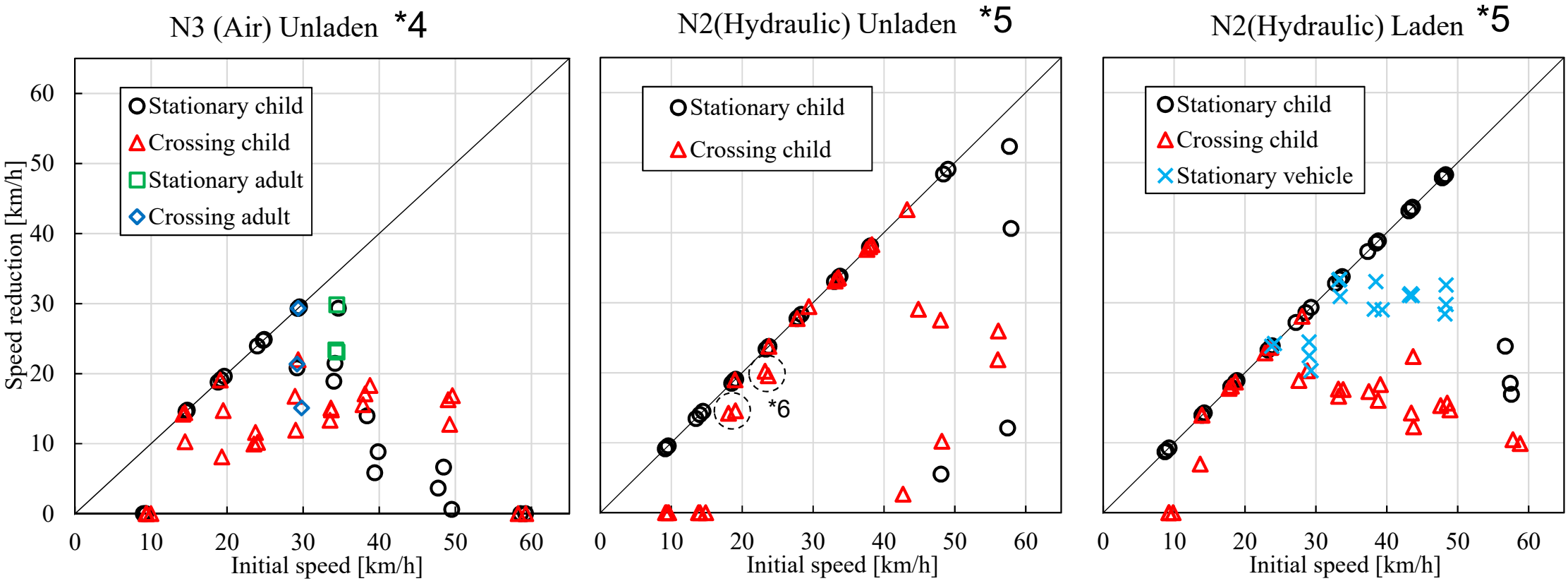
Overview of tests

N2(Hydraulic), Crossing (child)

N2(Hydraulic), Stationary (child)

N2(Hydraulic), Stationary vehicle

Test Result : Speed reduction



Initial speed means actual vehicle speed, and it was defined as below.

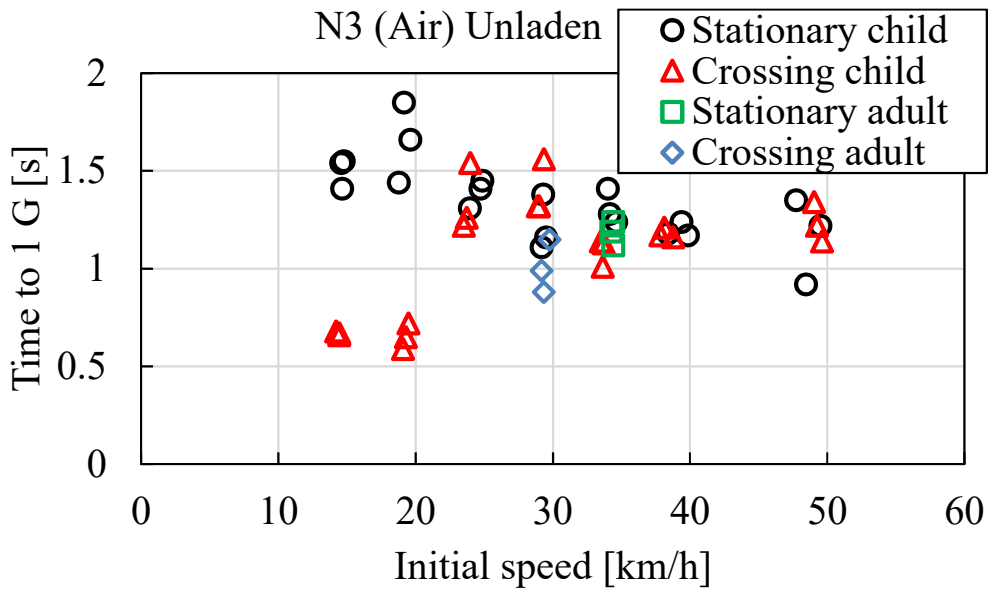
- In the case that emergency braking was observed : Vehicle speed at when deceleration exceeds 0.3 m/s^2.
- In the case that emergency braking was not observed : Vehicle speed at TTC 4 s.

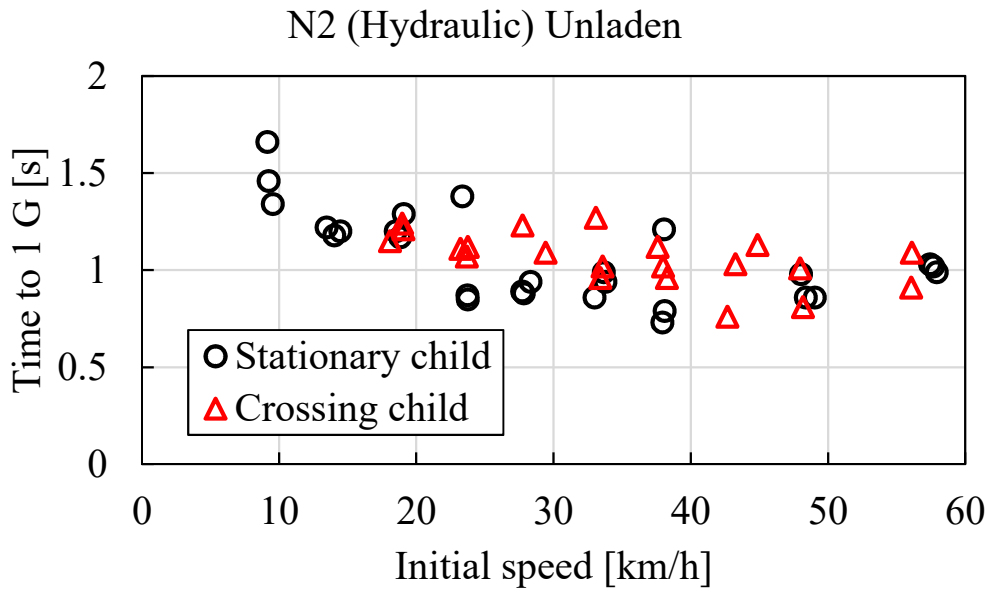
*4 In N3 with Unladen condition, tests on an adult target were performed only in particular speeds (stationary 35 km/h, crossing 30 km/h) in which some deviations of speed reduction were observed with a child target.

*5 In N2 with both Unladen and Laden conditions, tests with an adult target were omitted, because the deviations of speed reduction in each test with a child target were small.

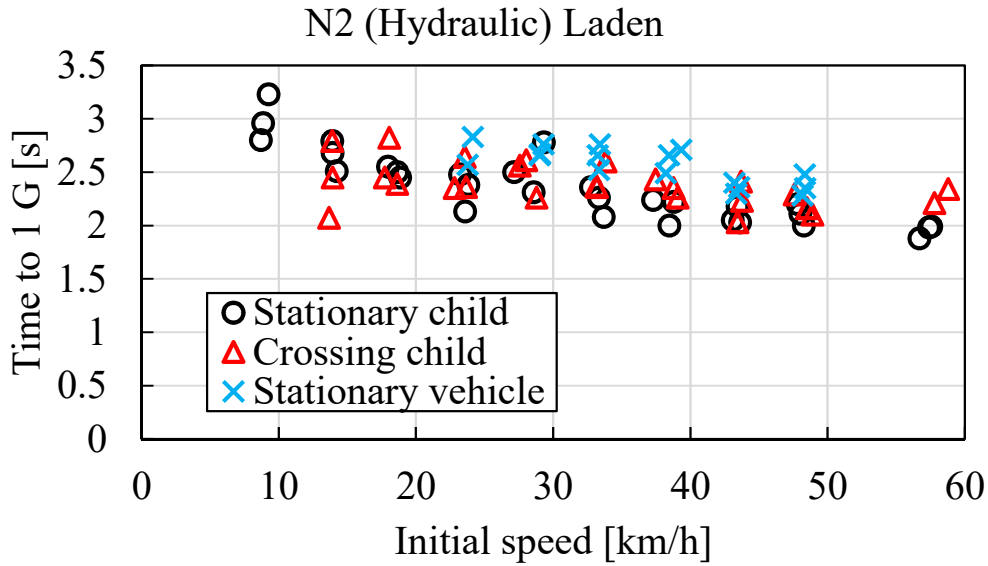
*6 Since the target had crossed the road without a collision due to significant deceleration of the test vehicle, the test vehicle did not stop completely and released the brake (avoid collision)

Test Result : Time to 1 G

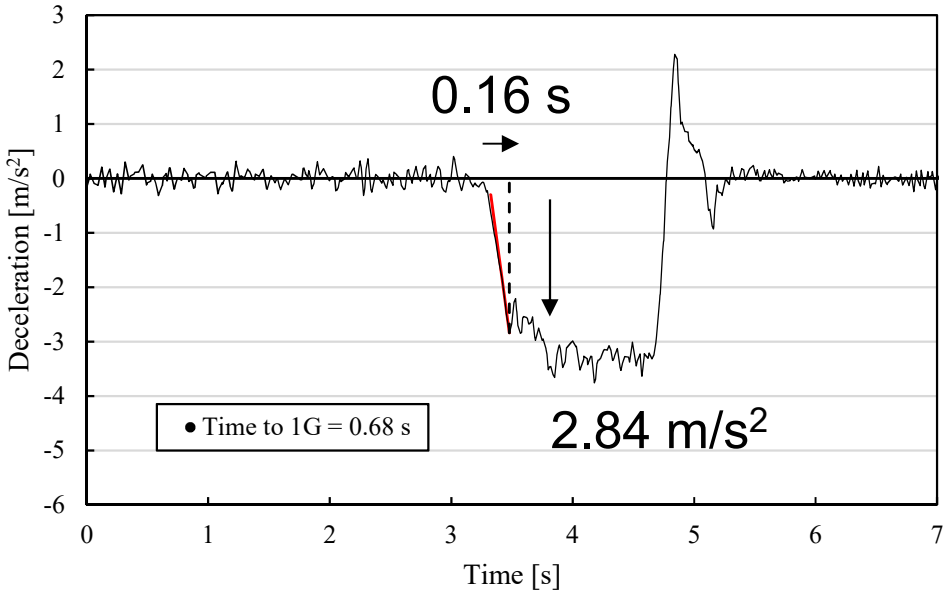




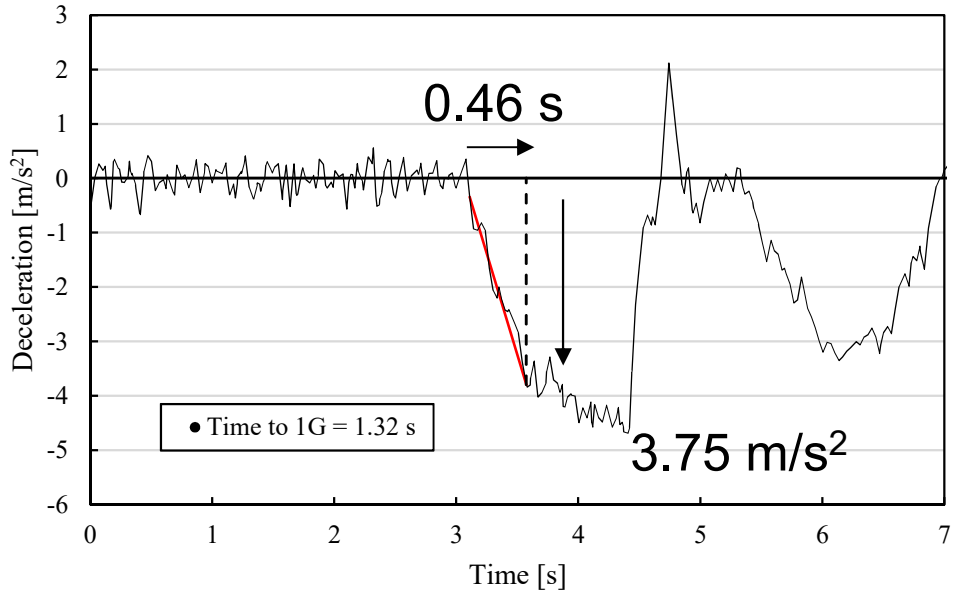
Only data in the case when deceleration by emergency braking was significantly observed was shown in the figure.



Example of time to 1 G (N3, Unladen)



N3(Unladen), Crossing child, test speed 15 km/h
(Example of TT1G becoming small value)



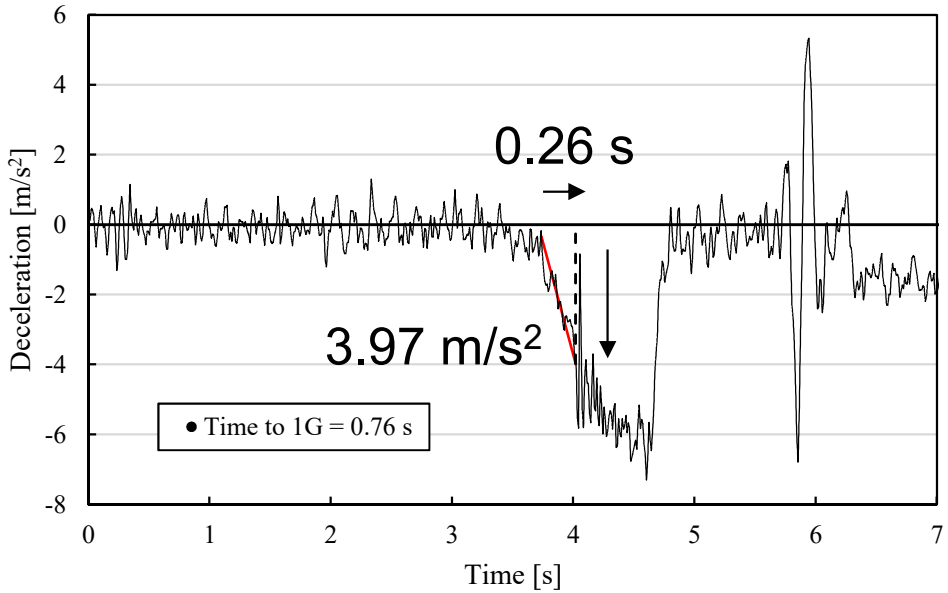
N3(Unladen), Crossing child, test speed 30 km/h
(Example of TT1G in which similar values were observed in many test cases)

0.16 s to 2.84 m/s^2
→ 0.68 s to 9.8 m/s^2

0.46 s to 3.75 m/s^2
→ 1.32 s to 9.8 m/s^2

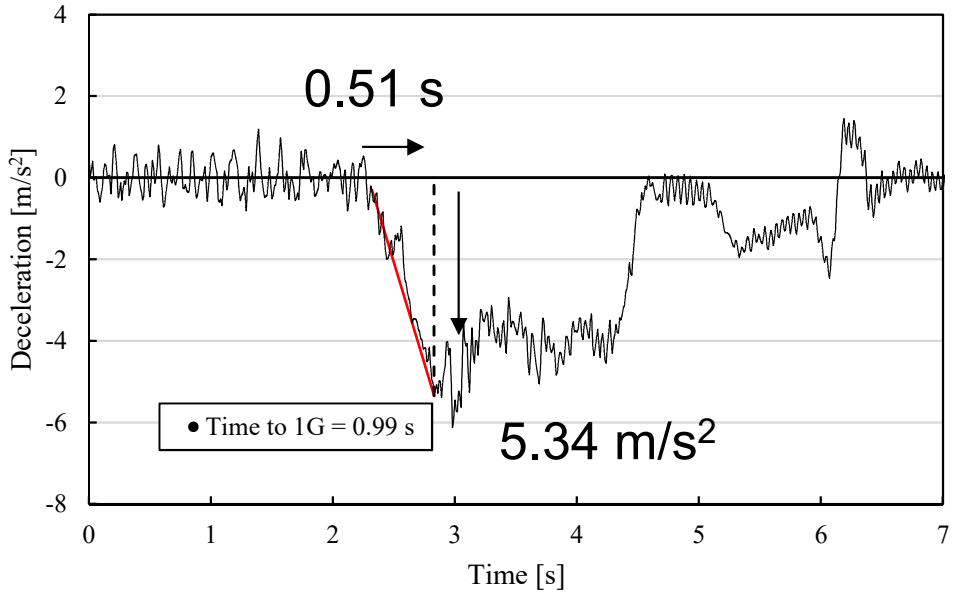
Time to 1G was measured from time series data of deceleration by the following method.
N3 Air brake : From the timing of deceleration 0.3 m/s^2 to the first peak value
N2 Hydraulic brake : From the timing of deceleration 0.3 m/s^2 to the first linear area

Example of time to 1 G (N2, Unladen)



N2(Unladen), Crossing child, test speed 45 km/h
(Example of TT1G becoming small value)

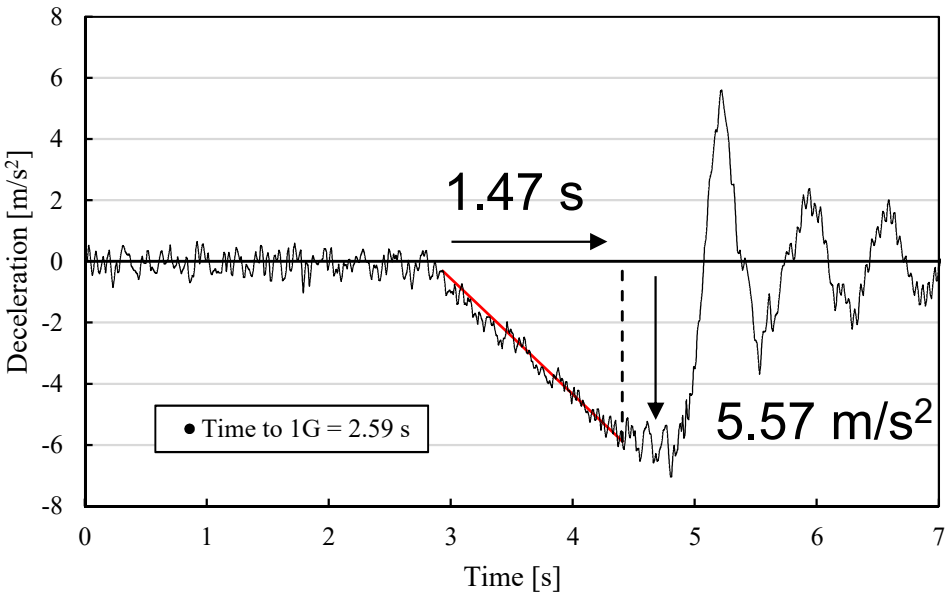
0.26 s to 3.97 m/s^2
→ 0.76 s to 9.8 m/s^2



N2(Unladen), Stationary child, test speed 35 km/h
(Example of TT1G in which similar values were observed in many test cases)

0.51 s to 5.34 m/s^2
→ 0.99 s to 9.8 m/s^2

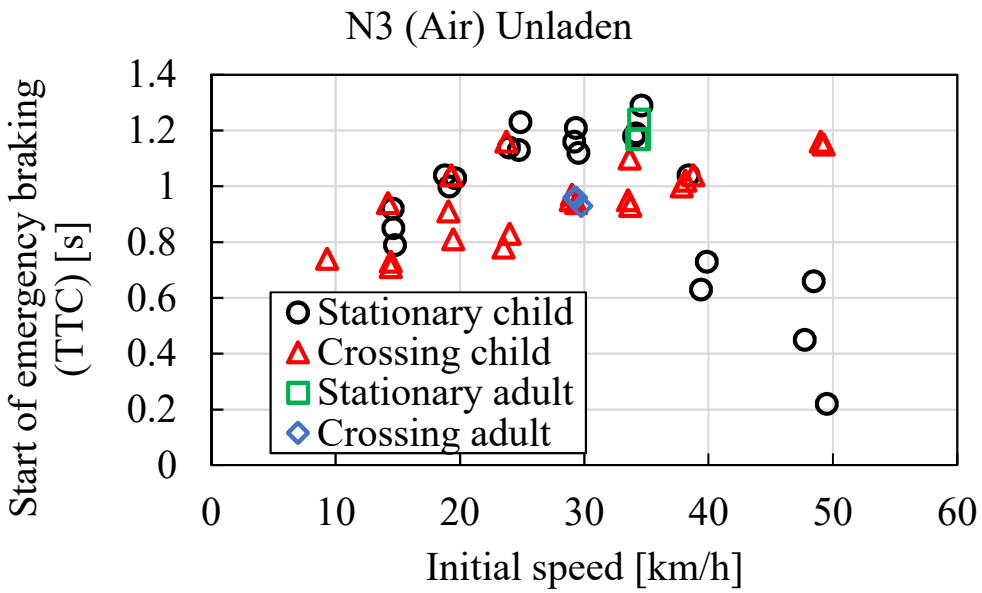
Example of time to 1 G (N2, Laden)

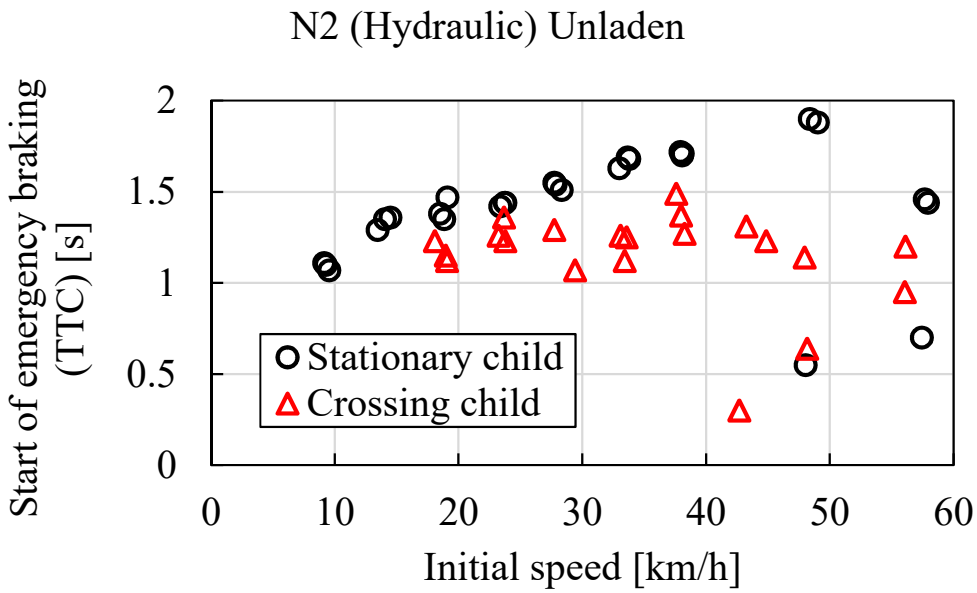


N2(Laden), Crossing child, test speed 30 km/h

1.47 s to 5.57 m/s^2
→ 2.59 s to 9.8 m/s^2

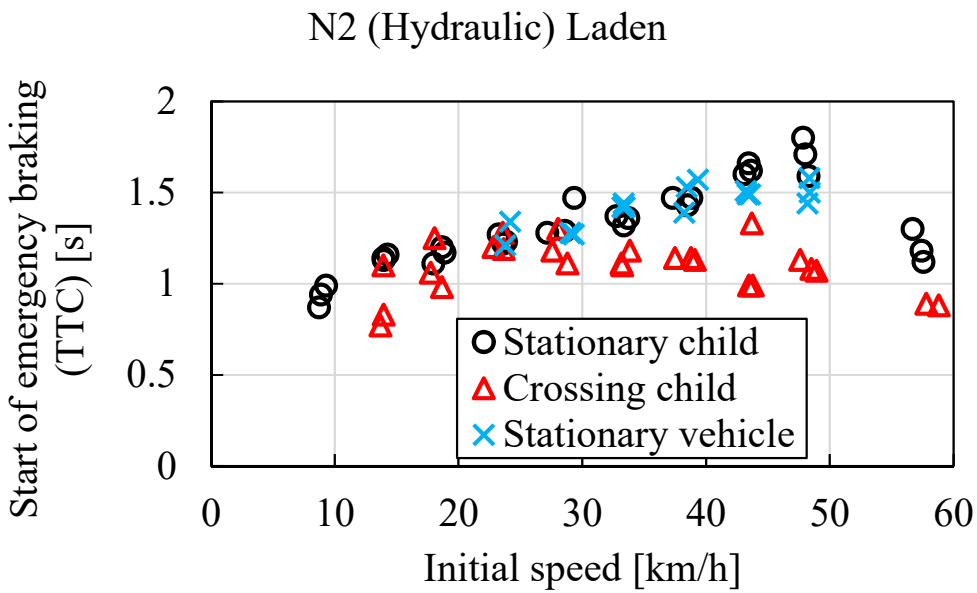
Test Result : Start of emergency braking (TTC)



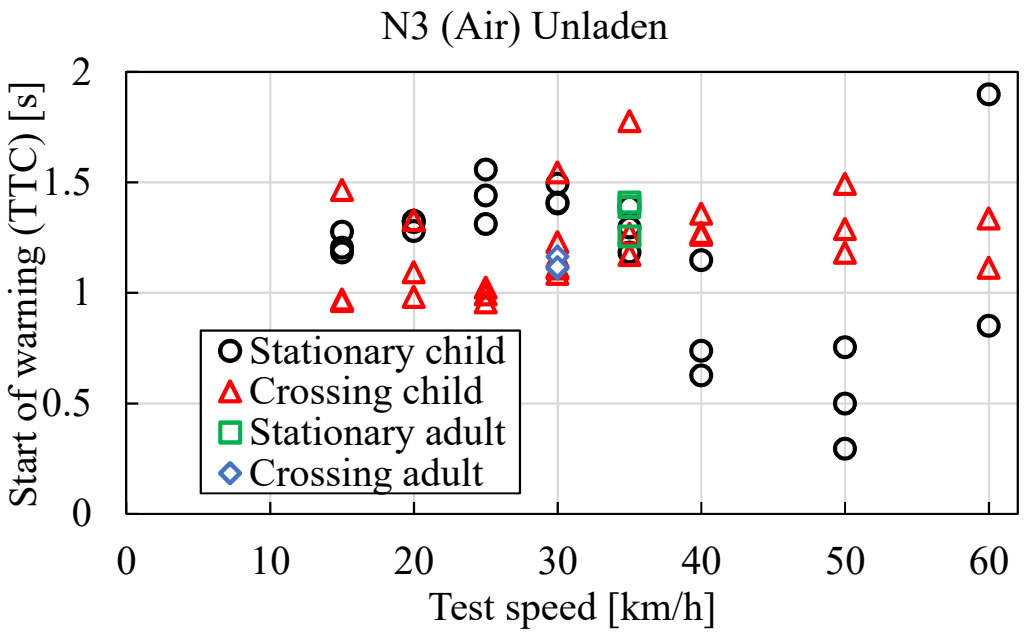


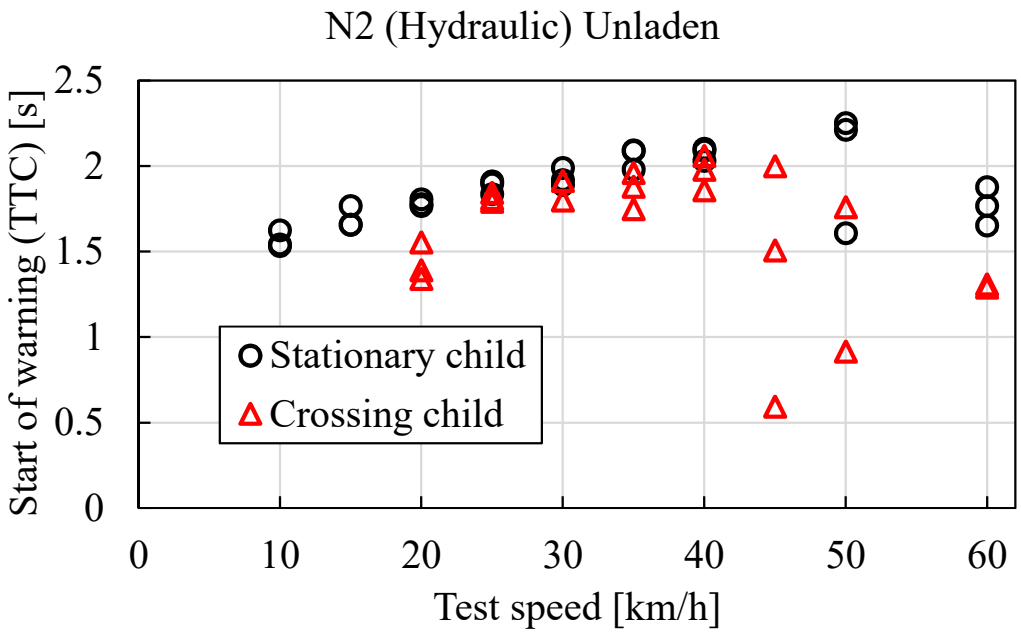
Only data in the case when deceleration by emergency braking was significantly observed was shown in the figure.

AEBS activation timing :
Timing at when deceleration exceeds 0.3 m/s^2.



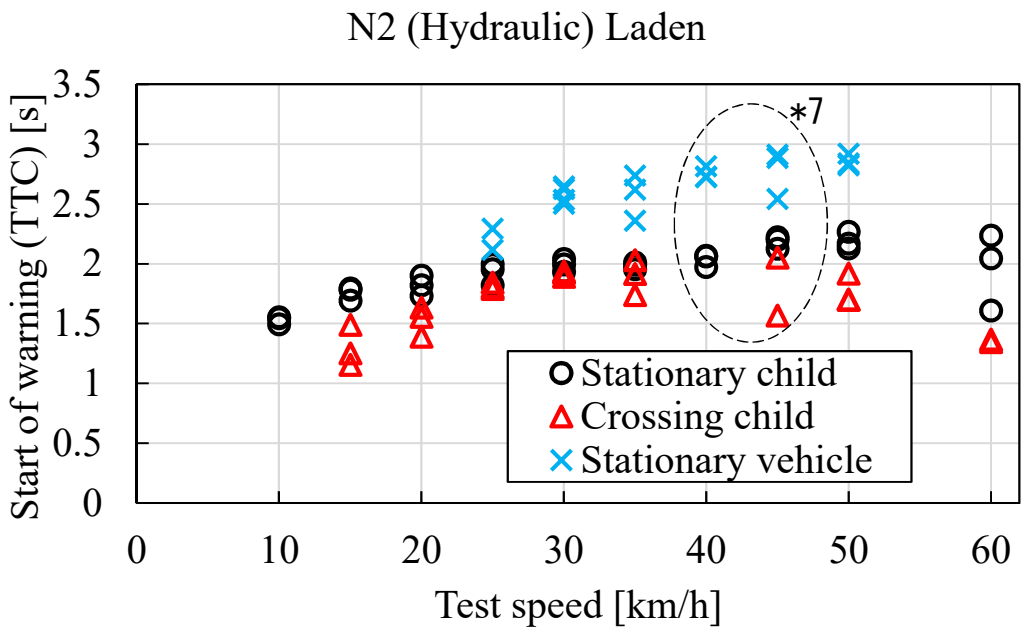
Test Result : Start of warning (TTC)





Test speed:
It is defined as the speed of test condition, and distinguished from the Initial Speed.

*7 Although activation of the warnings were confirmed, the start timing of the warning could not be measured in some cases, due to a malfunction of the measuring equipment (N2 with Laden condition, crossing child, 40 km/h 3 times and 45 km/h 1 time).



Overview of the Results of the Vehicle Performance Investigation

1. Summary of the results

- In the vehicle-to-pedestrian performance investigation using the N2 vehicle with hydraulic brake (laden), collision avoidance was observed in 1 out of 3 tests at 30 km/h. Collision avoidance was also observed in all 3 tests at 20 km/h as well as at 25 km/h.
- In the vehicle-to-pedestrian performance investigation using the N3 vehicle with air brake (unladen), collision avoidance was observed in 2 out of 3 tests at 15 km/h and 1 out of 3 tests at 20 km/h.

2. Why the collision avoidance speed was lower in the N3 vehicle than the N2 vehicle

- Although the precise cause is still under investigation, it is highly likely that the test vehicle's pedestrian detection was unstable. The vehicle could not avoid collisions because its detection of the crossing pedestrian was delayed due to the camera's angle of view, and also because it lost sight of the pedestrian during full braking and released the brake.

3. Japan's proposal

- The following pages describe Japan's proposals in view of the results of the previous and the present vehicle performance investigations using actual vehicles.
- As regards vehicle-to-cyclist performance requirements, we will continue investigating.

Japanese proposal（collision avoidance speed）

Update from JAPAN

	Vehicle category			CLEPA/OICA	D	J	
(V2P)	M2 N2 < 8t	derived from M1N1	Hydraulic braking	26 km/h	20	~~[20]~~ 26 km/h（R152 as alternative）	
		derived from / based on "heavies"	Hydraulic braking **(including M3)**	~~6 km/h~~ → 12 km/h	20	~~[20]~~ 20 km/h	
			Pneumatic braking	12.5 km/h	20	~~[20]~~ 22.5 km/h (20 km/h can be considered)	
	N2 > 8t M3 (except hydraulic braking) N3			20 → 22.5 km/h	20	~~[30]~~ 22.5 km/h (20 km/h can be considered)	

	Vehicle category			CLEPA/OICA	D	J	
(V2C)	M2 N2 < 8t	derived from M1N1	Hydraulic braking	50 km/h	40	50 (R152 as alternative)	R152 as alternative
		derived from / based on "heavies"	Hydraulic braking **(including M3)**	~~26.5 km/h~~ 35 km/h	40	35 km/h	
			Pneumatic braking	68 km/h (highway) 40 km/h (city)	40	68 km/h (highway) 40 km/h (city)	
	N2 > 8t M3 (except hydraulic braking) N3			68 km/h (highway) 40 km/h (city)	70	68 km/h (highway) 40 km/h (city)*	*CLEPA/OICA to propose a definition of "city" inspired from R152

Specific Proposals by Japan

1. Vehicle-to-pedestrian performance requirements

- **M2/N2 derived from M1/N1: 26 km/h**
  Since the laden N2 vehicle avoided collisions at 10 to 25 km/h in the present investigation, we support the speed proposed by OICA/CLEPA, considering that the equivalent or better avoidance collision performance is possible in M1/N1 vehicles.
- **M2/N2 (Hydraulic): 20 km/h**
  Although the laden N2 vehicle avoided collisions at 30 km/h in the present investigation, it was at 20 km/h and 25 km/h that perfect collision avoidance was observed in all three tests. Hence, we consider the range of 20 to 25 km/h to be appropriate. Further, as N2 vehicles are driven in urban areas more frequently than N3 vehicles, we need to take into account the possibility of unnecessary activation and therefore should start with 20 km/h as a first step.

- **M2/N2 (Pneumatic): 22.5 km/h**
  As M2/N2 vehicles are equipped with air brake systems whose performance is equivalent to that of M3/N3 vehicles, the speed should be equivalent as well, i.e., 22.5 km/h.

- **M3/N3: 22.5 km/h**
  Although the vehicle condition used in the present investigation was unladen, collisions were avoided at 20 km/h and thus we support the speed proposed by CLEPA/OICA, 22.5 km/h.

2. Vehicle-to-vehicle performance requirements

- **M2/N2 (Hydraulic): 35 km/h**
  Since the test vehicle avoided collisions at 35 km/h under the laden condition in the present investigation, we support the speed proposed by CLEPA/OICA.

Thank you for your kind attention!