Ministry of Land,
Infrastructure and Transport

Korea Automobile Testing &
Research Institute

Submitted by the Republic of Korea

Informal Document - ACSF-22-09r1

Minimum Safety Distance to the front

ACSF IWG 22nd session on April 2019, Brussels

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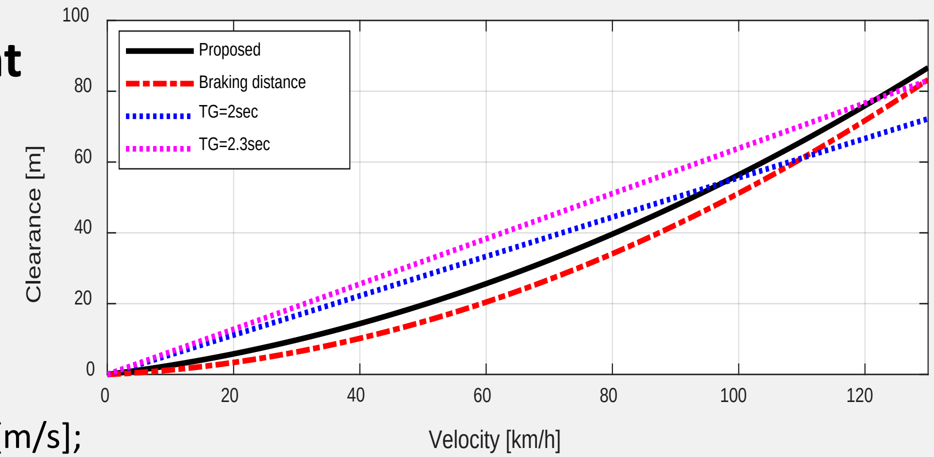
Time Gap proposed in last session

- **Minimum Safety Distance in front**



$$S = V_{ALKS} \times t_{front}$$

Where :

V_{LKLC} : the actual speed of the ALKS vehicle in [m/s];

t_{front} : time gap between the LKLC vehicle and the leading vehicle in front in [second] $= 0.8 + \frac{1.6 v_{LKLC}}{36.1}$

- **Comment from 20th session**

- Concern for too high deceleration($9m/s^2$)

- Taking Korean proposal(ACSF-20-08) with appropriate deceleration rate into account

Outline(Flow)

- **New Approach for appropriate deceleration**

  - To solve the concern of too high deceleration

  - Is that really too high? We got the data from the braking test(UN R-13H)

- **Braking Distance based on appropriate deceleration**

- **Time gap selection for Minimum Safety Distance**

- **Formula for Minimum Safety Distance**

- **Result of Formula**

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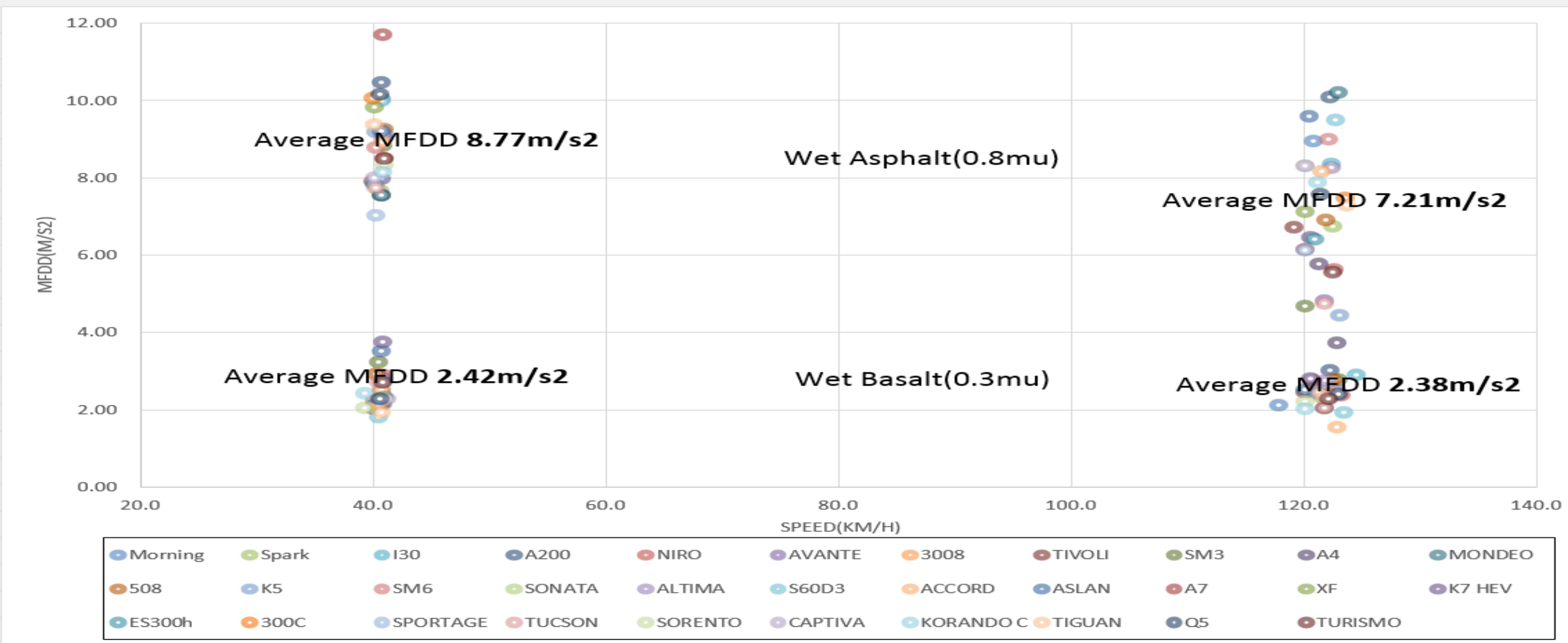
New Approach for appropriate deceleration(1)

- **Using deceleration data from the state of the art vehicle** (MY 2016 to 2018)

➢ UN Reg. R13-H ABS Test(Additional Check)

➢ 32 vehicle model, GVWR, 40km/h and 120km/h, 0.8μ / 0.3μ



New Approach for appropriate deceleration(2)

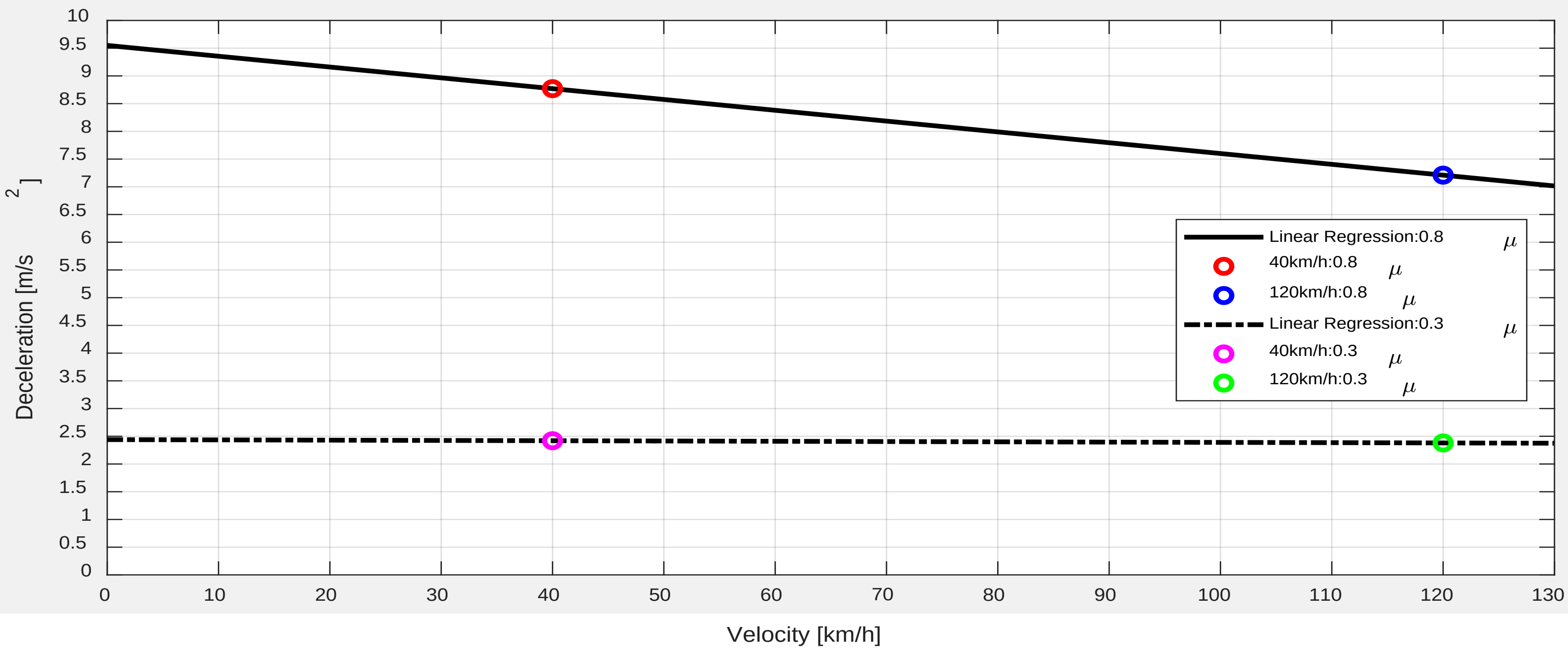
- **Deceleration ($a_{x,max}$) formulas by road condition(wet asphalt, wet basalt)**
  - Avg. MFDD deceleration ($a_{x,max}$) at 40km/h and 120km/h (0.8μ)= 8.77m/s^2 and 7.21m/s^2

$$a_{x0.8\mu}(v_x) = -0.0702 \times v_x + 9.55$$

  - Avg. MFDD deceleration ($a_{x,max}$) at 40km/h and 120km/h (0.3μ)= 2.42m/s^2 and 2.38m/s^2

$$a_{x0.3\mu}(v_x) = -0.0018 \times v_x + 2.44$$

  - Linear Decelerations by velocity

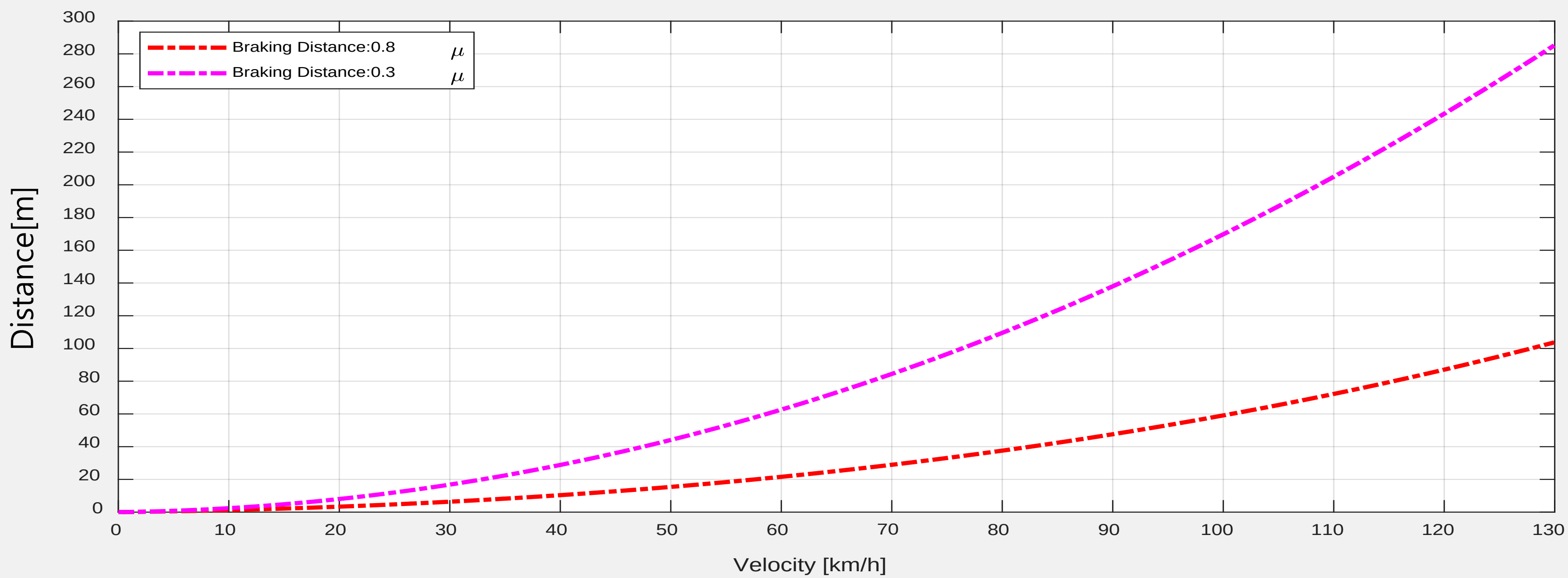


Braking Distance based on appropriate decel.

- **Braking distance (d_{brake})**
  - System delay (t_{sys}) = 0.3sec
  - Braking distance by deceleration & velocity

$$d_{brake(0.8\mu)} = \left(t_{sys} + {}^{v_x}/_{2a_x(v_x)}\right) \times v_x \leftarrow a_{x0.8\mu}(v_x) = -0.0702 \times v_x + 9.55$$

$$d_{brake(0.3\mu)} = \left(t_{sys} + {}^{v_x}/_{2a_x(v_x)}\right) \times v_x \leftarrow a_{x0.3\mu}(v_x) = -0.0018 \times v_x + 2.44$$



Time gap selection for Minimum Safety Distance

- **Principle of time gap selection**

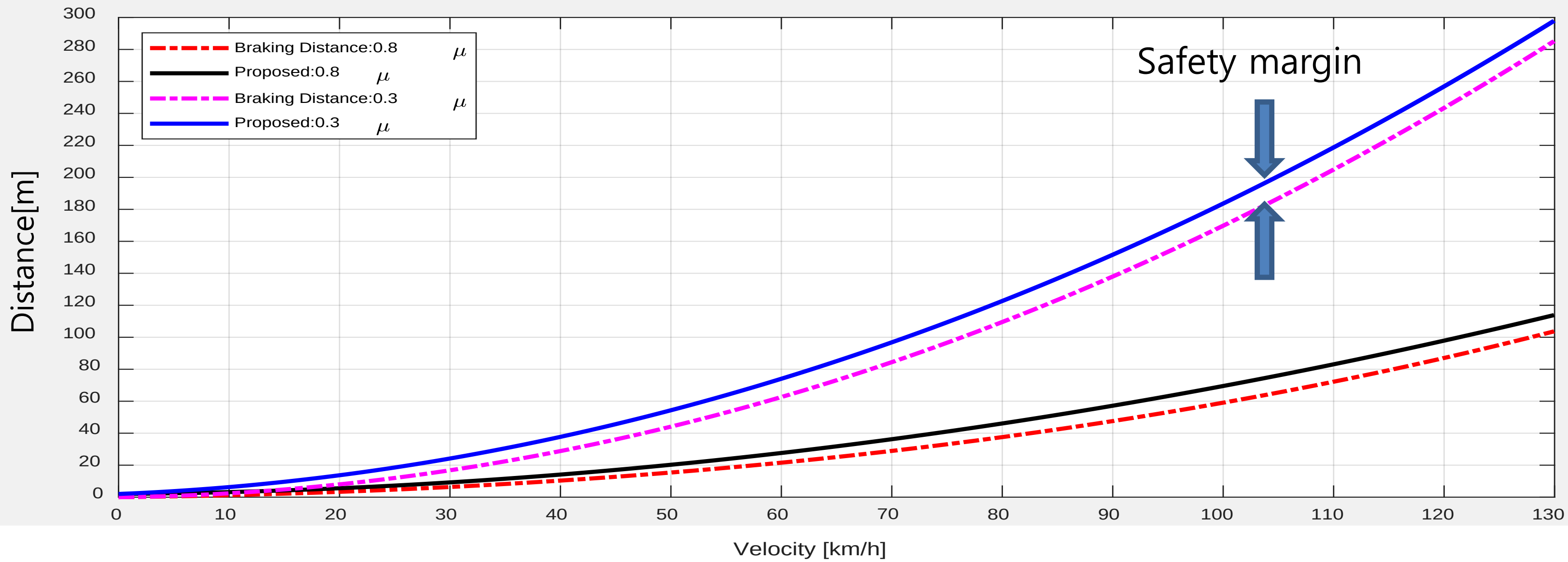
 - Minimum safety distance should be greater than braking distance

 - As the vehicle speed increase, safety margin should be larger.
 (e.g. safety margin at 20kph < safety margin at 30kph)

- **Selected time gap**

 - time gap 0.2 at 0 km/h and 3.1 at 130km/h for μ 0.8

 - time gap 1.0 at 0 km/h and 8.2 at 130km/h for μ 0.3



Formula for Minimum Safety Distance

- proposal

$$S = V_{ALKS} \times t_{front} + d_s$$

Where :

V_{ALKS} : the actual speed of the ALKS vehicle in m/s;

t_{front} : time gap between the ALKS vehicle and the leading vehicle in front in second

$= 0.2 + \frac{2.9 * V_{ALKS}}{36.1}$ for dry and wet condition

[$= 1.0 + \frac{7.2 * V_{ALKS}}{36.1}$ for snowy condition]

ds : minimum distance between the ALKS vehicle and the leading vehicle of 2m*

*Get from ACSF 19-06

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Result of Formula

VALKS (km/h)	a (0.8mu)	a (0.3mu)	d brake (0.8mu)	Proposed MSD (0.8mu)	d brake (0.3mu)	Proposed MSD (0.3mu)
0	-	-	0	2.0	0	2.0
10	9.36	2.44	1.2	3.2	2.4	6.3
20	9.16	2.43	3.4	5.6	8.0	13.7
30	8.97	2.43	6.4	9.2	16.8	24.2
40	8.77	2.42	10.4	14.1	28.8	37.7
50	8.58	2.42	15.4	20.3	44.1	54.4
60	**8.38**	**2.41**	**21.6**	**27.6**	**62.6**	**74.1**
70	8.19	2.41	28.9	36.3	84.4	96.8
80	7.99	2.40	37.6	46.1	109.5	122.7
90	7.80	2.40	47.6	57.2	138.0	151.6
100	7.60	2.39	59.1	69.5	169.8	183.6
110	7.41	2.39	72.2	83.1	204.9	218.7
120	7.21	2.38	87.1	97.9	243.4	256.9
130	**7.02**	**2.38**	**103.8**	**113.9**	**285.4**	**298.1**

Appendix

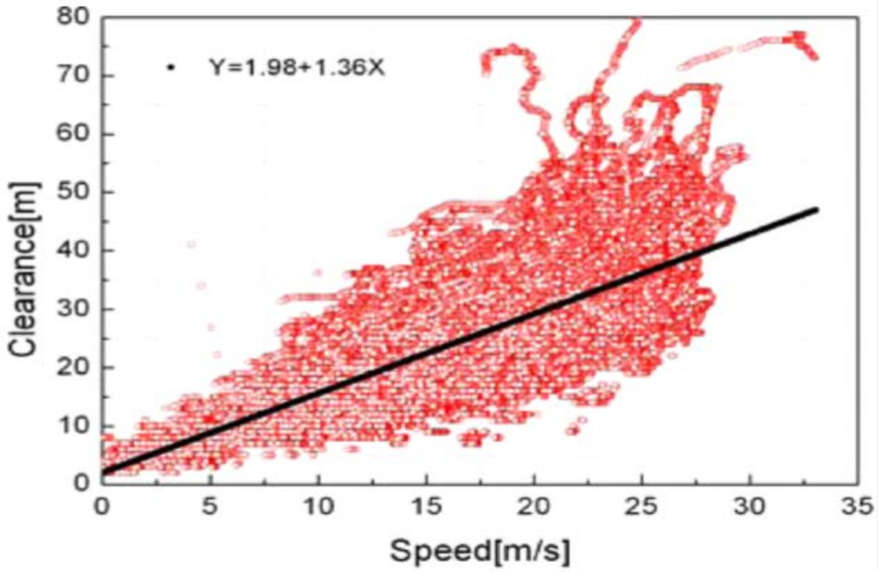
Minimum Distance

- **Consideration of minimum distance**

- Prevention of collision at 0km/h (repeated traffic jam situation, bumper to bumper)

- Minimum distance extracted from ACSF-19-06 : 2m

➢ Steady-state following data collected from 125 driver test data and the linear regression



$$Y = 1.36x + \mathbf{1.98}$$