

NON-EXHAUST PARTICLE EMISSIONS

Typical Driving Patterns Relevant to Non-Exhaust Particle Emissions



Joint Research Centre
the European Commission's
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SUMMARY REPORT RESULTS

Theodoros Grigoratos and Giorgio Martini

Sustainable Transport Unit
Institute for Energy and Transport
Joint Research Centre

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BACKGROUND

WI-1: INVESTIGATION OF TYPICAL DRIVING PATTERNS

- **An extended literature study was carried out by the JRC (March 2014) and its results were published on a JRC “Science and Policy Report” and also in a peer-reviewed paper. Also several presentations were made in different forums (PMP, UN GRPE, EuroBrake 2014 & 2015)**
- **Different driving conditions in experimental investigation of wear emissions is one important reason for different results and conclusions**
- **Speeds of 7-100 km/h and decelerations of 0.1-10 m/s² have been applied in brake and tyre/road wear investigation thus resulting in incomparable results**

WI-1: INVESTIGATION OF TYPICAL DRIVING PATTERNS

- **For that reason the PMP IWG introduced a dedicated Working Item (WI-1) in order to address the issue (Document GRPE-69-23)**
- **The purpose of this WI was to provide guidance for the harmonization of future wear studies and thus improve the comparability of the results**
- **The proposed approach involved the use of activity data collected in the framework of other projects (i.e. WLTP database)**
- **Parameters such as speed, acceleration & deceleration distributions, number and duration of braking events, etc. were calculated**

SUMMARY RESULTS FROM THE ANALYSIS OF THE WLTP DATABASE

WORKING ITEM 1 - MAIN FINDINGS

Region	Road Type	Vehicle Speed [km/h]	Acceleration Duration [s]	Acceleration [m/s^2]	Deceleration Duration [s]	Deceleration [m/s^2]	Stop Duration [s]	Short Trip Distance [m]	Brake Phase Duration [s]
Europe	Motorway	114.8	3.6	0.13	3.5	-0.23	6.2	4,290	2.5
	Rural	64.7	4.4	0.22	4.3	-0.33	5.9	1,736	3.4
	Urban	28.3	4.7	0.32	4.7	-0.41	5.8	264	3.3
India	Motorway	55.0	4.0	0.15	3.8	-0.27	6.2	1,839	2.7
	Rural	37.0	4.3	0.19	4.0	-0.30	5.9	2,558	2.8
	Urban	25.0	4.1	0.21	3.9	-0.32	6.2	576	2.6
Japan	Motorway	62.8	≤ 2	0.18	2.0	-0.28	6.1	143	1.6
	Rural	47.5	3.2	0.18	3.1	-0.30	12.6	934	4.1
	Urban	28.4	3.1	0.34	3.2	-0.42	19.5	244	2.6
Korea	Motorway	46.0	4.3	0.17	4.0	-0.27	6.2	344	2.7
	Rural	48.6	5.4	0.24	4.7	-0.35	16.9	1,575	3.7
	Urban	27.2	5.6	0.31	5.2	-0.41	21.9	322	3.7

Overview of median values (50th percentile) of non-exhaust related parameters worldwide

WORKING ITEM 1 - MAIN FINDINGS

- **Similar median vehicle speeds are found in urban areas worldwide (25-30 km/h). Big differences are observed among motorway speeds**
- **Similar acceleration and deceleration rates are found worldwide regardless the type of road. Somewhat lower rates found in India**
- **Significantly longer stop phases between short trips are observed in Asia compared to European urban areas (20 sec vs. 6 sec). Indicates probably more intense traffic jams at least in urban areas**
- **Median brake phase duration in urban areas worldwide is found to be approximately 3-4 sec. Shorter braking durations in motorways**

WORKING ITEM 1 - MAIN FINDINGS

Region	Road Type	Vehicle Speed [km/h]	Acceleration Duration [s]	Acceleration [m/s ²]	Deceleration Duration [s]	Deceleration [m/s ²]	Stop Duration [s]	Short Trip Distance [m]	Brake Phase Duration [s]
Europe	Motorway	137.9	15.6	0.78	14.6	-0.92	48.4	79,094	10.3
	Rural	113.7	17.6	1.14	16.9	-1.43	52.0	26,086	10.2
	Urban	60.2	15.1	1.28	14.5	-1.55	55.0	3,270	9.0
India	Motorway	83.9	17.3	0.74	13.7	-1.19	93.1	52,700	8.7
	Rural	68.7	16.1	0.82	12.8	-1.36	102.8	35,575	7.6
	Urban	65.2	15.0	0.80	13.2	-1.21	74.0	7,912	7.9
Japan	Motorway	99.7	10.1	0.91	10.1	-1.07	51.9	20,440	7.7
	Rural	64.5	19.2	1.11	17.6	-1.55	63.4	3,946	11.5
	Urban	59.5	12.3	1.34	14.0	-1.48	72.5	1,694	9.2
Korea	Motorway	91.1	16.0	0.72	14.7	-1.00	46.1	49,400	9.2
	Rural	79.3	21.3	0.99	17.6	-1.60	90.2	15,485	11.5
	Urban	56.4	18.0	1.13	17.3	-1.47	102.2	1,654	10.6

Overview of extreme (95th percentile) distributions of non-exhaust related parameters worldwide

WORKING ITEM 1 - MAIN FINDINGS

- **Speeds higher than 60 km/h in urban areas can be considered as “extreme”. Significant differences observed for threshold motorway speeds between Europe and Asia**
- **Similar “extreme” acceleration and deceleration duration and rates are found worldwide regardless the type of road. Decelerations in urban areas higher than 1.5 m/s² can be considered “extreme”**
- **Shorter stop phases between short trips are observed in Europe. Stop phases longer than 60 sec are extremely rare**
- **Brake phase duration higher than 10 sec can be counted as “extreme”**

WORKING ITEM 1 - MAIN FINDINGS

Number of Braking Events per km [# / km]				
Region	Average	Type of Road		
		Urban	Rural	Motorway
Europe	1.56	3.8 (31.8%)	1.0 (15.7%)	0.2 (13.5%)
India Class 1	1.36	3.2	1.6	0.0
India Class 2	1.55	2.3	1.5	0.8
India Class 3	1.84	2.8	2.1	1.0
Japan	3.00	4.5 (34.5%)	1.3 (38.6%)	1.2 (22.7%)
Korea	2.01	3.6 (42.4%)	1.4 (19.5%)	0.7 (15.9%)
USA	1.37	*	*	*

Number of brake phases per km (#) and percentage (%) of brake phases down to a stop phase with respect to the total number of brakes for different regions per road category

WORKING ITEM 1 - MAIN FINDINGS

- **The average number of braking events per km in Europe and the US is approximately 1.5. Higher braking rates are found in Asia with Japan exhibiting twice as high figures**
- **The breakdown of braking events in Europe shows that approximately 4 braking events per km occur in urban areas. Approximately one third of these events are full stop brakes**
- **Significantly lower braking rate is observed in rural and motorway driving. 1 event every 5 km is recorded in motorways, while only 1 event every 40 km is a full-stop braking event**

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