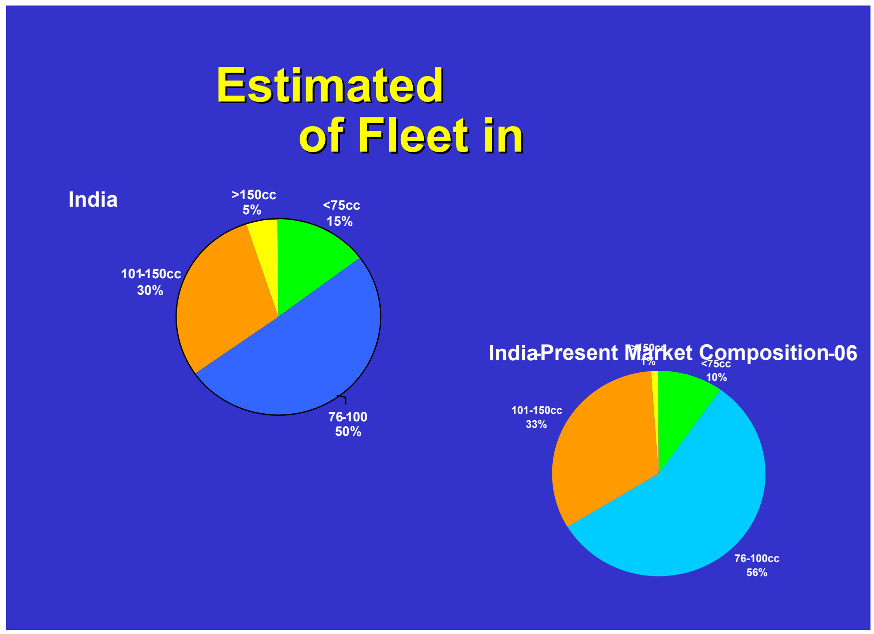
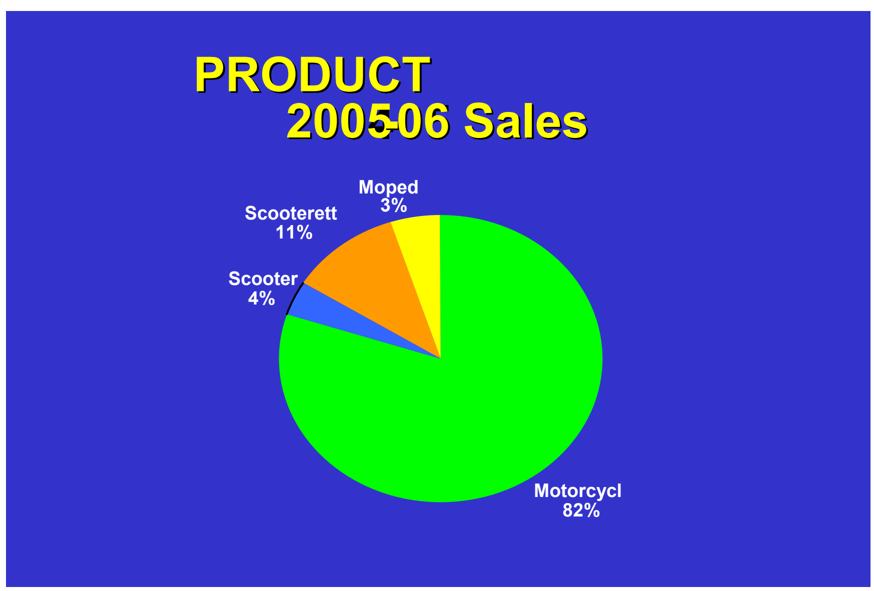
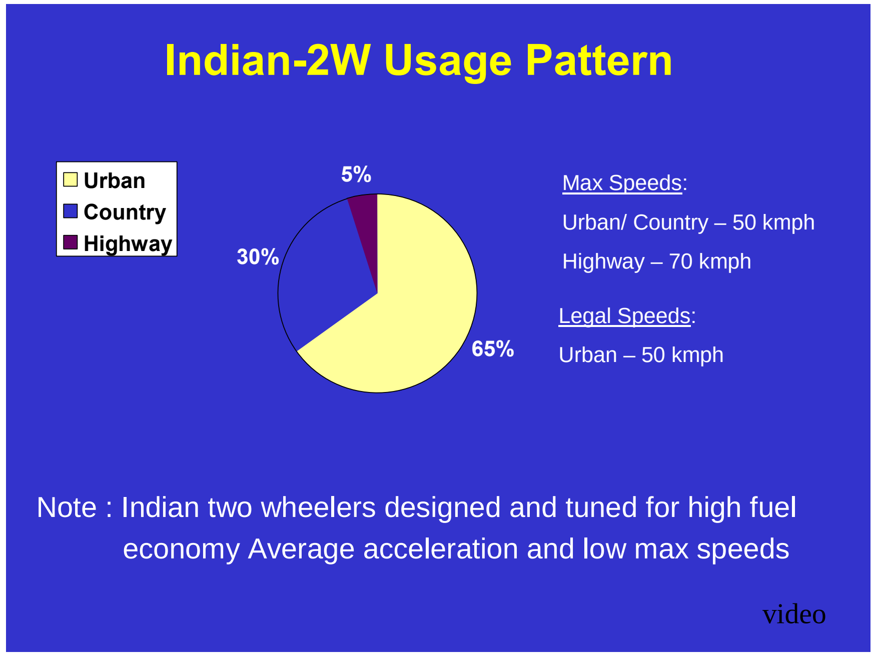
GTR on Motorcycle Braking - India's concerns
Justification for Clause 4.4.3 of the Draft GTR on Dry Stop test :

(1) Background :

i) The Indian Motorcycle industry is the second largest in the world. Nearly 99% of the motorcycles manufactured in India are below 125 cc. They are designed to be fuel efficient, environment friendly and used more for the purpose of commuting from residence to place of work and the secondary function of pleasure. Such vehicles form the backbone of transportation in most of the rural environment, towns and cities. This fact is supplemented by the following 3 slides.







ii) To be light and fuel efficient and environment friendly, such motorcycles are not large in size like most of the high cubic capacity motorcycles used for pleasure in Europe, USA and such other countries. These motorcycles have short wheelbases and higher center of gravity when laden, due to riding styles in Asian countries as against large wheel bases of the heavier, powerful motorcycles with raised riding styles associated to pleasure and motor sport. The maximum speed of these motorcycles in urban environment is around 50 km/h and not higher than 70 km/h on most Indian Highways.

(2) **Data on wheel base on Indian Motorcycles :** Bulk of the Indian motorcycles have wheel bases of less than 1.3 m which leads to a fairly large load transfer to the front wheel on braking. Due to this load transfer the rear wheel brakes are found to be ineffective if tested for performance under Clause 4.4.3 of this GTR. The larger heavier and powerful motorcycles popular in Europe, USA and the affluent countries have large wheel base and when tested in accordance with the performance requirement of Clause 4.3.3 of the GTR can easily meet the braking requirement .as the load transfer from the rear wheel to the front wheel is much lesser in proportion to the lighter, lower wheel base vehicles stated earlier. The following Table , gives a comparison of wheel base data for Indian and High end motorcycles.

Table : Wheel base data

S.No	Wheelbase of typical high end motorcycles	Wheelbase of typical Indian motorcycles
1	1420	1330
2	1415	1235
3	1450	1225
4	1435	1305
5	1392	1260
6	1390	1260
7	1395	1250
8	1380	1230
9	1430	1270
10	1385	1280
11	1410	-----
12	1460	-----
13	1445	-----
14	1405	-----

(3) **India's concerns :** The requirement of Clause 4.4.3. makes it more stringent for the lighter, low speed fuel efficient motorcycles that meet the basic personalized transport for the major population in developing and under developed countries. Thus it may be seen that there is an anomaly in applying the same yardstick of vehicle performance for small from large motor cycles.

(4) **Data Collected on Indian Motorcycles :** Brake performance data for some current models of motorcycles in India, carried out as per Clause 4.4.3 of MC GTR, is as given below.

Table : Data collected on Indian Motorcycles

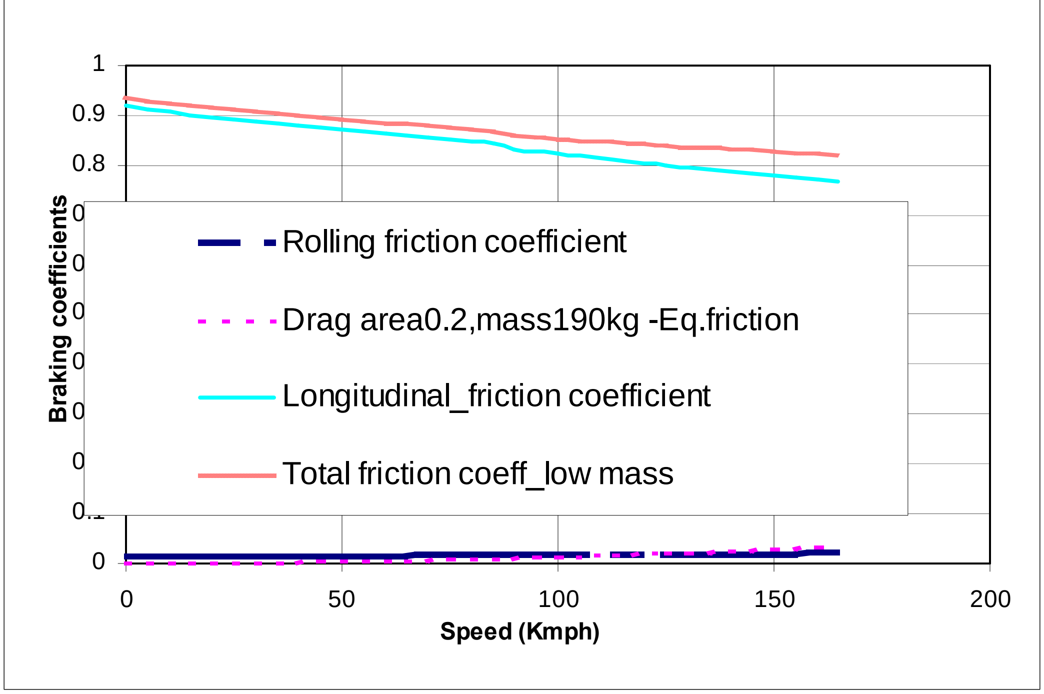
Model	Max Speed Vmax (km/h)	GVW kg.			CC Capacity	Power (kW)	Wheel base (mm)	Test Speed (km/h)	Stopping Distance Requirement	Stopping Distance (m) corrected *
		Front	Rear	Total						
Model A	90	67	172	239	99.27	6.03	1235	81	39.36	35.92 38.35 35.76
Model B	80	82	158	240	109.73	5.88	1225	72	28.51	28.37 27.93
Model C	100	99	156	255	124.5	8.47	1305	90	48.6	45.53 42.89
Model D	104	79	187	266	147.5	9.95	1260	93.6	52.6	53.1 52.9 52.2 53.2
Model E	100	81	171	252	124.8	7.36	1260	90	48.6	53.2 52.6 52.3
Model F	80	65	173	238	99.7	5.5	1250	72	28.5	34.8 35.3 35.9 34.7
Model G	68	72	153	225	87.8	3.68	1230	61.2	20.5	25.7 22.9 24.6 27.8
Model H	90	75	180	255	124.8	6.72	1265	81	39.36	38.9 36.6
Model I	85	70	169	239	97.2	5.5	1230	76.5	32.18	36.3 37.19 37.44
Model J	125	90	190	280	223	12.68	1355	100	60	67.87 68.41 63.64

* **Measured stopping distance corrected to the test speed (0.9 Vmax 0r 100 km/h whichever is lower).**

(5) Technical reasons supporting India's concerns :

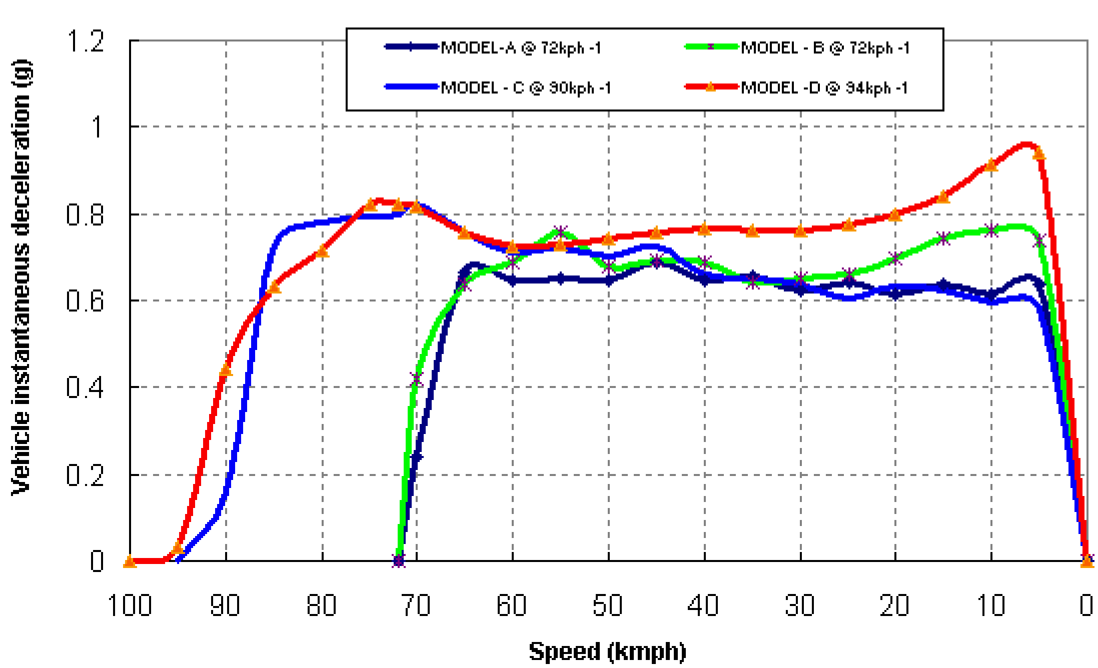
(i) **Drop in sliding friction coefficient at higher speed :** For test speeds from 40 km/h to 160 km/h the drop in sliding coefficient is of the order of 14 %. If the effect of rolling and aerodynamic resistance coefficient are also considered then the total drop in total braking coefficient is about 9%. This is indicated in the following Figure-1 based on Internationally published data.

Fig 1.



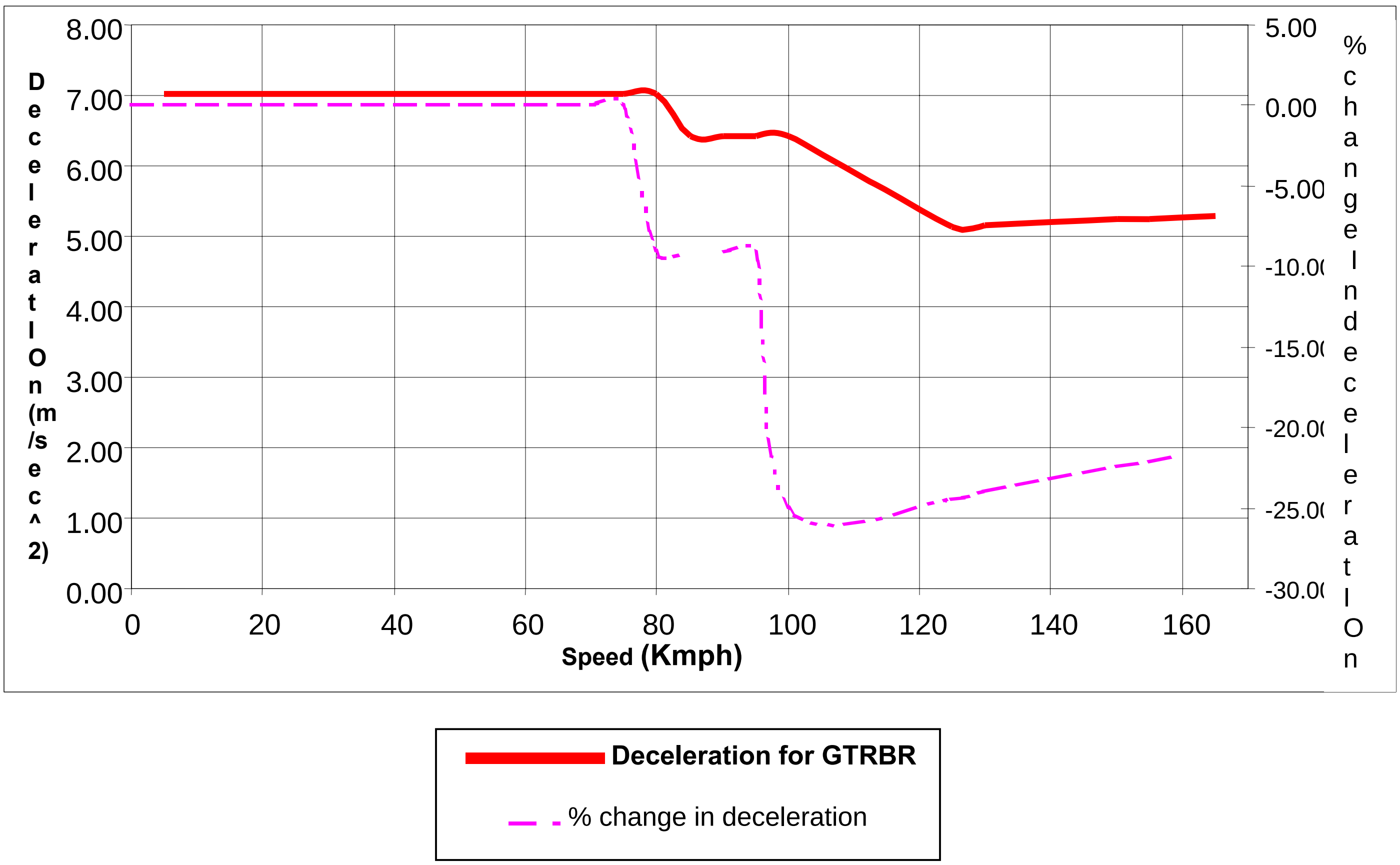
(ii) **Variation in vehicle instantaneous deceleration :** It may be observed that instantaneous deceleration values do not remain steady at 0.8 g during the entire process of braking. The values of the instantaneous deceleration droops down to a speed upto 20 km/h and then gradually shoots up. This phenomenon is observed and supported by the following Figure -2, for 4 representative vehicle models.

Figure -2



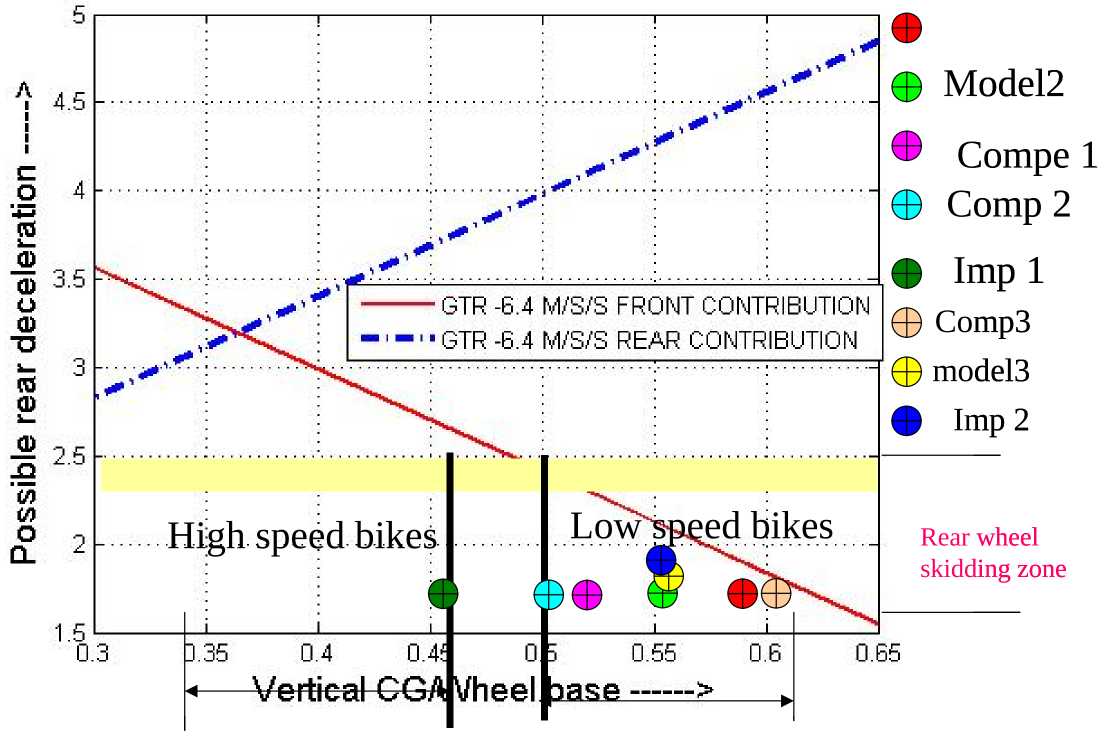
(iii) **Change in deceleration values for speeds below 80.5 km/h and speeds above 80.5 km/h :** Based on the proposed values of GTR, it may be seen from Figure-3 that , for vehicles upto 80.5 km/h there is no change in the requirements for deceleration values, i.e. 7.01 m/s^2. But the increase in average deceleration calculated from GTR is 12% for 80.5 to 100 km/h and about 21% for 100 km/h to 160 km/h, when tested for the high speed test as per clause 4.5 of the Draft GTR. Whereas the drop in 'total braking coefficient' considering the effect of rolling resistance and the aerodynamic resistance is 9% only. So any vehicle, which has test speed falling between 40.0 to 80.5 km/h, has to meet a more stringent requirement. This is supported by the following Figure – 3.

Figure – 3



(iv) **Effect of ratio of vertical (height of) CG / Wheel base, on Indian vehicles :** The wheel base and the height of CG is also a major contributing factor towards the effect of braking, both the front and the rear brakes in the dynamic condition. It may be seen from the following Figure 4, that the contribution from the rear brakes decreases with increase in vertical CG / wheel base, which largely affects the performance requirements at high speeds.

Figure – 4

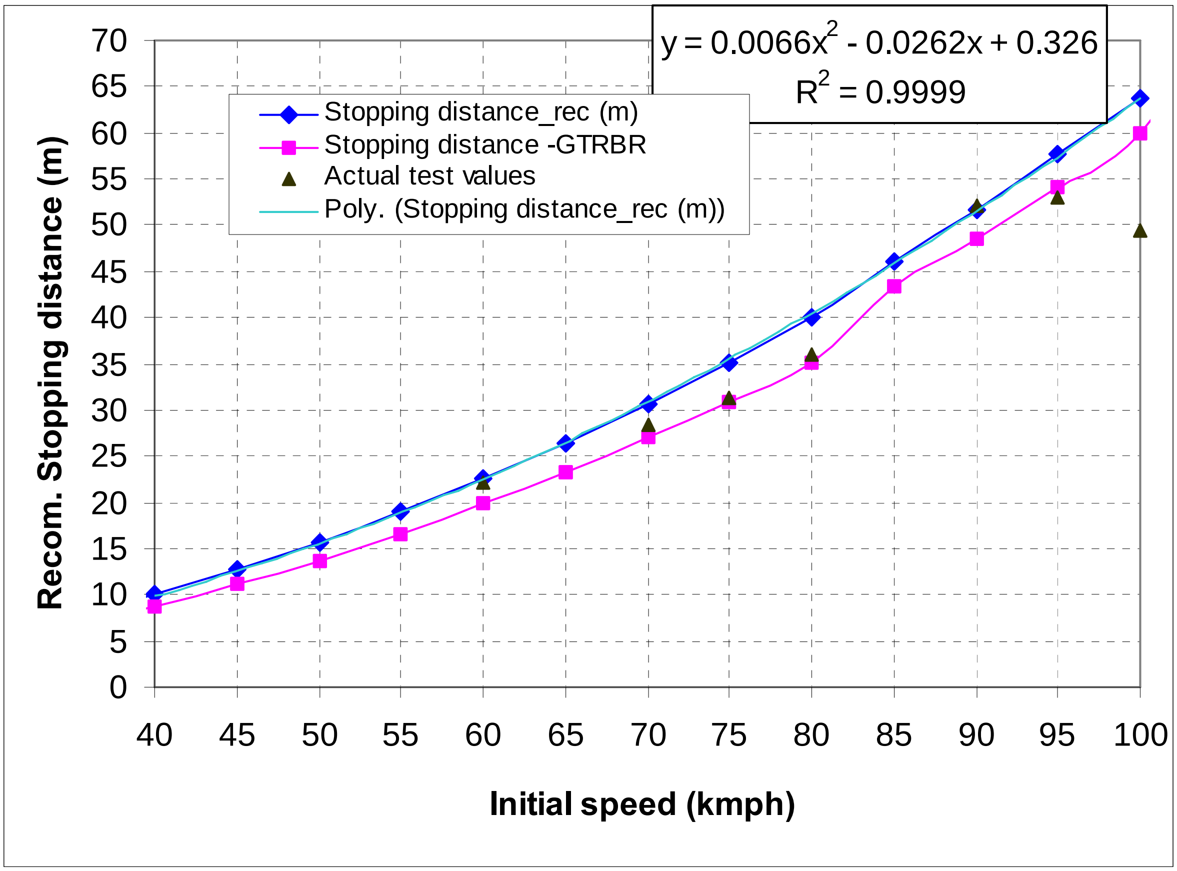


(6) Proposal from India :

In today's situation all our Indian vehicles are meeting the ECE requirements and we have not come across any adverse issues affecting safety on this front. We strongly propose the following equation for stopping distance based on the factors such as total braking coefficient, high speed braking tests as per GTR and the shorter wheel bases of Indian vehicles.

Stopping distance, S ≤ $0.0066 V^2 - 0.0262 V + 0.326$, in metres

The above proposal is stricter than ECE for 40 to 100 km/h. and closer to FMVSS. This is further explained by the following Figure - 5. From the above proposal a deviation of 12% occurs for test speeds from 40 km/h to 80.5 km/h and a deviation of 6% occurs for test speeds from 80.5 to 100 km/h.



(7) India's response to other points :

India 's response to some of the points put forth are as below :

(i) **Point 1 :** There is nothing unusual about the deceleration being lower for the higher speed test. This is consistent with tests in ECE standards (e.g., ECE R13-H where the test from 100 km/h requires a deceleration of 6.4 m/s2 and the high speed test from 160 km/h where the deceleration is 5.8 m/s2)where the deceleration for the higher speed test is lower than the deceleration for the lower speed test.

Response : This could not be a one to one comparison because the tests at 160 km/h in ECE R13H is an engine connected test and that at 100km/h is with engine disconnected. All the known standards prescribe the stopping distance for engine connected test higher, possibly because of difficulties in achieving braking without wheel lock.

(ii) **Point 2 :** Deceleration requirement is less from a high speed. The shape of the mu slip curve changes with speed. The vehicle speed decreases when the PBC increases. Hence a constant force does not get the maximum braking rate. Similarly as the vehicle speed increases the PBC decreases. Hence when a vehicle is braked from 160 km/h, the PBC is lower than when it is braked from 100 km/h. Given the lower PBC at a higher speed, the deceleration that can be attained by the vehicle from

160 km/h is lower than that attained from 100 km/h. Again, this is consistent in all the braking tests in all the regulations. (Note that the ASTM test to measure PBC is performed at a constant 40 mph (64 km/h).)

Response : It is true that coefficient of adhesion improves when the speed is less. However this increase in the coefficient, which is about 20% does not compensate for other parameters, which affect the braking. In case of braking from high speeds the aerodynamic resistance also helps in decelerating the vehicle, which is known to be proportional to square of the speed. The other major factor is the distance the vehicle rolls during the reaction time, till the deceleration is built up and stabilized. This is represented by the 0.1V term. As the braking distance, i.e. the distance traveled during the steady deceleration increased proportional to the square of the speed, the percentage of the rolling distance becomes more prominent. But the question that remains is, can a regulations stipulate that lower speed vehicles are expected to stop more efficiently than high speed vehicles ? The following table shows the test results on one vehicles at GTR test speed and at lower speeds. In one vehicle which incidentally can meet the GTR requirement, the average decelerations in the light loaded condition, recorded are as given in the following table.

Test speed (km/h)	Average. Deceleration (m/s/s)
100	7.9
60	7.3
50	7.2

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