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# **Analysis on the Design of Two Wheelers in India Keeping Women Drivers in Mind**

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## **ABSTRACT**

In India, the number of female drivers is increasing every day. The need to validate and improve the standards followed in the design of vehicles used by women is more important than is actually considered. The present paper analyses the design and positioning of brake lever and horn switch in the handle of Indian mopeds/scooterettes. The design has been done keeping the palm anthropometric measurements of an average Indian female driver in mind. After interviewing some female drivers and studying a few accidents involving females driving two wheelers, it has been found that operating the brake handle and the horn switch simultaneously on the move is more difficult than anticipated by the designers. For the present study, palm anthropometric measurements of 25 women have been taken and the average is compared against the design measurements taken from the mopeds of 5 mostly used models in India. The results showed that the design is not safe for the driver and needs improvements. Some suggestions of change in design have been made in this paper. The researchers sincerely believe, that, this design changes will help in increase of driving comfort, reduction of repetitive motion injuries and also in the reduction in the number of accidents caused due to this faulty design.

## **INTRODUCTION**

Two wheeler driving safety mostly depends upon the design of the handle bar and its ergonomics. Maintaining the balance of the vehicle is a part of driving in the case of a two wheeler. The driver has to perform the driving operation while he/she keeps the balance, which is not required in the driving of any other kind of vehicle. Also all types of controls, such as light switch, High/Low beam switch of light, indicator switch, horn switch, brake, clutch and self starter are mounted on the handle bar of a motor bike.

In the two wheelers designed with a gearless transmission, the clutch lever is replaced with the rear brake lever. Except for the self-start switch all the other switches are required while driving. Thus during the driving operation the driver should be able to manipulate all the controls without any hindrance, while maintaining proper grip on the handle with force equally distributed between both the hands, regardless of the condition of road or traffic. In India, women mostly prefer to drive a vehicle with gearless transmission due to the ease of driving.

After coming across many incidents regarding loss of balance or poor handling of the vehicles resulting in accidents, the researchers started to study the reasons leading to them and found a great need to re-evaluate certain design aspects.

One of such aspects, where the present paper focuses on and limited to, is the design, in respect to the relative positions of the brake lever and horn switch on the handle of the two wheeler with gearless transmission, keeping in mind that the majority of the drivers are female.

## DESIGN AND PROBLEM

The brake lever and various switches on the left hand side of the handle bar of a wheeler with gearless transmission are rear brake, horn switch, indicator switch and High/Low beam switch. Focusing on just the rear brake and horn switch positions, it has been noticed that, for an average woman driver, it is hard to operate both rear brake and horn switch simultaneously. That means, while the driver controls the brake with her hand, she is unable to reach the horn switch with the thumb. This is because the anthropometric measurements of an average female hand are shorter than anticipated by the designers. Although presently, the thumb reach problem is overcome by holding the handle closer to the horn, it results in increase in the effort required to pull the brakes. In addition, shifting of the hand to and fro to control both horn and brake compromises safety of proper gripping.

## METHOD

The method followed for measuring, has been studied from previous works done on hand anthropometry for women [1], [2] & [3]. The anthropometric measurements that are to be taken are decided based on the specific operations under focus for the present study. At any given moment during driving while maintaining proper grip on the handle bar,

- 1) The driver has his/her hands spread over the brakes in such a way that he/she is ready to apply brakes.
- 2) The driver should be able to readily press the horn switch with the thumb. For this the thumb is either placed on the switch always or moved to switch at required time. The movement of the metacarpal part of the thumb is not taken into consideration for the present study.

Physical requirements of the driver for performing the above operations simultaneously and independently are, the modified thumb crotch length should be sufficient for relative optimum grip span, as defined by Mahmut Eksioglu [4] and the thumb length should be sufficient enough for comfortable reach between the thumb and the horn switch.

On the left hand, as depicted in figures, 1 and 2

- i) The modified thumb crotch length,  $TCL_m$  [4] (Marked as A1 in Fig1)
- ii) Thumb length (A2, as has been marked in Fig 2)
- iii) Minimum hand breadth, (A3, as has been marked in Fig 2)

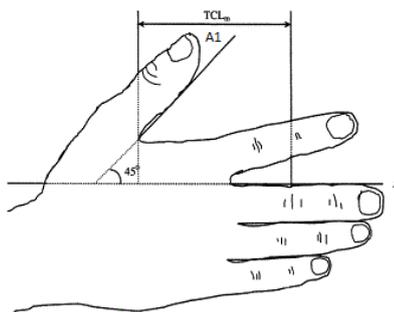
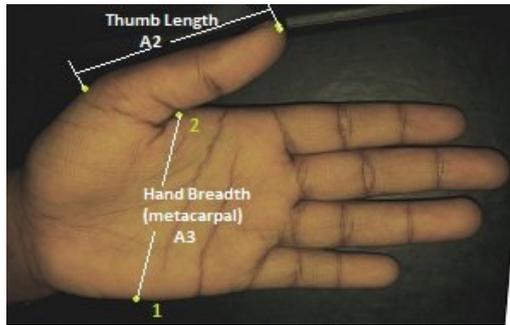


Fig 1 : Thumb Crotch Length  $TCL_m$  (A1)



**Fig 2 : Thumb Length & Hand Breadth**

**Selection of the Subjects**

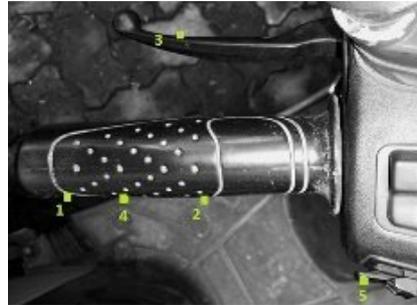
25 women were selected for the present study falling under the age group of 18 to 35 years old, belonging to various states of India and who are presently studying or working in Jadavpur University. All the subjects have an experience in riding a bicycle or a motor bike and do not have any physical disability.

**Table 1:** Measurements taken from the subjects

Sl.No.	Dimensions (mm)	n=25		Percentile 5 <sup>th</sup>
		Mean	SD	
1	Modified thumb crotch length (TCL <sub>m</sub> ) A1	6.976	0.70557	6
2	Thumb length A2	6.072	0.44857	5.6
3	Hand Breadth, Minimum A3	7.716	0.60444	7

**Measurements from Vehicles**

5 different models of two wheelers with gearless transmission were selected for the present study. Measurements to be taken from each vehicle were decided by determining the optimum position of the hand on the handle. After extensive observation of two wheeler traffic, it was seen that every driver holds the handle according to his/her own comfort. The comfortable holding position is such that the effort required in applying the brakes is minimum while proper grip and balance are maintained. Measurements depicted using the fig 3 are as follows: The mean hand breadth is used to determine the location of points 1 and 2. The position of the hand is considered to be between the points 1 and 2. Points 3 and 4 on an imaginary line passing through the middle figure show the length of spread over brake and grip, and point 5 is pressure point on the horn switch.



**Fig 3 : Top view of left hand grip showing brake and Horn**

- 1) The span of brake and handle with respect to the thumb crotch length(D1)
- 2) The operational distance between thumb root and the horn switch. The distance between the points 2 and 5 (D2)

**Table 2:** Measurements taken from the vehicles

Vehicle Model	Dimensions	
	Grip-Brake span D1	Thumb root-Horn distance D2
Model 1	9.5	7.5
Model 2	8.8	7.4
Model 3	10.5	6.1
Model 4	8.4	7.2
Model 5	8.0	6.2

## RESULTS AND SUGGESTIONS FOR MODIFICATIONS IN DESIGN DIMENSIONS

The subject dimensions A1 and A2 have been compared with vehicle dimensions D1 and D2 respectively and found to be notably shorter.

- 1) As could be seen from the results, the Brake-Grip span needs to be reduced.
- 2) The switch should be placed further outward (towards the edge of the handle) within the reach of the thumb.
- 3) The switch can be provided with adjustments such as a small retractable sliding extension to facilitate users with shorter thumbs.
- 4) The switch length could be increased and made to rotate in its plane, so that drivers with bigger hand measurements can also use the vehicle without any discomfort.

## **CONCLUSION AND SCOPE OF FUTURE RESEARCH**

More research is required in this area. The thumb reach study can be studied further by considering the movement of metacarpal of the thumb. Study can be done for optimum pull strength required for braking in case of women.

## **RELEVANCE TO INDUSTRY**

Vehicles are designed in such a way that they can be used safely and comfortable by a wide range of users. But such a design sometimes proves to be uncomfortable and in some cases unsafe for users of certain group. This study focuses on one such a design aspect and tries to shed some light on the problem.

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