

# A Study on Comfort Sensation of Road Bike Handlebar

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**Abstract:** The downward handle of road bikes not only could transfer the hand grip force of the rider, but also improve the hand stress by changing the hold location. Therefore, this study discussed the comfort of the holding position of downward handle. It first conducted morphological analysis on the product attribute elements, and conducted comfort experiment on the handle curve path, in order to confirm the effect of curve path on the hold comfort. It also conducted subjective questionnaire survey to measure the data, and experiments on the force impact area and comfort, in order to discuss the contact surface and received pressure of the handle in relation to the palm.

**Key words:** *Road bike, Handlebar, Human factors, Comfort sensation.*

## 1. Introduction

Road bike has increasingly become a popular recreational sport among many leisure activities. The characteristics of road bike are lightweight, low wind resistance and easy control in high-speed motion and the downward handlebars provide four different holding positions in order to reduce the wind resistance generated by the body and to control riding direction. Since cyclist has to support body weight on the handlebar with palm during riding, it is extremely important that handlebar can offer comfort on holding positions and ease painful sensation on the palm [1]. Therefore, the designs of downward handlebars have to meet relevant requirements to achieve a thrill in high-speed riding. Therefore, the main purposes of this study are to explore the comfortable sensation of downward style handlebar holding positions. First of all, an attribute elements table will be created by using morphological analysis from 106 products, and then execute comfort experiment of handlebar's curved path to determine the relationship between curved path and comfort. Secondly, this research carries out the experiment of pressured force on palm and comfort by using subjective assessment questionnaire method to explore the oppressed situation with contact surface area of palm. According to the experimental data, the most comfortable handles wide dimensions can be estimated by using regression statistics quadratic function. Designers can obtain design parameters about the pressure distribution on the palm from these experiments, and it is quite useful for designer to create a more suitable handlebar.

## 2. Comfort experiment

### 2.1 Riding posture and holding position

Lightweight and comfortable sensation are the basic design requirements of road racing bike. In order to accommodate various riding posture and reduce wind resistance during riding, cyclist has four hold positions as

shown in figure 1 [4]. Position 1 (P1) is the upper half of the handlebar near the center position; the part of curved on both sides is position 2 (P2); position 3 (P3) is the part of controlling braking and speed change; the part of the end handlebar with straight form is position 4 (P4). Cyclist has to use lower riding posture at position 3 and 4 for getting faster speed and reducing wind resistance. In order to disperse pressure happened on palm, the holding position area should as big as possible. Since the handlebar offered four different hold positions, cyclist can change the positions during riding for preventing one posture kept a long time and getting chance to take a rest. In recent years, the shape of handlebar has extremely changed from tube to more complex free form surface due to the application and development of manufacture processes and materials [2]. Therefore, this study aimed at exploring the reasonable contact area on each holding position and comfort of palm [3, 5].

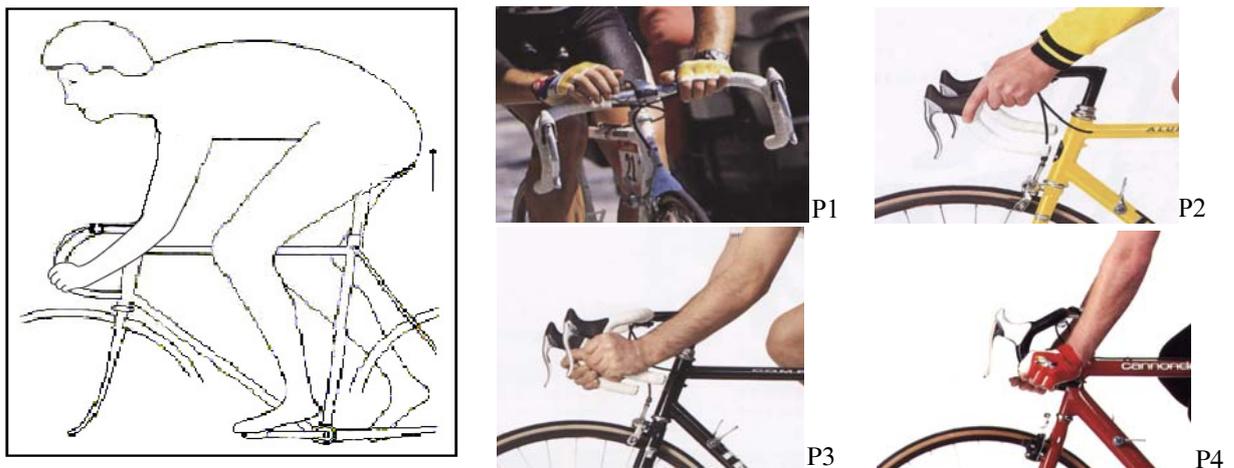


Figure. 1 Riding posture (left) and four holding positions (right)

## 2.2 Experimental samples and platform

In order to understand whether the comfort sensation will be affected by the shape of handlebar or not, three test samples are selected from market as shown in figure 2(a, b and c). The test sample, named S1, S2 and S3, have different shape and dimension. The width at position 1 is 4.6 cm, 4.0 cm and 3.2 cm and position 2 is 3.7cm, 3.4cm and 3.2cm respectively. The angle of position 3 is 131 °, 105 ° and 90 ° and the length of position 4 is 7.5cm, 7.2cm and 6.6cm.

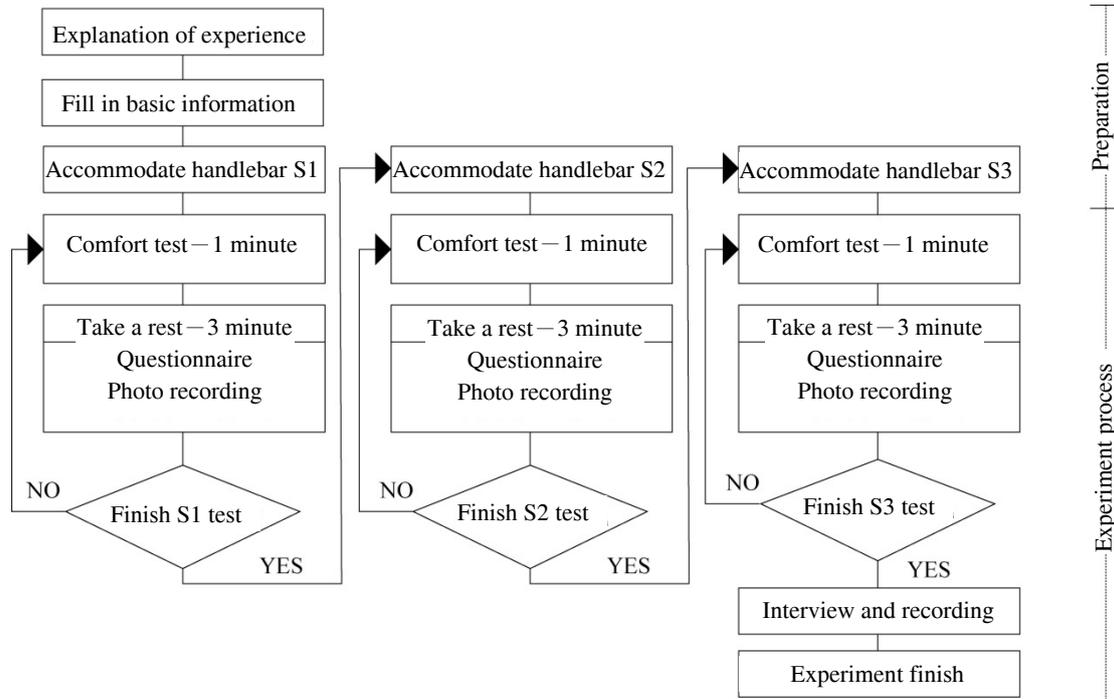
The comfort sensation experiment is not dynamic test, so that three test samples have sequentially to assemble on the test platform as shown in figure 2(d). All dimensions of test platform will be adjusted according to each tester's characteristics such as tall, the length of arm, and the distance from hip to ground. This is a complicated experience and takes a lot of time.



Figure. 2 Experimental samples (S1, S2 and S3) and test platform (d)

## 2.3 Experiment process

As mentioned above, the main purpose of this experiment is to evaluate comfort sensation on palm during riding. In order to estimate comfort sensation of each handlebar on four positions, there are 18 testers attending this experiment. These testers' average age is 35 and most of them have more than 8 years experience about riding road-racing bike. For exactly measuring comfort sensation, both methods of subjective questionnaire and recording pressure distribution on palm are conducted. The experiment process is shown in Figure 3.



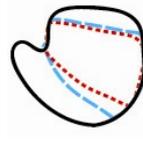
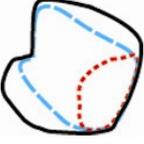
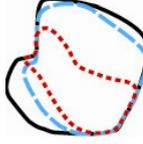
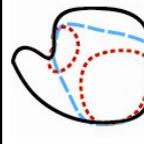
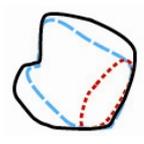
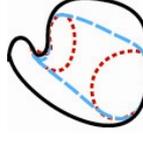
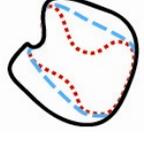
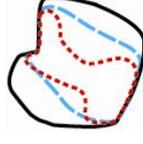
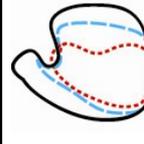
## 3. Experimental analysis

In table 1, long dot line represents contact area and short dot line specifies pain area. According to design rule and pressure analysis, the pain area on the palm should as small as possible that means a good handlebar can uniformly distribute pressure on the palm. The results showed in table 1 expose that the contact area of the test samples S1 and S2 are almost the same but both are larger than S3, and the contact area of S1 is as big as the palm. Sample S3, compared with S1 and S2, has the smallest contact area.

For the pain area discussion, test sample handlebar S1 has bigger pain area at position 1 and the pain area of position 2 to position 3 is the part between the little finger and the wrist. The pain areas of test sample handlebar S2 concentrate on the part from center of palm to rim except position 3. The pain area of the test sample handlebar S3 is the largest in four test samples. Especially at the position 1, the pain area is almost the same with the contact area. Besides, the pain areas of position 2 to 4 have more than half of the contact area. To make a comprehensive survey about the pressure distribution to four test samples, the contact area is the region from the thumb and the index finger to the little finger. The pain area concentrated on the regions of the thumb and the index finger, and between the little finger and wrist.

Meanwhile, two nouns, the ratio of contact (RC) and the ratio of pain (RP), had been defined to explain the relationship with comfort sensation. The ratio of contact is defined as the contact area divided by the area of palm, and the ratio of pain is the pain area divided by the area of palm. And then analyze the correlation of RC, RP, the area of palm and comfort sensation by using statistical analysis. According to the analysis data, comfort sensation and contact area has positive correlation at position 1 and 2.

Table 1. Pressure distribution of palm on four holding positions to each test sample

|            | Sample S1   | Sample S2   | Sample S3   |            | Sample S1  | Sample S2   | Sample S3   |
|------------|---|---|---|------------|--|---|---|
| Position 1 |  |  |  | Position 2 |  |  |  |
| Position 3 |  |  |  | Position 4 |  |  |  |

#### 4. Conclusions

In this study, both of the experimental method and interview method were utilized to explore the comfort sensation of road bike handlebar. Three significance test samples were used to analyze the correlation between the contact area and comfort sensation. According to the experiment data, the comfort sensation has positive correlation with contact area. It is a very useful data for designer to design the road racing bike handlebar. The results of experiment showed that comfort phenomenon has direct positive proportion with the width on holding position 1 and 2. A reasonable design parameter on holding position 1 and 2 is 5.38cm and 4.02cm, which can be used to design a new and more comfort handlebar, by using quadratic regression equation. Furthermore, the holding position 3 and 4 have no significant correlation with contact areas, that means designer just need to consider the bending curve fitting to cyclist's palm. The diagram of pressure showed that the pain area distribution is non-uniform on holding position 1 and 2, which concentrated on the part of the hand between the thumb and the index finger, and between center of the palm and wrist. In order to improve this situation, designer has to increase contact area, curved which can enlarge contact area, and uniformly disperse pain area for raising comfort sensation.

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