A Critical Analysis of Braking Performance Testing for Children's Bicycles under ISO 8098:2023

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Abstract:Children's bicycles are widely used by young riders for recreation and daily travel. As the number of bicycles in use continues to increase, the safety performance of children's bicycles has attracted increasing attention from manufacturers, testing laboratories and regulatory authorities. Among various safety-related requirements, braking performance is one of the most important factors affecting riding safety because it directly influences the rider's ability to control speed and avoid potential hazards. ISO 8098:2023 specifies detailed requirements and test methods for braking systems of bicycles intended for young children. Based on practical laboratory testing activities and the technical requirements of ISO 8098:2023, this paper discusses the braking performance test from three stages: before testing, during testing and after testing. Particular attention is given to factors that may influence test results, including bicycle preparation, fixture arrangement, force application, equipment calibration and operator consistency. Common problems observed during testing activities are also analysed. Furthermore, several suggestions are proposed regarding equipment management, testing procedures and quality control. The aim is to provide useful reference information for laboratories conducting children's bicycle safety testing and to improve the reliability and consistency of conformity assessment results.

Keywords: Children's Bicycle; ISO 8098:2023; Braking Performance; Laboratory Testing; Conformity Assessment

1. Introduction

Children's bicycles are an important category of consumer products and are widely used for entertainment, physical exercise and riding skill development. Compared with adult riders, children generally have less riding experience and weaker emergency response capabilities. Therefore, the safety performance of children's bicycles is particularly important.

In recent years, cycling has become increasingly popular as a healthy and environmentally friendly means of transportation. As a result, manufacturers, regulatory authorities and testing institutions have paid more attention to bicycle safety. Among all safety-related components, the braking system plays a key role in preventing accidents and reducing injuries. If the braking system cannot provide sufficient braking force, the rider may be unable to stop the bicycle effectively when encountering obstacles or unexpected situations. On the other hand, excessive braking force may also affect riding stability.

To improve product safety and facilitate international trade, ISO published ISO 8098:2023, which specifies safety requirements and corresponding test methods for bicycles intended for young children. The standard includes requirements related to braking systems, steering assemblies, structural integrity and other important safety aspects. Among these requirements, braking performance testing is one of the most frequently conducted evaluations during routine product testing and conformity assessment activities.

Based on laboratory testing experience and the requirements specified in ISO 8098:2023, this paper discusses the braking performance test and several factors that may influence testing results. The analysis is presented from the perspectives of preparation before testing, operation during testing and evaluation after testing. In addition, common laboratory issues and equipment limitations are discussed in order to provide practical reference information for testing institutions.

2. Braking Requirements in ISO 8098:2023

ISO 8098:2023 specifies a series of safety requirements for children's bicycles, including requirements related to braking systems.Most of

the regular product tests conducted by laboratories are brake strength, brake pad retention and braking force. The previous requirement is that the bicycle should have good braking performance in normal driving conditions .

The standard sets various levels of the force that needs to be applied to the brake lever of the hand-operated braking system, and the corresponding braking force at the wheel is measured. The chosen force levels are to simulate the operating conditions that may occur during the actual use by children. Besides measuring the braking force, the standard tests can also determine whether the braking components are still in good working order after a certain number of uses .

Braking performance tests can determine the actual braking ability of a car and find any issues in the components of the braking system that need to be corrected. Therefore, we need to ensure that the tests are accurate and consistent.

3. Importance of Braking Performance Testing

One of the essential safety features of children's bicycles is braking ability . The lab has repeatedly found that there is a lack of braking power, incorrect brake settings and unstable braking performance in the product tests. The following are problems with driving safety.

Children are generally younger, less experienced riders and have poorer emergency response abilities than adults. In the event of a danger, the rider will usually use the brake to reduce speed or stop the bike. Thus, the first goal is to reduce the risk of accident during operation.

The requirements for the braking performance in ISO 8098:2023 are based on the rules of mechanics and real driving conditions. The ideas of safety assessment are also in ISO 4210 for general bicycles. Instead of only measuring the braking performance in one situation, it should be done under various load conditions. The above will help us better understand how the braking system works and find any problems in its performance.

Lab tests are also a type of field test. Factors in real riding conditions that affect the outcome are the condition of the road, weather, tyre wear and rider operation. By controlling many of the external factors in the laboratory experiment, we can enhance the reproducibility and comparability of results among different laboratories.

4. Testing Activities

4.1 Before Testing

Before carrying out the braking performance test, laboratories should first confirm that the bicycle has been assembled according to the manufacturer's instructions. The braking system should be adjusted appropriately and all components should be checked for obvious defects or damage.

According to the above tests, the factors that affect the final result are brake cable tension, position of brake pads, wheel alignment and tyre pressure, etc. A small change will result in a relatively small change in the braking force. Therefore, the above items need to be confirmed before the start of testing.

Confirm that the calibration conditions of the test equipment are met. The force-measuring device, load cell and other measuring instruments should be within their valid calibration period. Some checks will be carried out before testing to confirm that the equipment operates correctly.

Record the Environment at the same time. Braking force measurement is not very sensitive to changes in the environment, but a large temperature or humidity fluctuation can affect some materials and measuring instruments. A Stable Environment will be created in the Lab.

4.2 During Testing

At the time of measurement, the location where the force is applied may affect the measurement results. The force should be applied at the position given in the standard. If the load position moves, the effective lever arm will change and thus the measured braking force will be off.

Another issue is how to arrange the fixtures. Put the bicycle in a good position and keep it still during the test. A wrong position will result in extra forces on the measuring instrument and an incorrect measurement result.

Some laboratories have not yet begun manual force application. Technicians have different work habits and may thus have different loading rates and force stabilities. There will be more measurement errors and reduced reproducibility. Thus, many automatic-loading systems have gradually been introduced in bicycle test laboratories.

All of the measured values at the time of testing need to be recorded. If there is a deviation from the norm, check the state of the apparatus and bicycle before proceeding with further tests.

4.3 After Testing

At the end of the test, please check if there are any damages, deformations, looseness or other abnormal wear in the braking system. Although the product can achieve the required braking force, the mechanical damage shown in the test may have been caused by other reasons.

Original records should include information such as bicycle identification, environmental conditions, calibration status, testing parameters and measured braking force values. All records should be reviewed to ensure completeness and traceability.

If abnormal results are identified, laboratories should analyse possible causes before issuing the final report. In some cases, unusual data may be related to equipment problems, operator errors or product-specific characteristics. Appropriate investigation helps improve the reliability of conformity assessment results.

4.4 Example of Braking Performance Test Results

To further illustrate the practical application of ISO 8098:2023 requirements, a children's bicycle equipped with front and rear hand-operated braking systems was tested in the laboratory.

According to ISO 8098:2023, the average braking force shall increase progressively with increasing brake lever input force. For front brakes, both minimum and maximum braking force limits are specified, while rear brakes are only required to satisfy the minimum braking force requirement .

The measured results are shown in Table 1.

Table 1. Results of Hand-Operated Brake Performance Test

Brake Lever Input Force (N)	Braking force at the tyre N	
	Front Brake Force (N)	Rear Brake Force (N)
40	69	88
50	84	93
60	99	119
70	116	135
80	140	153

The test results indicate that the braking force increased progressively with increasing lever force for both braking systems. For the front brake, the measured braking forces ranged from 69 N to 140 N, which complied with the minimum and maximum requirements specified in ISO 8098:2023. For the rear brake, all measured values exceeded the corresponding minimum braking force requirements.

To better evaluate the braking characteristics, the relationship between brake lever input force and braking force was analysed. The front brake showed a relatively linear increase in braking force as the input force increased from 40 N to 80 N. Similar behaviour was observed for the rear brake. No abnormal fluctuations or sudden reductions in braking force were found during the test.

From the laboratory perspective, this type of result indicates that the braking system was properly adjusted and that the force transmission efficiency of the brake mechanism was relatively stable. If significant deviations from the progressive increase requirement are observed, laboratories should verify brake cable adjustment, brake pad condition, wheel alignment and loading position before repeating the test.

As shown in the case, equipment calibration and operator consistency are also necessary. To obtain reliable test results, it is necessary to properly control the loading force, measurement system and fixture arrangement during the test .

5. Common Laboratory Issues

Some common problems in the laboratories have not been resolved by routine test activities yet.

One is the problem of force-measuring equipment. When the measured value is close to the upper or lower specification limit, it may not meet the requirements. According to the requirements of the tests, suitable measuring devices must be chosen.

The other is manual operation. Different technicians may apply force at various speeds or in different places, and thus the results will also vary. Although training can reduce the differences, full consistency is not yet achieved in the manual loading method.

Design of the Mould/Fixture is also required. Some of the old fittings were made for earlier bicycles and are not suitable for all the current products. The wrong fittings will be inconvenient to install and use during the test.

Some laboratories only conduct the first year's calibration and give less attention to intermediate verification. Regularly verify that

the calibration interval has not been exceeded to ensure the accuracy of the measurement.

6. Recommendations

Some ways to improve the quality of braking performance tests have been found in current laboratory practice.

First, laboratories should strengthen equipment management and ensure that measuring instruments are in good working order. At the middle of the calibration, check whether the equipment is working correctly.

Second, at that time, an automatic loader will be employed. Automatic equipment will have a more uniform load and less variation due to operators compared with manual operation.

Thirdly, the laboratory should periodically revise the test methods and organise training for staff. A long time will pass before it is stable and reproducible.

Finally, attention should also be given to uncertainty evaluation. A systematic assessment of measurement uncertainty can improve the technical credibility of testing results and support conformity assessment activities.

7. Conclusion

Braking performance testing is an important part of children's bicycle safety evaluation. ISO 8098:2023 provides a practical framework for assessing braking effectiveness and braking system reliability.

From laboratory experience, factors such as bicycle preparation, equipment calibration, force application and fixture arrangement may all influence testing results. Therefore, effective control of personnel, equipment, methods and environmental conditions is necessary to ensure reliable measurements.

As bicycle safety requirements continue to develop, testing laboratories should continuously improve their technical capabilities, testing procedures and quality management systems. Through effective testing activities and quality control measures, the reliability and consistency of children's bicycle braking performance assessment can be further improved.

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