Swix test protocol for testing of glide products

Lars Karlöf[1], Terje Smevold[2], Ole Bjørn Tretterud[2] Mitja Zupan[2]
[1]Swix Sport AS, Research and Development department, Servicebox, 2626 Lillehammer
[2] Swix Sport AS, International Racing Service, Servicebox, 2626 Lillehammer

1. Introduction

Testing the glide properties on snow of a new product sample is the ultimate test of the product. Many tests can be performed in the laboratory, however, in the laboratory it is not possible to simulate all the circumstances occurring during skiing in the nature. When testing in nature all parameters that gives the total friction and hence the perceived glide is real. When testing glide outside we actually are moving the laboratory outside. Since the environment is constantly changing it is important to keep track of these changes and also to take measures in order to understand how these changes may influence the results. In this paper we describe the procedures involved in performing a good glide test, including what equipment is needed, how to perform the test, what pitfalls to avoid and finally how to calculate and interpret the results. The procedures described can be adapted in both cross-country and alpine ski testing.

2. Preparations

In order to have good test results the preparations are essentials. We first describe the steps to take when test skis are new or they have been re-grinded.
A test series of skis normally consists of 6 to 8 pairs of skis. The amount of pairs is determined by the amount of variants to be tested. It is important that the physical parameters such as flex, chamber height and base, of the test skis are as even as possible, therefore the ski pairs are chosen from the same manufacturer and production series.
After this step the skis are grinded. Used sets of test skis are re-grinded after extensive usage or if damages have occurred to skis in the series. After grinding the test skis are prepared according to the procedures described in the SWIX technical manual (2007).
In short the preparations include saturation of the base with CH10. Scraping, brushing and polishing with violet and white Fibertex. In between a harder glider, LF6, is used. As finish CH10 is used before the skis are prepared with todays test wax.

A very important part of the preparations is the calibration of the skis. This special procedure is often called a “zero test”. The calibration is done to ensure that the test skis are as similar as requested. The zero tests are performed in the same manner as described below.
The difference between the skis in the test series shall be as small as possible. If deviations between the skis are too large then the particular skis are excluded from the test series. How to determine what difference that is acceptable will be discussed below.

2.1. Test Preparations

When preparing for a test we first have to ask ourselves what we want to test. Do we want to find the best pair of skis for a race situation or do we want to find the best structure or best wax. All these variations determine the set up of the test. The choice of products, wax techniques, base structure etc is determined by the objectives of the test. When testing the same alternatives several times it is important that a mutual circulation of the alternatives is performed within the test skis. This is done to eliminate a possible systematic error within the test skis.

2.2. Ski preparation

When preparing the test skis normally the test products are applied according to standard procedures, unless application procedures are the scope of the test. It is important to note

any deviations from standard procedures in order to be able to reproduce the test in the future. It is also important that the same person is performing each preparation step for all the skis in the test series. Again, this is to eliminate any systematic errors caused by the operator. This means that more persons can collaborate on the preparations however the same person should do all scraping and another person do all the brushing etc.

3. Performing the test

The test should preferably be performed at good weather conditions and the same test pilot should perform the whole test. If there is a need to change test pilot the test should be split in two tests. Preferably each ski should be tested 6 times which means that a test series of 6 skis would consist of 36 runs.

The test hill should preferably by steep in the start and then gradually flatten out in the run out zone. The track should be straight and any transversal undulations be avoided. The track should be firm and stable during testing. To achieve as stable track conditions as possible it is advisable to run through the track with all test skis prior the start of the test. The glide time should be around 10 to 15 sec, and the average glide velocity should be in the range of the race pace. This means that for cross country test the average glide velocity should be around 25 to 30 km/h and correspondingly higher for alpine testing ~100 km/h.

At start and stop of the test the meteorological and snow parameters are registered. Important parameters to characterise the whether and snow conditions include,

- Snow and air temperature
- Air humidity
- Snow humidity
- Wind
- Snow type (New, transformed, etc.)
- Track consistency
- Net Radiation

As mentioned above each ski is tested six times in a test. It is important to note that the skis are run in consecutive order and all skis are run through the loop prior the second run is started. This is a further measure to ensure as stable conditions as possible.

4. Evaluating the test

When evaluating the test both the ranking of the products and an estimation of the quality of the test are performed.
Since the purpose of the test is to find the true underlying value i.e. glide time, for the tested products we want to find a measure of this value. The mean of a series of values is a good estimator of the true underlying value.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad (1)$$

We use the mean of the measured runs to rank the tested products. However all measurements are associated with errors and in order to be sure we really have a difference between the tested products we need to estimate the associated errors. Errors can be both systematic and random. Example of systematic error would be differences between the skis. not stable track conditions. By ensuring to have well calibrated skis and well prepared ski tracks it is possible to minimise the systematic errors. The random errors are caused by variation in the surrounding environment, i.e. temperature, radiation, skier position during

sliding. The sum of the random errors can be estimated by studying the variation around the mean of the registered values. First the variance is defined as the squared deviation from the mean.

$$\text{var} = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2 \qquad (2)$$

And the standard deviation is the squared root of the variance,

$$SD = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2} \qquad (3)$$

The standard error measures the extent to which the sample mean vary due to chance,

$$SE(\bar{x}) = \frac{SD}{\sqrt{n}} \qquad (4)$$

Where *n* is the number of runs. As may be obvious from above, the SE is directly related to the variance and the error decrease with higher *n*.

When evaluating the data the values are considered as significantly different if the SE of the means does not overlap. The ranking is then based on the mean values. The run times and ranking results as well as meterological data is entered into a data base for storage and further investigations and comparisons.

Ski	Waxname (1)	SKU or lotn. (1)	Waxname (2)	SKU or lotn. (2)	Remarks
G-F121	CH 8				
G-F122	HF 8				
G-F123	LF 8				
G-F124	CH 7				
G-F125	CH 6				

Ski	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Avg.	Factor	Result	Feeling
G-F121										
G-F122										
G-F123										
G-F124										
G-F125										

Figure 1. Ski numbers and corresponding test products. Each product is tested in consecutive order i.e. all five products are tested through the first run before continuing with the remaining and the order of the skis is kept constant throughout of the test. Red arrow indicates mean run time (MRT) and blue arrow indicates mean ski time (MST). MST is used to rank the products.

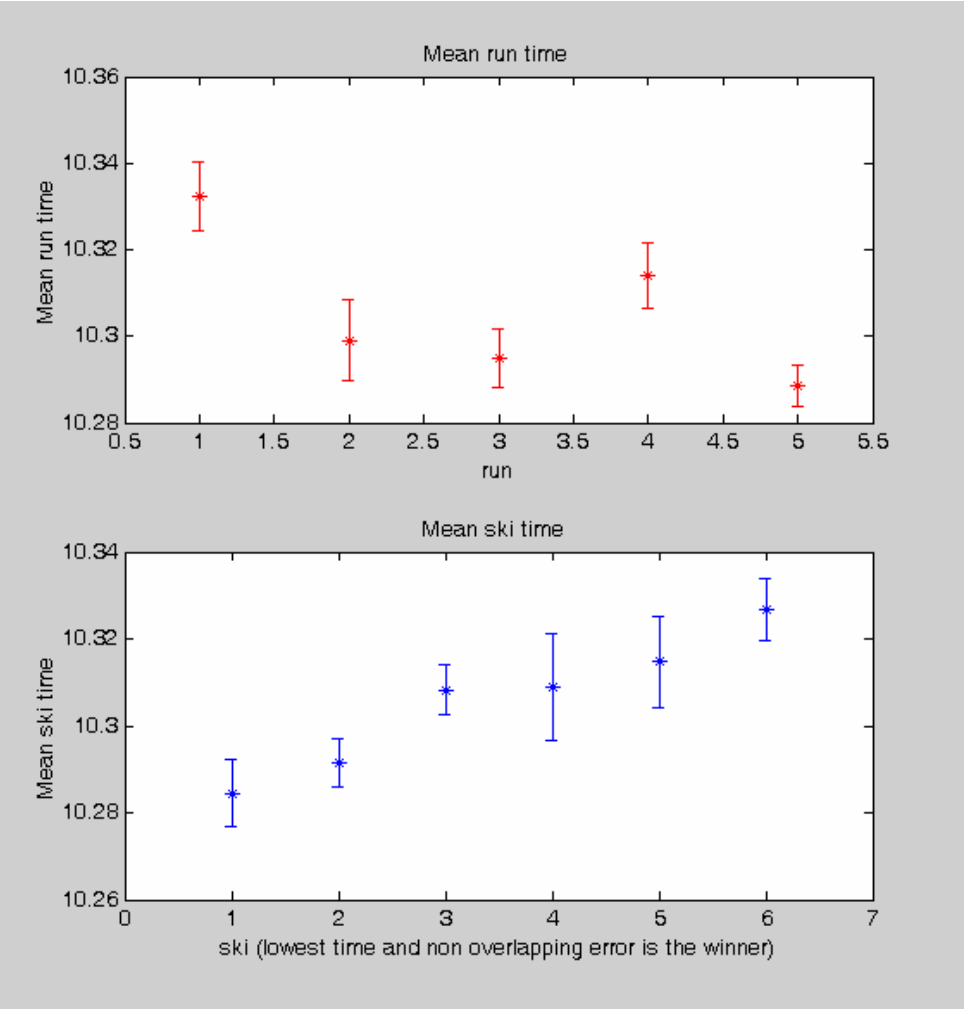

Figure 2. Upper panel shows the mean run times with associated standard error. The lower panel shows the mean ski time with the associated errors. From this example test it is obvious that there have been some significant variations between the runs. The ranking of the products show that product one and two have overlapping error bars and therefore can not be separated. Thus they are considered equal in this test.

In addition to the objective ranking by time, another measure “feeling” is also used. Feeling is a subjective measure on how the ski performs in flat terrain and uphill. The purpose of this test is to judge how well the skis run under these conditions, i.e. cycles of acceleration and deceleration. The skis are ranked in the same way as above and entered into the data base. Naturally the parameter is not judged during alpine ski testing.

5. Post treatment of the skis

The post treatment of a ski is as important as the pre test preparations. The purpose of the post-treatment is to eliminate any errors in future test that can be related to earlier tests.

Normal post treatment consist of applying the glide zone cleaner I84, light brushing with a nylon brush (T161), wiping of the base, let dry for 10 min and then light brushing with a bronze brush (T162), before waxing the skis with a similar glider on all ski pairs. After cooling to room temperature the skis are scraped and brushed – the skis are ready for preparations

for a new test or a transport wax is added. It should also be considered whether a new calibration run is called for.

6. Conclusion

The conclusion of a glide test should be based on the objective data acquired during the test. Based on this the ranking of the products are done in addition to judging the feeling parameter. To determine if a product is better than another one over time it is necessary to perform several tests under different conditions.
When testing for race recommendations the results of the test serve as basis for the waxing recommendations published by SWIX Racing service at the venue.

All test results obtained during our test programmes are stored in a central database. From this database we are able to track performance changes of product formulations with regard to all the parameters logged during the different test occasions.