Designation: F 504 – 00

Standard Test Method for Measuring the Quasi-Static Release Moments of Alpine Ski Bindings[1]

This standard is issued under the fixed designation F 504; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a procedure for the measurement of release moments of ski bindings under conditions where inertia loadings of the ski binding system are not significant.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

F 498 Test Method for Center Spring Constant and Spring Constant Balance of Alpine Skis[2]

F 779 Test Method for Torsion Characteristics of Alpine Skis[2]

F 944 Specification for Properties of Adult Alpine Ski Boots[2]

2.2 *ISO Standard:*

ISO 9838[3]

ISO 9462[3]

ISO 9465[3]

3. Terminology

3.1 The following terminology is introduced with reference to the sketch of the boot-ski system shown in Fig. 1.

3.1.1 Six points of load application to the standard test ski are required. With the adult boot sole (300 mm in length) the most forward point, located at a position 90 ± 0.5 cm from the centerline of the test shaft, shall be called the "forward point" and shall be designated as *F*. The second point, 45 ± 0.5 cm in front of the centerline of the test shaft, shall be designated the "near point," *N*. The third point, located 45± 0.5 cm behind the centerline of the test shaft, shall be designated "rear point," *R*.

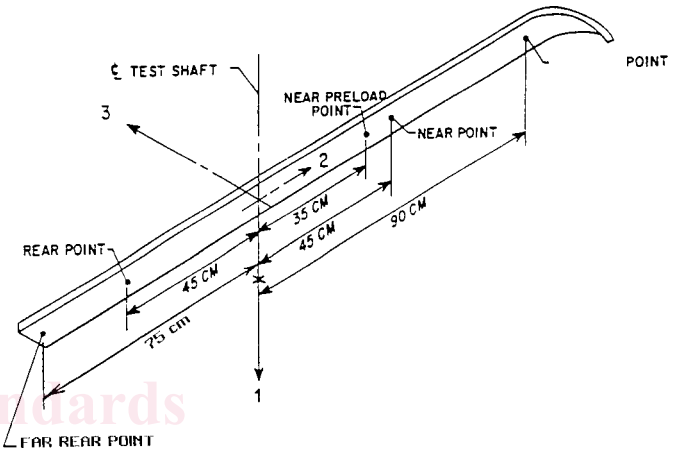

FIG. 1 Load Application

The fourth point, located 35± 0.5 cm in front of the center line of the test shaft, shall be designated the "near preload point," *NP*. The fifth point, located 75 ± 0.5 cm behind the centerline of the test shaft shall be designated the "far rear point," *FRP*. The sixth point, the "alternate near preload point," ANP, is located 7.5 ± 0.25 cm, in the minus y-direction from the point NP. For sole lengths longer than 300 mm the F and FR points are not changed from the location used for the 300 mm boot sole. For sole lengths shorter than 300 mm the N, R, ANP and NP points are not changed from the location used for the 300 mm sole. For bindings which are to be used exclusively with skis shorter than the test ski, F and FR tests shall be performed at the N and R points. If the ski is too short for the specified N and R points, N and R shall be moved closer to the z axis by 10 cm each, and all tests performed using the new N and R points. The forces that are applied to the standard ski at these six designated points may now be described by simple vector notation. A laboratory-fixed axis designation shall be used with the numeral z denoting the vertical axis normal to the top face of the ski (in the region of the test shaft) and positive in the direction outward from the ski; the numeral x denoting the longitudinal axis, positive in the forward direction of the ski; and the numeral y denoting the lateral axis, the positive direction of which is determined by the right-hand rule. The z axis is coincident with the centerline of the test shaft. The origin of XYZ coordinate system taken to be a point 230 mm

[1] This test method is under the jurisdiction of ASTM Committee F27 on Snow Skiing and is the direct responsibility of Subcommittee F27.10 on Binding Test Procedures.

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[2] *Annual Book of ASTM Standards*, Vol 15.07.

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

along the axis of the test shaft from the bearing surface of the tests sole for 300 mm test soles. The location is changed proportionally for soles other than 300 mm. The direction of any force applied to the ski is defined by its unit vector. The magnitude of a preload force applied to the ski is defined by the M_z or M_y moment created by the force.

4. Summary of Test Method

4.1 The ski binding is mounted on a standard ski and a standard boot is inserted into the binding. A relatively stiff test shaft instrumented for moments is affixed to the inside of the boot and attached rigidly to the test frame. The test equipment is shown in Fig. 2.

4.2 Loads sufficient to produce binding release are applied to the binding by forcing the ski to displace relative to the frame until the release occurs. The components of the moments transmitted through the binding to the test shaft are recorded. These records are interpreted to provide the static release moments of the binding.

5. Significance and Use

5.1 This test method involves simulation in the laboratory of potential injury-producing loads that can occur in skiing, without implying the frequency or the magnitude of the danger. This test method does not include the simulation of all or part of a skier, and care must be taken not to confuse the values of moments measured by the test shaft with the values of these quantities that would occur in the tibia of a skier under the same load conditions.

6. Apparatus

6.1 *Ski and Bindings*:

6.1.1 *Ski*—Three test skis are defined in Table 1 of ISO 9462. The mounting platform shall be as specified in the relevant ASTM standard. The boot's ski location marker as shown on Specification F 944 or ISO 9838 shall be aligned with the boot centerline marker on the ski. If there are no markers on the boot or ski the center of the boot sole shall be located 15 ± 0.5 cm behind the center of the ski's projected length unless the relevant ASTM standard applies.

6.2 *Boot*—Four boot soles are defined in Table 2 of ISO 9462. The standard boot sole shall be 300 ± 0.5 cm in length and shall be adjustable, ±4 cm. It shall be constructed of materials and have a tread pattern as established in specifications. Details concerning boot characteristics shall conform to the relevant ASTM standard. However, it shall be permissible to modify the boot if the binding manufacturer specifies that modification is necessary for proper function of the binding.

6.3 *Stiffener*—When called for, a channel of dimensions 80 mm wide by 40 mm high by 4 mm thick shall be used to stiffen the ski between the near and rear points. The channel shall be made of 6061 T6 aluminum, or equivalent. The bar shall be attached to the ski by bolts or screws at near and rear points and at a point half way between near and rear.

6.4 *Test Frame*:

6.4.1 The test frame consists of all mechanical components that connect the boot to a stationary reference, including the boot sole attachment, the test shaft, and the supporting structure for the test shaft. The test frame shall include a boot sole attachment constructed in accordance with ISO 9838 for the standard sole.

6.4.2 The angle between the bottom of the boot sole and the test shaft shall be 90 ± 1 deg in the z−x and z−y planes; the positions of centerline of the test shaft relative to the boot shall be at a longitudinal location 20 ± 1 cm from the front of the boot sole when the 300-mm boot sole is used. For other boot sole lengths the distance shall be two thirds the distance from the front of the sole.

6.4.3 The test shaft and associated instrumentation shall be capable of measuring moments about the x, y, and z axes as required. Further specifications for the test shaft as part of the instrumentation system are discussed in 6.6.

6.4.4 The linear compliance of all combined mechanical components of the test frame shall be no more than 4×10^{-6}

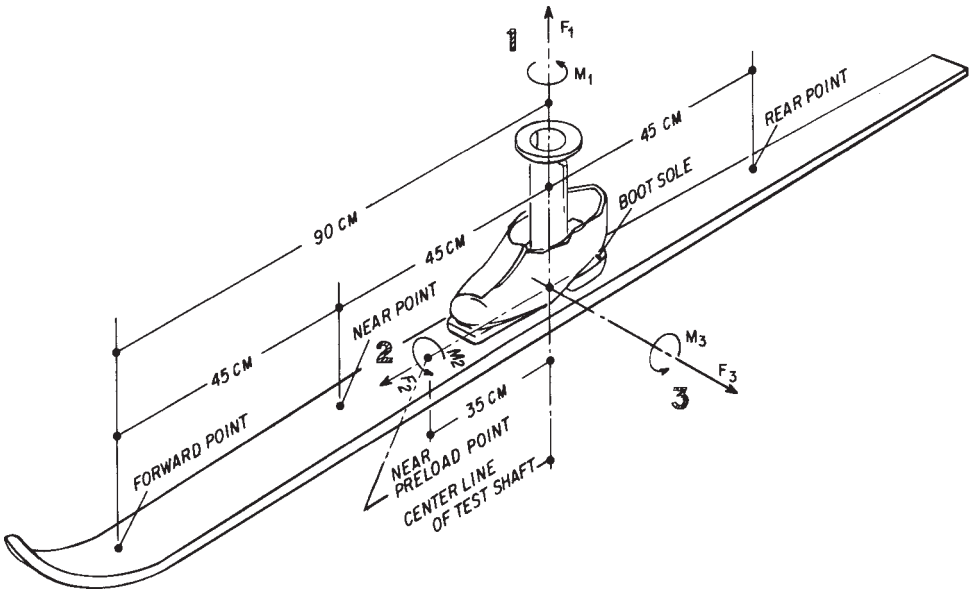

FIG. 2 Test Equipment

m/N in either of the x or y directions, and no more than 4×10^{-7} m/N in the z direction for loads applied at the intersection of the test shaft and the attachment plate. The angular compliance shall be no more than 5×10^{-5} rad/N · m for rotations around the x, y, or z axes.

NOTE 1—When an associated high-speed test series is established, the angular compliance shall be no more than 2.5×10^{-5} rad/N · m for rotations around the x, y, or z axes.

6.5 *Cable*:

6.5.1 The minimum length of cable between the point of attachment to the ski and the nearest support shall be 1 m.

6.5.2 The cable shall be attached to the ski such that the resultant force transmitted through the cable passes within 1 cm of the centeroid of the cross section of the ski.

6.5.3 Preloads are applied through a pulley near the base of the load cell pedestal with an attachment swivel not more than 12 cm offset from the load cell axis. A spring with a spring constant of 65 N/cm (± 10 %) and an unloaded length of at least 20 cm is attached between the preload cable and the attachment fixture. When a preload (PL) is used in a test the preload cable force will induce a measured M_y that is a specified percentage of the nominal heel release moment (see Fig. 11).

6.6 *Instrumentation*:

6.6.1 *Measurements*—The instrumentation shall provide measurement of the peak M_z and M_y moments. The values of measured moments should be referred to a point 23 ± 0.1 cm above the bearing surface of the boot sole on the z axis for 300-mm sole lengths. Other length soles shall require this reference point to be shifted proportionally.

6.6.2 *Range*—Maximum moment along a single axis:

$$300\ N \cdot \mathrm{m}\ (\mathrm{full-scale\ for}\ M_z M_x) \quad (1)$$

$$1000\ N \cdot \mathrm{m}\ (\mathrm{full-scale\ for}\ M_y)$$

6.6.3 *Accuracy*—Absolute accuracy for moment measurements to errors less than 5 % of reading for readings above 50 N·m and less than 2.5 N·m for readings below 50 N·m. Applied force components must be accurate within 5 % of reading for readings above 200 N and within 10 N for readings below 200 N.

6.6.4 *Repeatability*—Repeated readings under standard test conditions shall be repeatable to ± 1.5 % for moment readings above 50 N·m. Repeatability shall be to ± 0.75 N·m for lower readings.

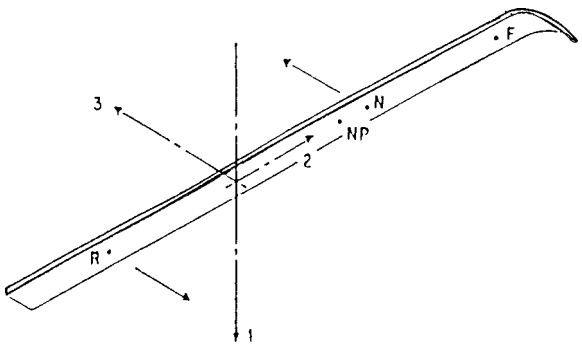

FIG. 3 Test 1.1

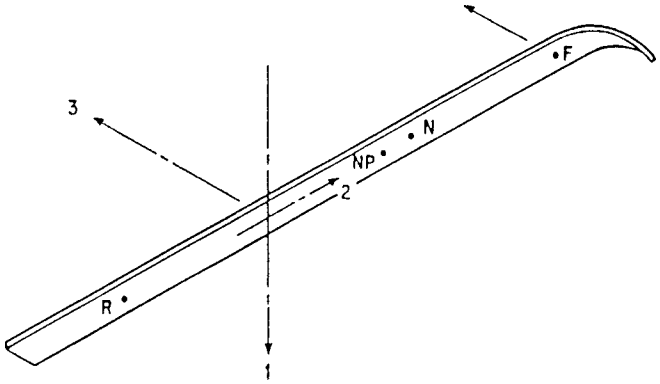

FIG. 4 Test 1.3

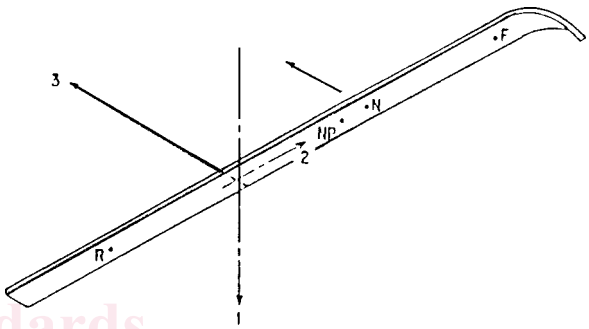

FIG. 5 Test 1.4

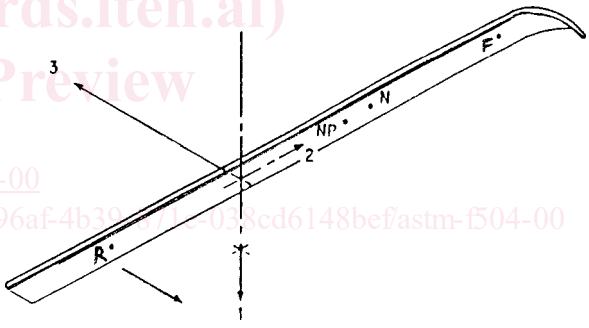

FIG. 6 Test 1.5

6.6.5 *Hysteresis*—The hysteresis measured at no load shall be less than 1.5-N·m moment following a cyclical load to full scale.

6.6.6 *Null Drift* shall be correctable to less than 0.75-N · m moment at 20°C.

6.6.7 *Temperature Sensitivity*:

$$\text{Gain variations: correctable to 0.2 \% } °C \text{ at } T_o \pm 0.5°C \quad (2)$$

$$\text{Null variations: correctable to 0.5 } N \cdot \mathrm{m}/°C \text{ at } T_o \pm 0.5°C \quad (3)$$

where: T_o = equilibrium environmental temperature and is in the range from − 20 to + 20°C.

6.6.8 *Frequency Response*—Gain measured at full scale shall vary less than 1 dB over the bandwidth 0 to 100 Hz. Phase lag shall be less than 10 deg over the same bandwidth.

6.7 *Load Application*: