STEEL TAPE CERTIFICATION

Introduction

Steel tapes are a basic means of measuring field event performances in athletics. Even when electronic distance measuring (EDM) is used the accuracy of the EDM measurement is checked using a calibrated certified steel tape.

The IAAF has relied on its federations to have the accuracy of the steel tapes used certified by an appropriate Weights and Measure Authority (IAAF Rule 148). Nowhere is it stated what the accuracy of the calibration should be.

In the industrialised nations it is becoming more usual for the government Weights and Measure Authority to charge a substantial fee for calibrating federation's steel tapes to the appropriate standard recognised in the particular country. The calibration standards may vary slightly from country to country.

Accuracy

In Australia the only available standard for calibration of steel tapes is AS 1290.5 - 1999 "Linear measuring instruments used in construction Part5: Coated and etched steel measuring tapes" that covers tapes not more than 50m in length. In preparing this standard consideration was given to the BS 4484.1:1969.

It is noted that there is also a BS 7334-2:1990, ISO 8322-7:1991 "Measuring instruments for building construction. Methods for determining accuracy in use: measuring tapes".

AS 1290.5 requires that when the tape is supported on a horizontal surface at a temperature of 20°C and subject to a tensile force of 50N, the magnitude of the error in the distance from the zero of the instrument to the centre-line of any graduation marks throughout the length of the ribbon shall not be greater than 0.5mm + 0.1mm/m. It is assumed that the other above mentioned standards have a similar requirement.

Now it should be noted that these standards only refer to tapes not longer than 50m. In athletics it is usual to have steel tapes 100m long. It would seem that the standard tensile force used by testing authorities for such long tapes is 100N. The steel tapes used at the 2000 Sydney Olympic Games were tested in accordance with AS 1290.5 except that the tensile force was 100N. The Cooper Tools' (makers of Lufkin tapes) paper on steel tape accuracy available on their Web site states that for tapes over 100ft (30m) the standard tension should be 9kg (90N) supports this. I assume that this is as recommended by the US Bureau of Standards. Yamayo Measuring Tools Co. Ltd. provides calibration certificates for 100m steel tapes tested with a tension of 10kgf (98N). See also the Yamayo Web site for details of the formulae and tape properties to be used in calculating the temperature and pull corrections for their various steel tapes.

The effect of having a different pull to that used in the tape calibration is quite substantial. For a typical steel tape the difference could be about 2.7mm per 10N for a 100m length. As the pull tension used by athletics officials is likely to be less than the calibration tension of 100N the effect is always to over measure the distance. Table 1 gives corrections to the length measured for varying pull tension and distance measured for a Yamayo tough carbon steel tape. The characteristics of other makes and types of steel tapes need to be determined from the tape manufacturer.

Also there is a temperature effect of 1.15mm for a 100m length per degree C different from 20°C for a carbon steel tape. Thus it will be seen that the tape pull is likely to have a more significant effect than temperature.

It has been stated by the Australian National Measurement Laboratory (ANML) [(1)] that using the nominal intervals on a steel tape calibrated using a standard such as AS 1290.5-1999, measuring to the lower whole centimetre, with no temperature correction that the 95% confidence limit the uncertainty of the measurement would be -12mm to +22mm for 100m in the temperature range 10°to 30°C. The 95% confidence limit uncertainty of measurement is increased further when the standard calibration tension is not applied when measuring.

The Sydney 2000 Olympic Games steel tapes were check measured every metre and the maximum deviation was -1.0mm whereas the allowable deviation could have been 10.5mm for 100m i.e. 1 in 10,000 plus 0.5mm uncertainty of a single measurement.

The ANML has suggested that checking the calibration at 10m intervals would be sufficient to uncover any scale error in a tape [(2)].

Surveyors in Australia are required by government regulation to have their steel measuring tapes calibrated once a year. The standards noted above do not make any statement on the required frequency of calibration. Steel tapes used by federations only to check records and EDM accuracy at infrequent intervals should not in view of the cost be required to be tested at more frequent intervals than say every four years unless the tape is damaged in any way. This view is reinforced by the ANML[(1)] that advises that four years is the recalibration interval specified in the Verifying Authorities handbook for steel tapes. Confidence in the tape's calibration stability is increased if the tape has a history of calibration compliance.

By comparison a manufacturer's standard deviation for an EDM is 3mm + 2ppm. The 95% confidence limit for such an instrument measurement is 6mm + 4ppm which indicates that EDM is inherently more accurate than a steel tape especially over longer distances.

Conclusions

Steel tapes are not an accurate means of measuring over long distances when there is no temperature or pull tension corrections applied. Therefore EDM should always be used for measuring long throws at national and international competitions.

Uncertainty and inaccuracy in measurement can be reduced if a standard pull is applied to the steel tape using a spring balance.

Recommendations

1. That steel tapes used for measuring field performances and checking the accuracy of EDM at international competitions should meet the following calibration requirements:

- The calibration temperature shall be 20°C and a tensile force 100N for 100m tapes and 50N for tapes 50m or shorter shall be applied with the tape supported on a horizontal surface;
- The calibrations shall be checked at 10m intervals; and
- The magnitude of the error in the distance from the zero of the instrument to the centre-line of any graduation marks throughout the length of the tape shall not be greater than 0.5mm + 0.1mm/m.
- Tapes should be recalibrated at not more than four yearly intervals unless the tape is damaged.

2. The above information should be inserted in a Calibration Handbook to be produced by the IAAF for the guidance of federations and manufacturers along with calibration information for EDM, wind gauges, false start and timing equipment.

3. In measuring records with a steel tape a standard pull of 50 N and 100N for 30/50m and 100m tapes respectively shall be applied with a spring balance. These requirements shall be specified in Rule 260.10 (a).

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August 2001

References:

(1) Private communication from the Australian National Measurement Laboratory 16 July 2001.

(2) Private communication from the Australian National Measurement Laboratory 24 July 2001.