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AMENDMENT 1
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Quasi-static calibration procedure for belt force transducers

AMENDMENT 1

Procédure d'étalonnage quasi-statique pour capteurs d'efforts pour ceintures

AMENDEMENT 1

Reference number
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Amendment 1 to ISO/TS 17242:2014 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 36, *Safety and impact tests*.

Quasi-static calibration procedure for belt force transducers

AMENDMENT 1

5.2

Replace the first sentence with the following:

The sensor offset should be measured under no load condition. A new belt strap shall be inserted and mounted in the fixture[8].

5.3

Replace the third sentence with the following:

Only one loading sequence with one belt strap per test transducer up to a force level at least at 100 % of the transducer's calibration range shall be performed within the given velocity range.

5.6

Replace the last item of the list with the following:

— non-linearity as a percentage in % of the transducer's calibration range (for linear regression only).

Annex B

Replace the entire Annex B with the following:

Annex B
(normative)
Evaluation method

B.1 Linear regression

For the software linearization a least-squares fit method applied through the point of origin is used:

The starting point of the linearized line is identical with the starting point of the measurement. This point is set to zero (point of origin). This measurement is independent of the defined evaluation interval (see 4.7). The resulting linear equation is

$$F_i = b(S_i - S_0) + D \qquad \text{(B.1)}$$

where

S_0 = 0;

D = 0.

For the linearization, the square sum of the difference between measured value and linearized value must be minimal:

$$\sigma = \sum_{i=1}^{n}\left[F_i - \left(b\left(S_i - S_0\right) + D\right)\right]^2 \quad \text{(B.2)}$$

where S_i, F_i = measured.

The differentiation is equated to zero:

$$\frac{d\sigma}{db} = 2\sum_{i=1}^{n}\left[-\left(S_i - S_o\right)\left(F_i - D\right) - b\left(S_i - S_o\right)^2\right] = 0 \quad \text{(B.3)}$$

From this will follow:

$$b = \frac{\sum_{i=1}^{n} -\left(F_i - D\right)\left(S_i - S_0\right)}{\sum_{i=1}^{n}\left(S_i - S_0\right)^2} \qquad a = \left|\frac{1}{b}\right| \quad \text{(B.4)}$$

where

F is the actual force, in kN;

S is the sensor output reading, in mV/V;

D is the calculated offset (linear regression), in kN;

a is the sensitivity, in mV/kN/V;

b is the inverse sensitivity, in kN/mV/V;

σ is the deviation.

B.2 Polynomial regression

For the polynomial approximation, a least-squares fit method shall be utilized to determine the polynomial coefficients A, B, C, and M.

With mesh points (S_i; F_i) the third degree polynomial will acquire the general form:

$$F_i = A \cdot S_i^3 + B \cdot S_i^2 + C \cdot S_i + M \quad \text{(B.5)}$$

The function values F_i are complemented by residues r_i (corrections)

$$F_i + r_i = A \cdot S_i^3 + B \cdot S_i^2 + C \cdot S_i + M \quad \text{(B.6)}$$

Applied on the mesh points the observation formulae follow:

$$r_1 = A \cdot S_1^3 + B \cdot S_1^2 + C \cdot S_1 + M - F_1$$

$$\downarrow \quad \text{(B.7)}$$

$$r_1 = A \cdot S_i^3 + B \cdot S_i^2 + C \cdot S_i + M - F_i$$

The observation formulae are squared and then pooled:

$$\sum r_i^2 = \sum A^2 . S_i^6 + 2\sum AB . S_i^5 + 2\sum AC . S_i^4 + 2\sum AM . S_i^3 - 2\sum A . F_i . S_i^3 + 2\sum B^2 . S_i^4 + 2\sum BC . S_i^3 + 2\sum BM . S_i^2 - 2\sum B . F_i . S_i^2 + \sum C^2 . S_i^2 + 2\sum CM . S_i - 2\sum C . F_i . S_i + M^2 - 2M . F_i + F_i^2$$

To determine the minimum of the residues r_i, the observation formula's sum of squares are differentiated and equated to zero.

$$\frac{d\left(\sum r_i^2\right)}{dA} = 2\sum A . S_i^6 + \sum B . S_i^5 + \sum C . S_i^4 + \sum M . S_i^3 - \sum F_i . S_i^3 = 0$$

$$\frac{d\left(\sum r_i^2\right)}{dB} = \sum A . S_i^5 + 2\sum B . S_i^4 + \sum C . S_i^3 + \sum M . S_i^2 - \sum F_i . S_i^2 = 0$$

$$\frac{d\left(\sum r_i^2\right)}{dC} = \sum A . S_i^4 + \sum B . S_i^3 + 2\sum C . S_i^2 + \sum M . S_i - \sum F_i . S_i = 0$$

$$\frac{d\left(\sum r_i^2\right)}{dM} = 2\sum A . S_i^3 + \sum B . S_i^2 + \sum C . S_i + 2\sum M - \sum F_i = 0$$

A linear system of formulae results from putting in the mesh points (x_i; y_i). Coefficients A, B, C, and M, and therefore the equalization polynomial through the point of origin, can be calculated, where

F	is the actual force, in kN;
S	is the sensor output reading, in mV/V;
M	is the physical offset prior to the test (polynomial regression), in kN;
A, B, C	are the calibration coefficients.
B	is the inverse sensitivity, in kN/mV/V;
C	is the deviation.

Annex C

Replace the entire Annex C with the following:

Annex C
(informative)
Belt strap characteristics

C.1 Specifications for the standardized calibration belt strap

For the calibration of the belt force transducers, a test belt strap with the specifications shown below should be utilized

C.1.1 Construction

Normal band equal on both sides, bonding K2/2, double shot.

C.1.2 Width

47 mm to 49 mm

C.1.3 Thickness

1,25 mm to 1,35 mm

C.1.4 Weight

64 g/m to 68 g/m

C.1.5 Minimum breaking load

≥30 kN

C.1.6 Strain

14 % to 16 % at 10 kN

C.1.7 Colouring/Finishing

Spin dying

C.1.8 Number of chaining threads

300 ± 10

C.1.9 Number of filling threads

66 ± 5 (1/100 mm)

The belt strap shall be stored in a packed condition. Furthermore it should be protected from sunlight.

NOTE If the recommended belt strap is not used, then the test belt strap which is in accordance with customer requirements is chosen.

C.2 Measurement of test belt strap thickness

For verification of significant belt strap characteristics, and to ensure traceability, the average thickness of the utilized belt strap lot should be identified. The average and the classification of the belt strap shall be noted in the calibration report. Measurements of the test belt strap thickness are taken as follows.

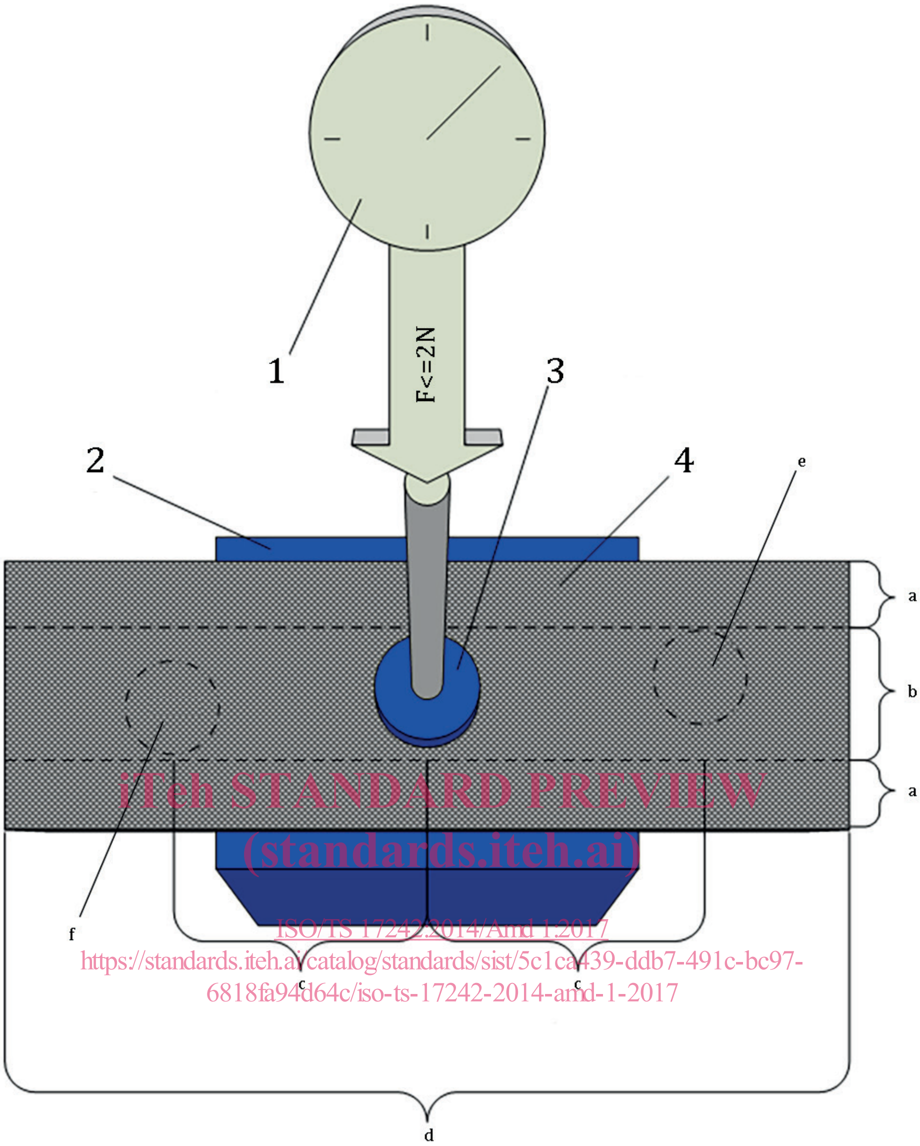
— The test gauge should have a resolution of 0,01 mm and a maximum indication error of 3 %.

— The belt strap shall be measured between a planar overlay and a flat transceiver with a calibre of 10 mm within a test load of less than 2 N.

— The averaged belt strap thickness is calculated by three measurements on different points in the medium range of the belt strap.

— The minimum distance between these points should be 25 % of the overall tested belt strap length.

— If a belt strap charge is longer than 10 m, the average belt strap thickness should be identified once per each 10 m section.



Key

1 test gauge (0,01 mm resolution; 3 % error of indication)
2 overlay
3 transceiver (⌀10 mm)
4 test belt strap
a 25 % of width
b medium range
c minimum 25 % of test belt strap length
d test belt strap length
e point 3
f point 2

Figure C.2 — Schematic measurement setup for the belt strap thickness

