BS EN 14081-3:2012

BSI Standards Publication

Timber structures — Strength graded structural timber with rectangular cross section

Part 3: Machine grading; additional requirements for factory production control

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National foreword

This British Standard is the UK implementation of EN 14081-3:2012. It supersedes BS EN 14081-3:2005, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/518, Structural timber.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Structures en bois - Bois de structure à section rectangulaire classé pour sa résistance - Partie 3: Classement mécanique - Exigences complémentaires relatives au contrôle de la production en usine

Holzbauwerke - Nach Festigkeit sortiertes Bauholz für tragende Zwecke mit rechteckigem Querschnitt - Teil 3: Maschinelle Sortierung, zusätzliche Anforderungen an die werkseigene Produktionskontrolle

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Foreword

This document (EN 14081-3:2012) has been prepared by Technical Committee CEN/TC124 “Timber structures “, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2012, and conflicting national standards shall be withdrawn at the latest by July 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14081-3:2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

Other parts of the series of EN 14081 are:

— EN 14081-1, *Timber structures — Strength graded structural timber with rectangular cross section — Part 1: General requirements*;

— EN 14081-2, *Timber structures — Strength graded structural timber with rectangular cross section — Part 2: Machine grading; additional requirements for initial type testing*;

— EN 14081-4, *Timber structures — Strength graded structural timber with rectangular cross section — Part 4: Machine grading — Grading machine settings for machine controlled systems*.

Compared to EN 14081-3:2005 the following modifications have been made:

— the additional factory production control requirements for output controlled systems are transferred in Annex B (informative);

— in Annex A, the requirements for using control planks are updated.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Machine grading is in common use in a number of countries. The countries use two basic systems, referred to as ‘output controlled’ and ‘machine controlled’. Both systems require a visual override inspection to cater for strength-reducing characteristics that are not automatically sensed by the machine.

The output-controlled system is suitable for use where the grading machines are situated in sawmills grading limited sizes, species and grades in repeated production runs of around one working shift or more. This enables the system to be controlled by testing timber specimens from the daily output. These tests together with statistical procedures are used to monitor and adjust the machine settings to maintain the required strength properties for each strength class. With this system it is permissible for machine approval requirements to be less demanding and for machines of the same type to have non-identical performance.

The machine controlled system was developed in Europe. Because of the large number of sizes, species and grades used it was not possible to carry out quality-control tests on timber specimens drawn from production. The system relies therefore on the machines being strictly assessed and controlled, and on considerable research effort to derive the machines settings, which remain constant for all machines of the same type.

The acceptability of grading machines and the derivation of settings rely on statistical procedures and the results will therefore depend on the method used. For this reason, this European Standard gives appropriate statistical procedures.

The requirements in this European Standard are based on machines in current use and on future types of machines as far as these can be foreseen. It is recognised that additional clauses or standards may be required if unforeseen developments take place.

1 Scope

This European Standard specifies requirements additional to those given in EN 14081-1 for factory production control of machine graded structural timber with rectangular cross-sections shaped by sawing, planing or other methods, and having deviations from the target sizes corresponding to EN 336.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 408, *Timber structures — Structural timber and glued laminated timber — Determination of some physical and mechanical properties*

EN 14081-1, *Timber structures — Strength graded structural timber with rectangular cross section — Part 1: General requirements*

EN 14081-2, *Timber structures — Strength graded structural timber with rectangular cross section — Part 2: Machine grading; additional requirements for initial type testing*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN 14081-1 and the following apply.

3.1
depth
dimension perpendicular to the longitudinal axis of a timber beam, in the plane of the bending forces

3.2
grade determining property
mechanical or physical property for which a particular value of that property has to be achieved for the material to be assigned to that grade, e.g. bending strength, mean modulus of elasticity and density for the strength classes of EN 338

3.3
indicating property
measurement or combination of measurements made by the grading machine, which are closely related to one or more of the grade determining properties. For grading machines which compute and predict values of the grade determining properties directly from numerous measuring devices, the indicating property may be a predicted value of a grade determining property

3.4
sample
number of specimens of timber of one size and representative of one species population

4 Symbols

A	cusum control parameter
B	cusum control parameter
B_a	cusum parameter associated with acceptable quality level

B_r cusum parameter associated with rejectable quality level

E_p actual modulus of elasticity measured in a proof load test (in N/mm^2)

$E_{0,mean}$ characteristic mean modulus of elasticity parallel to grain (in N/mm^2)

F_p proof load (in N)

K cusum control parameter

L_a run length in acceptable region for cusum control

L_r run length in rejectable region for cusum control

N cusum control parameter

Y cusum control parameter

Z cusum control parameter

5 Requirements for the operation, calibration and maintenance of a grading machine

5.1 No modifications that are in conflict with the machine manufacturer's specification shall be made to the machine.

5.2 Access to all machine adjustments shall be limited to personnel authorised to operate or set up the machine.

5.3 The strength grading machine shall be regularly calibrated in accordance with the manufacturer's specification.

5.4 A strength grading machine shall only be fitted with spare parts equivalent to, or improving upon, the performance of those fitted at the time the machine was assessed by initial type testing. If spare parts are fitted that are not identical to those fitted at the time the machine was assessed by initial type testing, the machine shall be reassessed to establish their effect on grading accuracy.

5.5 The results of routine service and maintenance to the strength-grading machine and ancillary equipment shall be recorded together with the results of calibration checks.

6 Additional requirements for factory production control for machine controlled systems

6.1 General

When grading structural timber in a machine controlled system, grading accuracy shall be monitored, A grading machine's dynamic performance shall be controlled by the use of control planks using the procedures given in Annex A.

6.2 Requirements for strength grades with a characteristic strength level above C30

During each working shift, two pieces of timber from each grade produced shall be randomly selected and tested for edgewise bending strength as given in EN 408 with the tension edge selected at random and the estimated weakest cross section positioned where possible within the centre third of the span. The fifth

percentile value, determined by ranking, of the 100 bending strength values from 50 consecutive shifts shall meet the required bending strength (as given in EN 14081-2).

A strength property other than edgewise bending strength may be used for factory production control as an alternative, provided the relation between the two properties is verified from test data.

If the timber is graded to tensile strength classes then this test shall be carried out in tension or bending in accordance with EN 408.

7 Additional factory production control requirements for output controlled systems

A procedure is given in Annex B and Annex C.

Annex A
(normative)

Requirements for using control planks

A.1 General

When grading structural timber in a machine controlled system, grading accuracy shall be monitored by controlling the grading machine whilst it is running at production speed.

The installation and calibration shall be checked by the use of control planks, using the procedures given in this Annex. The grading process shall be considered to be in control when the procedures given in A.3 and A.4 indicate it to be so.

If the indicating property or the values measured by the machine to determine the indicating property deviate more than 7 % from the original data, the control plank shall be defined as out of control. Where the machine measures in fixed increments then the limit shall be taken as the next increment boundary above 7 %.

For each control plank, all data shall be recorded on the datasheet including:

a) the date;

b) density or weight and dimensions of the control plank;

c) grading model (reference to the report number for deriving the grading machine settings);

d) indicating property;

e) values measured by the machine to determine the indicating property.

A.2 Requirements for selecting the control planks

Three control planks labelled A, B, and C shall be randomly selected from timber that is typical, in terms of species, size and strength reducing characteristics, of timber to be graded by the particular machine installation. Each control plank shall be indelibly marked with its orientation and feeding direction and be accompanied by a datasheet where all data gathered under A.3 and A.4 shall be recorded.

NOTE Where changes in moisture content of the plank may affect measurements made by the grading machine, the plank should be stored in a way that minimizes changes in moisture content.

A.3 Requirements for the use of control planks for internal factory production control

A.3.1 At the commencement of each working day the machine shall be set up to the machine manufacturer's instructions and the machine settings checked. This shall also be done after any major adjustment to the machine that could affect the dynamic performance regardless of the point in the working day at which it occurs.

Control plank A shall be used at least:

— once per working day, and

— after machine maintenance or repair, and

— when the machine software model is changed.

Control plank B shall be used once a month and when A is not working correctly.

A.3.2 The internal verification procedure shall be carried out, according to the decision diagram given in Figure A.1.

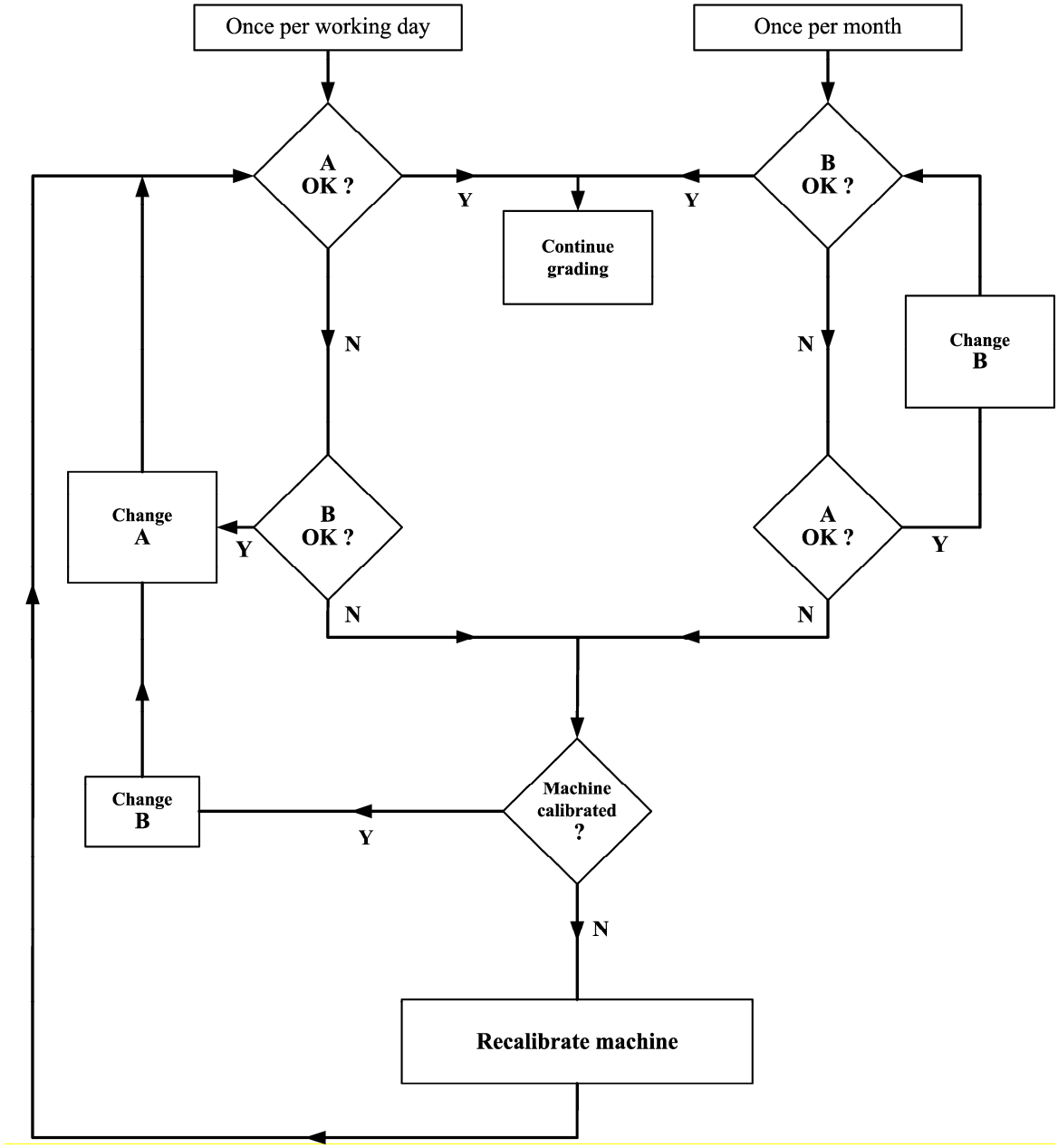


Figure A.1 — Decision diagram for internal verification procedure

A.4 Requirements for the use of control planks for third party factory production control

The machine shall be checked twice per year using control plank C.

NOTE This control plank is intended to be used by a third party involved in the factory production control.

If control plank C is out of control, then an internal check shall be carried out as given in A.3.

Annex B
(informative)

Additional factory production control requirements for output controlled systems

B.1 General

When grading structural timber in an output controlled system, grading accuracy shall be monitored by testing samples drawn from production and analysing the results using the cusum procedure described as follows.

B.2 Production control

B.2.1 Five specimens of the strength class to be tested shall be counted, and then the sixth specimen shall be selected for the test sample. This procedure shall be carried out five times to select one five-specimen sample from each class produced during each working shift. This process shall take place at approximately equal intervals during the shift period. For the first three working shifts the sampling rate shall be doubled using newly assessed settings.

B.2.2 Each sample selected from production shall be tested as follows, using the apparatus and procedure described in EN 14081-2 under additional requirements for initial type testing for output controlled systems.

a) Proof load to F_p each specimen edgewise over a span of 18 times the piece depth and using third-point loading with the tension edge selected at random and the estimated weakest cross section positioned where possible within the centre third of the span.

b) Determine the actual modulus of elasticity E_p.

The rate of applied stress shall be 110 N/mm^2/min. The number of specimens that fail below the proof load and the values of E_p shall be recorded on the cusum control charts.

NOTE For an example see Annex C.

B.2.3 Calculate the three cusum control constants K, Y and Z and enter them on the cusum control charts.

These shall be determined as follows:

— control of bending strength: $K = 1$, $Y = 1$, $Z = 6$;

— control of characteristic mean modulus of elasticity parallel to grain:

$$K = 0{,}95 \times E_{0,mean} - 345 \quad (1)$$

where

$E_{0,mean}$ is equal to the mean modulus of elasticity for the strength class.

A constant 'A' shall be calculated from the equation $A = 7\,381/E_{0,mean}$ and used in Figure B1 to determine two values of B expressed as B_a when $L_a = 150$ and B_r when $L_r = 5$.

The remaining control constants *Y* and *Z* shall then be calculated from:

$$Y = 0{,}0467 \times E_{0,\,mean} \times B_a \quad (2)$$

$$N = 0{,}0467 \times E_{0,\,mean} \times B_r \quad (3)$$

$$Z = Y + N \quad (4)$$

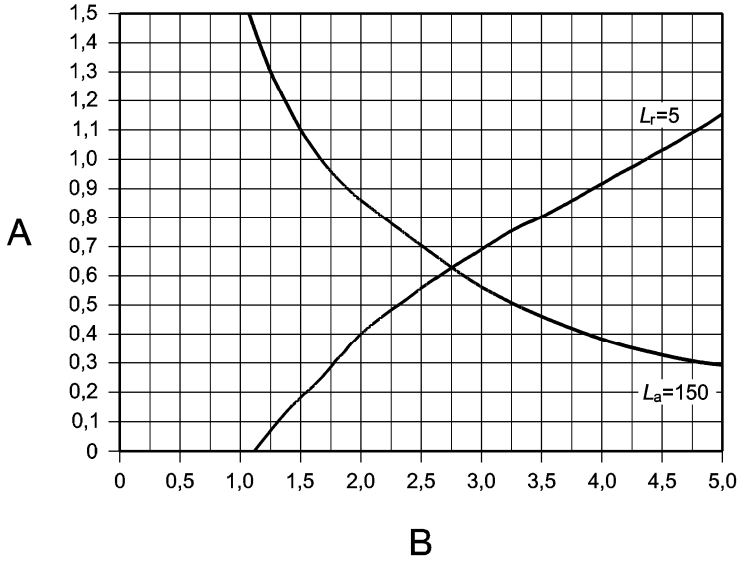


Figure B1 – Graph of variables *A* and *B* for use in the determination of cusum control constants for modulus of elasticity

B.2.4 All results from the tests on factory production control specimens shall be entered on the control charts.

There are two charts, one for use when the process is 'in control' (see Table C.1) and one for use when the process is 'out of control' (see Table C.2). If the process goes out of control then, irrespective of which or how many properties are involved, the out-of-control chart shall be used. An example showing the method of filling in the control charts is given in Annex C.

B.2.5 The directions for determining cusum values on 'in-control' charts shall be as follows:

a) if sum is 0 or less, then cusum equals 0;

b) if sum is greater than 0 and less than *Y*, then cusum equals sum. (For bending strength, *Y*=1, therefore this condition does not apply.);

c) if sum is greater than or equal to *Y*, then cusum equals *Z* and the process is out of control. Use the 'out-of-control' chart.

B.2.6 The directions for determining cusum values on 'out-of-control' charts shall be as follows:

a) if sum is greater than *Y* and less than or equal to *Z*, then cusum equals sum;

b) if sum is less than or equal to *Y*, then cusum equals 0 and the process is now back in control. Use the 'in-control' chart.

B.2.7 The following actions shall be taken.

If the cusum charts indicate that the production is in control then the timber may be released for delivery.

If the manufacturer wishes to maximize grade yields, the grade-boundary settings may be adjusted in increments of 5 % or less. After each adjustment, results from 12 five-specimen samples shall be tested and entered on the cusum charts which shall indicate that the production remains in control.

If the cusum charts indicate that the production is out of control, then all timber represented by that sample shall be held pending results of confirmation tests as set out below.

Upon determining that the production is out of control, the grading machine shall be checked for basic calibration and accuracy of grade settings. The proof load test equipment shall be checked for accurate calibration.

Following machine and test-equipment checks, the manufacturer shall undertake one of the following actions.

a) No machine adjustment. If no adjustment is made the manufacturer shall select 30 specimens from production by choosing every third piece, sequentially numbered in six samples of five specimens each. Tests shall be made in accordance with 7.2.2. When control charts indicate that production is in control, after one or more of the six samples have been tested and evaluated the production may continue and the graded timber may be released for delivery. If the control charts indicate that the process is still out of control, the manufacturer shall proceed to either b) or c).

b) setting adjustment of 5 % or less. If a single 5 % or less adjustment is made, the manufacturer shall select 30 specimens representative of production following the adjustment by choosing every third piece, sequentially numbered in six samples of five specimens each. Tests shall be made in accordance with 7.2.2. If, after the adjustment, the control charts indicate that production is in control, after one or more of the six samples have been evaluated, the production may continue and the graded timber may be released for delivery. If the control charts indicate that the process is still out of control, the operator shall proceed to c).

c) setting adjustment of greater than 5 %. If machine settings are adjusted by more than 5 %, then the grade marks on the graded timber being held shall be obliterated.

The production process shall only be considered back in control after appropriate steps have been taken to correct the process and a subsequent test (in accordance with B.2.2) of 30 pieces representative of production, selected as every third piece to give six samples of five specimens, shows the process to be in control. After this action, the quality-control sampling rate shall be doubled for the first three working shifts.

B.2.8 Graphs of the cusum values shall be drawn to provide an overall representation of how the production is fluctuating over long periods of time.

NOTE A graph of the example of Annex C is given in Figure C.1.

Annex C
(informative)

Example of cusum control charts

The following procedure should be followed to produce the cusum charts. Examples are given in Tables C.1, and C.2 and in Figure C.1.

At the heading of the chart enter the following:

a) size, species, grade and tolerance class (from EN 336);

b) values for F_p, K, Y and Z from 7.2.2 and 7.2.3;

c) machine settings used and the date and shift in the first column.

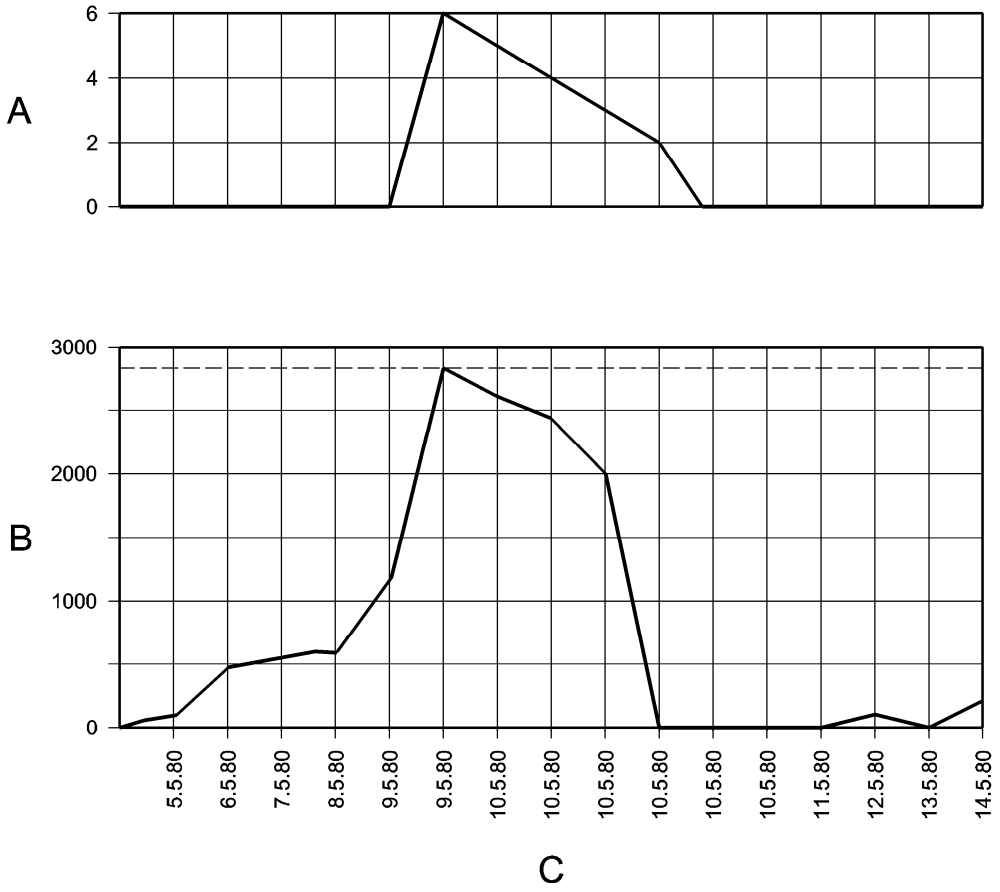
Lines 1 to 5	Enter E_p values for the five test specimens (see B.2.2).
Line 6	Enter the mean value from lines 1 to 5.
Line 7	Enter the cusum value from the previous column. If no previous column exists for this species/grade/size combination, then cusum is 0.
Line 8	Enter K for mean modulus of elasticity.
Line 9	Enter the sum of lines 7 and 8.
Line 10	Enter the mean value of E_p from line 6.
Line 11	Enter sum by subtracting line 10 from line 9.
Line 12	Enter cusum determined from sum and B.2.5 (or B.2.6 for out-of-control chart).
Line 13	Enter a tick if process is in control, otherwise write ‘no’ (see B.2.5 and B.2.6).
Lines 14 to 18	If a test piece failed during proof loading, write the failure load, otherwise add a tick.
Line 19	Enter the number of failures.
Line 20	Enter the cusum value from the previous column.
Line 21	Enter the sum of lines 19 and 20.
Line 22	Enter K for bending strength.
Line 23	Enter sum by subtracting line 22 from line 21.
Line 24	Enter cusum determined from sum and B.2.5 (or B.2.6 for out-of-control chart).
Line 25	Enter a tick if process is in control otherwise write ‘no’ (see B.2.5 and B.2.6).

Table C.1 – Example of cusum control form (in control)

Size (35 x 97) mm	IN CONTROL CHART							*K*	*Y*	*Z*	
	Species: Spruce		Grade: XX				Mean *E*	10215	1336	2812	
*F*p: 3 898	Tolerance class: 2						Bending strength	1	1	6	
Machine Settings											
Date	5/5/10	6/5/10	7/5/10	8/5/10	9/5/10	10/5/10	11/5/10	12/5/10	13/5/10	14/5/10	
Shift	Day	Day	Day	Day	Day	Day	Day	Day	Day	Day	
*E*d value	10 632	10 432	10 710	9 735	10 220	9 206	9 962	7 510	8 626	10 312	1
*E*d value	9 529	9 304	9 601	10 680	9 110	10 280	1 0424	10 425	10 917	7 846	2
*E*d value	10 011	12 842	10 100	10 240	9 632	6 690	1 0681	12 681	12 467	11 567	3
*E*d value	9 873	6 700	9 890	9 910	9 465	12 490	1 0310	10 276	9 832	9 341	4
*E*d value	10 356	10 123	10 460	10 390	9 915	9 976	1 1262	9 987	11 428	10 878	5
Mean *E*d	10 080	9 880	10 152	10 191	9 668	9 728	1 0527	10 175	10 653	9 988	6
Last cusum	0	135	470	533	557	1 104	0	0	40	0	7
K	+10 215	+10 215	+10 215	+10 215	+10 215	+10 215	+10 215	+10 215	+10 215	+10 215	8
Subtotal	10 215	10 350	10 685	10 748	10 772	11 319	10 215	10 215	10 255	10 215	9
Mean *E*d	-10 080	-9 880	-10 152	-10 191	-9 668	-9 728	-10 527	-10 175	-10 653	-9 988	10
Sum	135	470	533	557	1 104	1 591	-312	40	-398	227	11
Cusum	135	470	533	557	1 104	2 812	0	40	0	227	12
In control ?	yes	yes	yes	yes	yes	No	yes	yes	yes	yes	13
Test result	✓	✓	✓	✓	✓	3 672	✓	✓	✓	✓	14
Test result	3 820	✓	✓	✓	✓	✓	✓	✓	✓	3 563	15
Test result	✓	✓	✓	✓	✓	3 504	✓	✓	✓	✓	16
Test result	✓	3 796	3 805	✓	✓	✓	✓	✓	✓	✓	17
Test result	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	18
No. failed	1	1	1	0	0	2	0	0	0	1	19
Last cusum	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	20
Subtotal	1	1	1	0	0	2	0	0	0	1	21
K	1	1	1	1	1	1	1	1	1	1	22
Sum	0	0	0	-1	-1	+1	-1	-1	-1	0	23
Cusum	0	0	0	0	0	6	0	0	0	0	24
In control ?	yes	yes	yes	yes	yes	No	yes	yes	yes	yes	25
Operator											

Table C.2 – Example of cusum control form (out of control)

Size (35 x 97) mm	OUT OF CONTROL CHART							*K*	*Y*	*Z*	
	Species: Spruce						Mean *E*	10 215	1 336	2 812	
*F*p: 3898	Tolerance class: 2						Bending strength	1	1	6	
Machine settings											
Date	10/5/10	10/5/10	10/5/10	10/5/10	10/5/10	10/5/10					
Shift	Day	Day	Day	Day	Day	Day					
*E*d value	10 825	9 900	10 408	11 868	10 654	10 322					1
*E*d value	10 131	11 123	10 890	12 242	10 523	10 426					2
*E*d value	10 462	10 504	10 670	11 126	10 142	10 016					3
*E*d value	10 326	10 415	10 458	10 862	10 425	10 563					4
*E*d value	10 290	10 328	10 394	10 531	10 290	10 728					5
Mean *E*d	10 406	10 454	10 578	11 323	10 406	10 410					6
Last cusum	2 812	2 621	2 382	2 019	0	0					7
K	+10 215	+10 215	+10 215	+10 215	+10 215	+10 215					8
Subtotal	13 027	12 836	12 597	12 234	10 215	10 215					9
Mean *E*d	-10 406	-10 454	-10 578	-11 323	-10 406	-10 410					10
Sum	2 621	2 382	2 019	911	-101	-195					11
Cusum	2 621	2 382	2 019	0	0	0					12
In control ?	No	No	No	yes	yes	yes					13
Test result	✓	✓	✓	✓	✓	✓					14
Test result	✓	✓	✓	✓	✓	✓					15
Test result	✓	✓	✓	✓	✓	✓					16
Test result	✓	✓	✓	✓	✓	✓					17
Test result	✓	✓	✓	✓	✓	✓					18
No. failed	0	0	0	0	0	0					19
Last cusum	+6	+5	+4	+3	+2	+0					20
Subtotal	6	5	4	3	2	0					21
K	1	1	1	1	1	1					22
Sum	5	4	3	2	1	-1					23
Cusum	5	4	3	2	0	0					24
In control ?	No	No	No	No	yes	yes					25
Operator											



Key

A = Cusum for bending strength

B = Cusum for mean modulus of elasticity

C = Date

Figure C.1 – Cusum chart of data from Tables A.1 and A.2

Bibliography

[1] EN 336, *Structural timber — Sizes, permissible deviations*

[2] EN 338, *Structural timber — Strength classes*

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