STRENGTH GRADING OF TIMBER IN THE UK IN 2018

Dan Ridley-Ellis

Centre for Wood Science & Technology, Edinburgh Napier University (UK)
& secretary of CEN TC124 WG2 TG1 "task group for machine grading settings & visual grading assignments for EN1912"

SUMMARY

This paper summarises the state-of-the-art of strength grading of UK-grown timber. It lists the following information along with the primary references: visual grading grades and strength class assignments; grading machines with approved settings for machine control; the species, size ranges and strength class combinations covered; and grade determining properties of UK specific strength classes.

KEYWORDS: grades, classes, machine strength grading, visual strength grading

INTRODUCTION

In the UK, structural timber is graded under the system set out by the harmonised European standard EN14081-1:2016 and supporting standards. It sorts rectangular cross-section timber into categories based on required characteristic values of grade determining properties. For normal construction timber those are usually bending strength, bending stiffness and density (at 12% reference moisture content). Strength and density are specified as fifth percentiles and stiffness by the mean. Secondary properties are calculated from equations in EN384:2016 (or may be determined by testing). At time of writing EN14081-1:2016 is not yet cited in the OJEU and an amendment is underway to resolve this, but this does not affect the content of this paper. This is related to a misunderstanding that new (and already existing, but newly mentioned) strength classes are limitations, when in truth they are more options for industry.

This paper covers the position as of May 2018 and is for information only. The primary references should be consulted, noting that new assignments and settings can be added, existing ones can be changed, and even the definition of EN336 strength classes may change. The machine grading reports are confidential, but the reference number helps to identify the settings table. Contact machine manufacturer or a Notified Body to obtain more information.

CURRENT GRADING POSSIBILITIES

There are two parallel systems for grading: visual and machine, both of which follow the same basis: timber is sorted into grades according to a non-destructive assessment that is predictive of the grade determining properties, and the collective characteristic properties of the timber sorted into those grades determines the strength class (see Ridley-Ellis *et al.* 2016a for a more detailed explanation). Strength class is usually specified with reference to EN338:2016, but properties can be declared directly, or by means of a user-defined strength class. The latter is convenient when grading as part of a fabrication process, or for a specific customer, since it makes better use of the real properties of the graded timber (see Ridley-Ellis *et al*. 2016b for discussion of the potential for this, and illustration with UK grown timber). The definition of UK specific strength classes is repeated in Table 5. TR26 is in longstanding common usage in the trussed rafter industry in the UK. The other strength classes are new. Species are commonly grouped for grading, and the individual species not differentiated (see Table 2).

Visual grading is carried out according to grading rules that are usually (but do not have to be) national standards. Assignment to a strength class is specific to a combination of grading standard and timber source. The assignments for UK grown timber are listed in Table 3 and Table 4.

Table 1: Definition of UK specific strength classes (reference moisture content is 12%)

Class	5^{th} percentile strength (N/mm^2)	Mean stiffness (kN/mm^2)	5^{th} percentile density (kg/m^3)	Reference (first report to use)
	Bending			
TR26	28.3	11.0	370	EN14081-4:2009
C16+	18.5	8.0	330	TG1/201410/34rev
NapierSA	25.0	11.0	375	TG1/201703/27rev
NapierSB	22.0	10.0	360	
NapierSC	16.0	8.0	320	
NapierSD	15.0	7.0	310	
NapierLA	30.0	13.0	480	TG1/201703/26rev
NapierLB	28.0	12.0	440	
NapierLC	21.0	9.0	400	
NapierLD	20.0	8.0	390	
NapierDA	35.0	13.0	460	TG1/201804/25
NapierDB	30.0	12.0	460	
NapierDC	16.0	10.0	400	
NapierDD	14.0	9.0	400	

Table 2: Species (see also EN13556:2016)

Group	Common name	Botanical name	Reference
British spruce WPCS	Sitka spruce PCST	*Picea sitchensis*	EN14081-1:2016 (§B2)
	Norway spruce PCAB	*Picea abies*	
British pine WPNN	Scots pine PNSY	*Pinus sylvestris*	EN14081-1:2016 (§B2)
	Corsican pine PNNL	*Pinus nigra laricio*	
Larch WLAD	European larch LADC	*Larix decidua*	EN14081-1:2016 (§B2)
	Hybrid larch LAER	*Larix x eurolepsis*	
	Japanese larch LAKM	*Larix kaempferi*	
Douglas-fir	Douglas-fir PSMN	*Pseudotsuga menziesii*	EN13556:2003 (Tab2)
Oak	European oak QCXE	Quercus petraea	EN13556:2003 (Tab1)
		Quercus robur	
Sweet chestnut	Sweet chestnut CTST	*Castanea sativa*	EN13556:2003 (Tab1)

Machine grading can be by machine control or output control. Output control requires the producer to periodically test batches of graded timber and, if necessary (by statistical procedures), adjust the grading machine settings to ensure grading proceeds correctly and efficiently. This method is not common in Europe, but it allows the use of any grading machine that meets the general requirements of EN14081. The much more common method is machine control, where settings are determined by previous testing and the grading machines of a certain model are expected to have identical performance. These settings are examined and approved by European Committee for Standardization (CEN) committee

TC124/WG2/TG1 ("TG1"), which consists of a panel of experts with sufficient experience to be able to identify potential problems separate from simple compliance with the standards. See http://blogs.napier.ac.uk/cwst/tg1/ for the latest additional rules and guidelines from TG1.

Table 3: Visual grading assignments when grading with BS 4978

Species	Source	Visual grade	Strength class	Reference
British spruce	UK	GS	C14	EN1912:2012 (§6)
		SS	C18	EN1912:2012 (§6)
British pine	UK	GS	C14	EN1912:2012 (§6)
		SS	C22	EN1912:2012 (§6)
Larch	UK	GS	C16	EN1912:2012 (§6)
		SS	C24	EN1912:2012 (§6)
Douglas-fir	UK	GS	C14	EN1912:2012 (§6)
		SS	C18	EN1912:2012 (§6)
		SS*	C24	PD6693-1:2012 (§6.2)

* cross-section area >20,000 mm^2, width and thickness ≥ 100 mm

Table 4: Visual grading assignments when grading with BS 5756

Species	Source	Visual grade	Strength class	Reference
Oak	UK	TH2	D24	PD6693-1:2012 (§6.1)
		TH1	D30	PD6693-1:2012 (§6.1)
		THB*	D30	PD6693-1:2012 (§6.1)
		THA*	D40	PD6693-1:2012 (§6.1)
Sweet chestnut	UK	TH1	D24	PD6693-1:2012 (§6.1)

* cross-section area >20,000 mm^2, width and thickness ≥ 100 mm

Machines currently approved for machine control grading are listed in Table 7 and currently available settings for UK grown timber are listed in Table 8 (spruce) Table 9 (pine) Table 10 (larch) and Table 11 (Douglas-fir). Settings for larch and Douglas-fir are expected for the Precigrader in the near future, as are settings for tiling batten sized spruce for Microtec and Brookhuis machines. Note that machine grading is a separate route from visual grading, and parameters like knot size and ring width are not inherent in the definition of the strength classes, which are concerned with the actual characteristic properties. Note also that the United Kingdom is officially GB in ISO3166-1:2014, but sometimes appears in standards and settings tables as UK. UK is used in this paper as the more familiar abbreviation.

CONCLUDING REMARKS

Timber grading in Europe is fast developing, with new machines, updating of standards and processes, and new visual grading assignments and machine grading settings added regularly. There are grading machine settings for UK grown timber that exceed both the common expectation, and the current industrial practice. As machine grading becomes more accessible to building fabricators it opens up more potential for wider, and more efficient, use of the domestic forest resource. Not all the permitted settings have commercially viable yields.

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Table 5: List of grading machines for machine control

Manufacturer	Name	ID*	Description
Tecmach Ltd	Cook Bolinder	1	Mechanical bending
	Computermatic Micromatic	2	Mechanical bending
VTT	Raute Timbergrader	3	Mechanical bending
Microtec s.r.l. – GmbH	EuroGrecomat-702	4	X-ray
	Goldeneye 702	5	X-ray
	EuroGrecomat-704	6	X-ray & mechanical bending
	Viscan	8	Longitudinal resonance
	EuroGrecomat-706	9	X-ray with longitudinal resonance
	Goldeneye 706	10	X-ray with longitudinal resonance
	Viscan Plus	20	Longitudinal resonance with x-ray density
	Viscan Compact	22	Longitudinal resonance with density
	Viscan portable with balance	29	Portable, longitudinal resonance with density
	Viscan portable	30	Portable, longitudinal resonance
Dynalyse AB	Dynagrade	7	Longitudinal resonance
	Precigrader	12	Longitudinal resonance with density
Brookhuis Applied Technologies BV	MTG 960	11	Portable, longitudinal resonance with density
	MTG 920	19	Portable, longitudinal resonance
	MTGbatch 962/966	23	Longitudinal resonance with density
	MTGbatch 922/926	24	Longitudinal resonance
Dimter GmbH	Grademaster	13	Longitudinal resonance with density & knots
Luxscan technologies (now Weinig Group)	Escan FWM/FW	14	Longitudinal resonance with density
	EScan FM/F	26	Longitudinal resonance
	OptiStrength XE	33	X-ray with longitudinal resonance
	OptiStrength X	34	X-ray
Concept Bois Structure SARL	Triomatic	15	Ultrasonic time of flight & pin indentation density
Automatisation J.R.T Inc	CRP	16	Mechanical bending
XYLOMECA	Xyloclass T	17	Longitudinal resonance with density
	Xyloclass F	21	Flexural resonance with density
SARL Esteves	Noesys	18	Flexural resonance with density
Rosén & Co Maskin	Rosgrade	25	Longitudinal resonance
	Rosgrade plus	28	Longitudinal resonance with density
Innodura	E-CONTROL model AC	27	Longitudinal resonance with density
Innovativ Vision AB	WoodEye Strength Grader	31	Longitudinal resonance with density & laser tracheid grain angle
RemaSawco AB	RS Strength Grader	32	Laser tracheid grain angle
Ilkon	STIG	35	Longitudinal resonance

* ID relates to the TG1 machine number for naming the ITT reports (settings tables)

Table 6: Machine settings for British spruce WPCS (Picea sitchensis, P. abies)

Source	Size (mm) & *report by*	Combinations	[Machine] & *table*	Reference
UK IE	35-75 x 60-300 *Timbersolve*	[C24/C16] [C18] [C16]	[1]-*1*	TG2/0801/03 TG1/0211/15
UK IE	35-75 x 60-300 *Timbersolve*	[C24/C16] [C18] [C16]	[2]-*1*	TG2/0801/03 TG1/0211/15
UK IE	35-80 x 70-260 *HFM*	[C24/C16] [C16]	[5]-*1* also [10]	EN14081-4:2009 TG1/1005/08
UK IE	35-82 x 57-275 *Napier Uni*	[C24/C16] [C22/C14] [C18] [C16]	[5]-*17* also [10]	TG1/0211/13rev
UK IE	20-83 x 47-275 (*A) *Napier Uni*	[C24/C16] [C22/C14] [C18] [C16] [C16+]	[5]-*34* also [10]	TG1/201410/38rev1
UK IE	34-83 x 57-275 *Napier Uni*	[C24/C16] [C22/C14] [C20/C14] [C18] [C16] [C24/C16+] [C16+]	[5]-*48* also [10]	TG1/201703/21rev
UK IE	35-82 x 57-275 *Napier Uni*	[C22/C14] [C18] [C16]	[8]-*18* *also [10] [20] [22]*	TG1/0211/10rev
UK IE	20-83 x 47-275 (*A) *Napier Uni*	[C22/C14] [C18] [C16] [C16+]	[8]-*32* *also [10] [20] [22]*	TG1/201410/35
UK IE	34-83 x 57-275 *Napier Uni*	[C24/C16] [C22/C14] [C20/C14] [C18] [C16] [C24/C16+] [C16+]	[8]-*45* *also [10] [20] [22]*	TG1/201703/25rev
UK IE	35-82 x 57-275 *Napier Uni*	[C27/C16] [C24/C16] [C22/C14] [C18] [C16] [TR26/C16]	[10]-*22*	TG1/0211/14rev
UK IE	20-83 x 47-275 (*A) *Napier Uni*	[C27/C16] [C24/C16] [C22/C14] [C18] [C16] [TR26/C16] [C16+]	[10]-*43*	TG1/201410/39
UK IE	34-83 x 57-275 *Napier Uni*	[C27/C16] [C24/C16] [C22/C14] [C20/C14] [C18] [C16] [C27/C16+] [TR26/C16] [TR26/C16+] [C24/C16+] [C16+]	[10]-*58*	TG1/201703/22rev
UK IE	35-82 x 57-275 *Napier Uni*	[C24/C16] [C22/C14] [C18] [C16]	[20]-*6* *also [10]*	TG1/0211/12rev
UK IE	20-83 x 47-275 (*A) *Napier Uni*	[C24/C16] [C22/C14] [C18] [C16] [C16+]	[20]-*25* *also [10]*	TG1/201410/37
UK IE	34-83 x 57-275 *Napier Uni*	[C27/C16] [C24/C16] [C22/C14] [C20/C14] [C18] [C16] [C27/C16+] [TR26/C16] [TR26/C16+] [C24/C16+] [C16+]	[20]-*39* *also [10]*	TG1/201703/24rev
UK IE	35-82 x 57-275 *Napier Uni*	[C24/C16] [C22/C14] [C18] [C16]	[22]-*4* *also [10]*	TG1/0211/11rev
UK IE	20-83 x 47-275 (*A) *Napier Uni*	[C24/C16] [C22/C14] [C18] [C16] [C16+]	[22]-*24* *also [10]*	TG1/201410/36
UK IE	34-83 x 57-275 *Napier Uni*	[C27/C16] [C24/C16] [C22/C14] [C20/C14] [C18] [C16] [C27/C16+] [TR26/C16] [TR26/C16+] [C24/C16+] [C16+]	[22]-*37* *also [10]*	TG1/201703/23rev
UK IE	34-83 x 57-275 *Napier Uni*	[C24/C16] [C22/C14] [C20/C14] [C18] [C16] [TR26/C16] [TR26/C16+] [C24/C16+]	[29]-*20* *also [10] [22]*	TG1/201703/23rev

UK IE	34-83 x 57-275 *Napier Uni*	[C22/C14] [C18] [C16]	[29]-*20* *also [8] [10] [20] [22]*	TG1/201703/25rev
UK IE	34-83 x 57-275 *FCBA*	[C27/C18] [C27/C16] [C24/C16] [C24] [C18] [C16] [TR26/C16] [TR26]	[12]-*9*	TG1/1011/11rev
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C24/C16] [C22/C14] [C20] [C18] [C16]	[11]-*13*	TG1/201410/34rev
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C18] [C16]	[11]-*14*	TG1/201410/40rev for green timber
UK IE	34-84 x 84-168 *Napier Uni*	[C27/C16] [C24/C16] [C22/C14] [C20] [C18] [C16] [NapierSA/NapierSC] [NapierSB/NapierSD]	[11]-*18*	TG1/201703/27rev
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C18] [C16] (correction of [11]-*14*)	[11]-*22*	TG1/201410/40rev for green timber
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C20] [C18] [C16]	[19]-*10*	TG1/201410/33rev
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C24/C16] [C24/C14] [C22/C14] [C22] [C20] [C18] [C16] [C16+]	[23]-*13*	TG1/201410/34rev
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C22] [C20] [C18] [C16]	[23]-*14*	TG1/201410/40rev for green timber
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C22] [C20] [C18] [C16] (correction of [23]-*14*)	[23]-25	TG1/201410/40rev for green timber
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C22/C14] [C20] [C18] [C16]	[24]-*10*	TG1/201410/33rev
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C24/C16] [C24/C14] [C22/C14] [C22] [C20] [C18] [C16] [C16+]	[14]-*14*	TG1/201410/34rev
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C22] [C20] [C18] [C16]	[14]-*15*	TG1/201410/40rev for green timber
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C22] [C20] [C18] [C16] (correction of [14]-*15*)	[14]-*26*	TG1/201410/40rev for green timber
UK IE	20-83 x 47-165 (*A) *Napier Uni*	[C22/C14] [C18] [C16]	[26]-*10*	TG1/201410/33rev

*A: Minimum cross-section area ≥ 1600mm^2

Table 7: Machine settings for British pine WPNN (Pinus sylvestris, P. nigra laricio)

Source	Size (mm) & *report by*	Combinations	[Machine] & *table*	Reference
UK IE	35-75 x 60-300	[C24/C16] [C16]	[1]-*1*	EN14081-4:2009 TG2/0801/03
UK IE	35-75 x 60-300	[C24/C16] [C16]	[2]-*1*	EN14081-4:2009 TG2/0801/03

Table 8: Machine settings for larch WLAD (Larix decidua, L. x eurolepsis, L. kaempferi)

Source	Size (mm) & *report by*	Combinations	[Machine] & *table*	Reference
UK	43-82 x 92-250 *Timbersolve*	[C27/C16] [C18] [C16]	[1]-*4*	TG2/0801/03 TG1/0511/02
UK	43-82 x 92-250 *Timbersolve*	[C27/C16] [C18] [C16]	[2]-*5*	TG2/0801/03 TG1/0511/02
UK	20-110 x 47-303 (*A) *Napier Uni*	[C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[5]-*31* also [10]	TG1/201410/21rev1
UK	20-110 x 47-303 (*A) *Napier Uni*	[C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[8]-*29* *also [10] [20] [22]*	TG1/201410/18
UK	20-110 x 47-303 (*A) *Napier Uni*	[C35/C18] [C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[10]-*39*	TG1/201410/22
UK	20-110 x 47-303 (*A) *Napier Uni*	[C35/C18] [C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[20]-*22* *also [10]*	TG1/201410/20
UK	20-110 x 47-303 (*A) *Napier Uni*	[C35/C18] [C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[22]-*21* *also [10]*	TG1/201410/19
UK	20-110 x 47-303 (*A) *Napier Uni*	[C35/C18] [C30/C16] [C27/C16] [C24/C14] [C20] [TR26/C16]	[29]-*11* *also [10] [22]*	TG1/201410/23
UK	20-110 x 47-303 (*A) *Napier Uni*	[C35/C18] [C30/C16] [C27/C16] [C24/C14] [C20] [TR26/C16]	[30]-*9* *also [8] [10] [20] [22]*	TG1/201410/23
UK	20-110 x 47-303 (*A) *Napier Uni*	[C30/C16] [C27/C16] [C24/C14] [C22] [C20] [TR26/C16]	[11]-*12*	TG1/201410/32
UK	42-112 x 88-307 *Napier Uni*	[C35/C18] [C30/C16] [C27/C16] [C24/C14] [C22] [C20] [NapierLA/NapierLC] [NapierLB/NapierLD]	[11]-*19*	TG1/201703/26rev
UK	20-110 x 47-303 (*A) *Napier Uni*	[C30/C16] [C27/C16] [C24/C14] [C22] [C20] [TR26/C16]	[19]-*9*	TG1/201410/31rev
UK	20-110 x 47-303 (*A) *Napier Uni*	[C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[23]-*15*	TG1/201410/32
UK	20-110 x 47-303 (*A) *Napier Uni*	[C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[24]-*9*	TG1/201410/31rev
UK	20-110 x 47-303 (*A) *Napier Uni*	[C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[14]-16	TG1/201410/32
UK	20-110 x 47-303 (*A) *Napier Uni*	[C30/C16] [C27/C16] [C24/C14] [C22] [TR26/C14]	[26]-9	TG1/201410/31rev

*A: Minimum cross-section area ≥ 2000mm^2

Table 9: Machine settings for Douglas-fir PSMN (Pseudotsuga menziesii)

Source	Size (mm) & *report by*	Combinations	[Machine] & *table*	Reference
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C35/C18] [C35/C16] [C30/16] [C27/16] [C24/C16] [C24/14] [C22/C14] [C20/C14] [C20] [C18] [C16] [TR26/C16]	[5]-*?* also [10]	TG1/201804/16
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C30/16] [C27/16] [C24/C16] [C24/14] [C22/C14] [C20/C14] [C20] [C18] [C16] [TR26/C16]	[8]-*?* *also [10] [20] [22]*	TG1/201804/17rev1
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C40/C30/C16] [C40/C27/C16] [C40/C24/C16] [C35/18] [C35/16] [C30/16] [C27/16] [C24/C16] [C24/14] [C22/C14] [C20/C14] [C20] [C18] [C16] [TR26/C16]	[10]-*?*	TG1/201804/13rev1
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C40/C30/C16] [C40/C27/C16] [C40/C24/C16] [C35/18] [C35/16] [C30/16] [C27/16] [C24/C16] [C24/14] [C22/C14] [C20] [C18] [C16] [TR26/C16]	[20]-*?* *also [10]*	TG1/201804/15
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C40/C30/C16] [C40/C27/C16] [C40/C24/C16] [C35/18] [C35/16] [C30/16] [C27/16] [C24/C16] [C24/14] [C22/C14] [C20] [C18] [C16] [TR26/C16]	[22]-*?* *also [10]*	TG1/201804/14
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C40/C30/C16] [C40/C27/C16] [C40/C24/C16] [C35/18] [C35/16] [C30/16] [C27/16] [C24/C16] [C24/14] [C22/C14] [C20/C14] [C20] [C18] [C16] [C14] [TR26/C16]	[29]-*?* *also [10] [22]*	TG1/201804/14
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C30/16] [C27/16] [C24/C16] [C24/14] [C22/C14] [C20/C14] [C20] [C18] [C16] [C14] [TR26/C16]	[30]-*?* *also [8] [10] [20] [22]*	TG1/201804/17rev1
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C35/C16] [C24/C14] [TR26/C16] [NapierDA/NapierDC] [NapierDB/NapierDD]	[11]-*?*	TG1/201804/25
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C35/C16] [C24/C14] [TR26/C16]	[19]-*?*	TG1/201804/25
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C35/C16] [C24/C14] [TR26/C16] [NapierDA/NapierDC] [NapierDB/NapierDD]	[23]-*?*	TG1/201804/25
UK IE	33-84 x 68-248 *Napier Uni & NUI Galway*	[C35/C16] [C24/C14] [TR26/C16]	[24]-*?*	TG1/201804/25

Note: ITT tables are not yet updated, so numbers are not available at time of writing

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Contact machine manufacturer or a Notified Body to obtain more information about grading settings tables, their limitations and yields. Please report any errors in this summary to d.ridleyellis@napier.ac.uk