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ROUTE TO EUROPEAN STRENGTH CLASSES FOR MALAYSIAN TIMBERS

Mohd-Jamil AW

INTRODUCTION

The European standard for the classification of structural timbers is given in a table of strength classes as presented in EN 338. The standard provides a ranking of timbers based on some mechanical properties, i.e. C14 to C50 for softwood species, D18 to D70 for hardwood species (Table 1). Each class is designated by a number indicating the value of bending strength. A strength class of EN 338 groups timbers of species-grade combinations that are having similar strength properties. Additional species or grades can be incorporated into the system at any time without affecting the existing classification.

Properties that determine the corresponding strength class are expressed as "characteristic values". Characteristic values shall be derived from the results of bending test of structural size specimens. The system of strength classes permits engineers to specify a chosen strength class and use the characteristic values of that class in structural design calculation. Engineers can simply design based on the strength, stiffness and density values of a particular class and to select the most suitable and economic species and grade. Conversely, suppliers can offer alternative material to meet the specifications if the intended strength class is specified.

In general, there are two ways to incorporate a Malaysian timber species into the European strength class system: one is to conduct the destructive structural size bending test, or, the other means is to manipulate the existing data of small clear specimen bending test. EN 384 permits the derivation of characteristic values for hardwood species through conversion of small clear specimen test results, provided that the relationship between the two sets of data is statistically proven. This article presents route maps to demonstrate the way forward for incorporating the Malaysian timbers in the European strength class system.

ALLOCATION OF A TIMBER SPECIES TO EN STRENGTH CLASS – METHOD 1 (STRUCTURAL SIZE TEST)

The population of a timber is the material for which the associated characteristic values are relevant now or in the future. A population can be defined as a single species group. It can also be of the same genus or even from different genera. Or, it can also be defined as a group that matches the normal pattern of supply. Either way, a population is a single grade timbers and allocated to a single strength class. In order to determine the corresponding strength class, test samples are selected and tested to provide a good representation of the variability in that population.

Every structural size specimen must be visually graded before test for the data to be useful. The Malaysian grading rules for timber (MS 1714) provides measuring techniques and limits for strength reducing characteristics. The standard classifies timber into three strength grades – Select Structural Grade (SSG), Standard Structural Grade (ASG) and Common Building Grade (CBG). Malaysian graders are familiar with the rules for these grades, therefore it is best not to introduce a new set of rules (Mansfield-Williams 2010).

Table 1 The characteristic values of strength, stiffness and density for strength classes (EN 338)

		Softwood species												Hardwood species							
		C14	C16	C18	C20	C22	C24	C27	C30	C35	C40	C45	C50	D18	D24	D30	D35	D40	D50	D60	D70
Strength properties (in N/mm^2)																					
Bending	$f_{m,k}$	14	16	18	20	22	24	27	30	35	40	45	50	18	24	30	35	40	50	60	70
Tension parallel	$f_{t,0,k}$	8	10	11	12	13	14	16	18	21	24	27	30	11	14	18	21	24	30	36	42
Tension perpendicular	$f_{t,90,k}$	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6
Compression parallel	$f_{c,0,k}$	16	17	18	19	20	21	22	23	25	26	27	29	18	21	23	25	26	29	32	34
Compression perpendicular	$f_{c,90,k}$	2,0	2,2	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3,1	3,2	7,5	7,8	8,0	8,1	8,3	9,3	10,5	13,5
Shear	$f_{v,k}$	3,0	3,2	3,4	3,6	3,8	4,0	4,0	4,0	4,0	4,0	4,0	4,0	3,4	4,0	4,0	4,0	4,0	4,0	4,5	5,0
Stiffness properties (in kN/mm^2)																					
Mean modulus of elasticity parallel	$E_{0,mean}$	7	8	9	9,5	10	11	11,5	12	13	14	15	16	9,5	10	11	12	13	14	17	20
5 % modulus of elasticity parallel	$E_{0,05}$	4,7	5,4	6,0	6,4	6,7	7,4	7,7	8,0	8,7	9,4	10,0	10,7	8	8,5	9,2	10,1	10,9	11,8	14,3	16,8
Mean modulus of elasticity perpendicular	$E_{90,mean}$	0,23	0,27	0,30	0,32	0,33	0,37	0,38	0,40	0,43	0,47	0,50	0,53	0,63	0,67	0,73	0,80	0,86	0,93	1,13	1,33
Mean shear modulus	G_{mean}	0,44	0,5	0,56	0,59	0,63	0,69	0,72	0,75	0,81	0,88	0,94	1,00	0,59	0,62	0,69	0,75	0,81	0,88	1,06	1,25
Density (in kg/m^3)																					
Density	ρ_k	290	310	320	330	340	350	370	380	400	420	440	460	475	485	530	540	550	620	700	900
Mean density	ρ_{mean}	350	370	380	390	410	420	450	460	480	500	520	550	570	580	640	650	660	750	840	1080

NOTE 1 Values given above for tension strength, compression strength, shear strength, 5 % modulus of elasticity, mean modulus of elasticity perpendicular to grain and mean shear modulus, have been calculated using the equations given in Annex A.
NOTE 2 The tabulated properties are compatible with timber at a moisture content consistent with a temperature of 20 °C and a relative humidity of 65 %.
NOTE 3 Timber conforming to classes C45 and C50 may not be readily available.
NOTE 4 Characteristic values for shear strength are given for timber without fissures, according to EN 408. The effect of fissures should be covered in design codes.

Each test population has only a single grade, e.g. SSG kulim, or ASG mengkulang. Thus, for two grades of the same species, the amount of testing will be doubled. If two or more grades are chosen for one species, there must be a sufficient resource in the market for each grade, and also a clear price range should be justified between different grades. These considerations imply that it is preferable to choose a single grade per species or per species group.

Nevertheless, irrespective of whether visual grading or mechanical grading is considered, a proportion of reject specimens may be added to the test programme. The test results of the rejects should not be included in the calculation, but they should demonstrate that the grading rules successfully exclude the weakest material (Mansfield-Williams 2010).

EN 408 is the absolute testing reference which specifies methods to determine some physical and mechanical properties of timber in structural sizes. The standard explains on the arrangements and procedures for mechanical tests such as bending and compression. In general, structural size test based on EN 408 is required to establish the bending strength, bending stiffness and density. The conditioning requirement for all test pieces is a standard environment of 20 ± 2°C and 65 ± 5% relative humidity.

A characteristic value corresponds to the lower 5th percentile or the mean value of the statistical distribution of a timber property. The lower 5th percentile is used when there is a risk of material failure, otherwise the mean value is adopted (Mansfield-Williams 2010). For example, the characteristic value of modulus of rupture refers to the lower 5th percentile while the characteristic value for modulus of elasticity is the corresponding mean value. The characteristics values of bending strength, modulus of elasticity in bending and density for a population of timber shall be calculated based on several factors in accordance with EN 384.

ALLOCATION OF A TIMBER SPECIES TO EN STRENGTH CLASS – METHOD 2 (CONVERSION FACTORS)

European standard mentions briefly on the alternative methods of determining the characteristic values of bending strength and modulus of elasticity by converting existing small clear specimens' data. However, the conversion procedure is permitted under several conditions (Mansfield-Williams 2010):

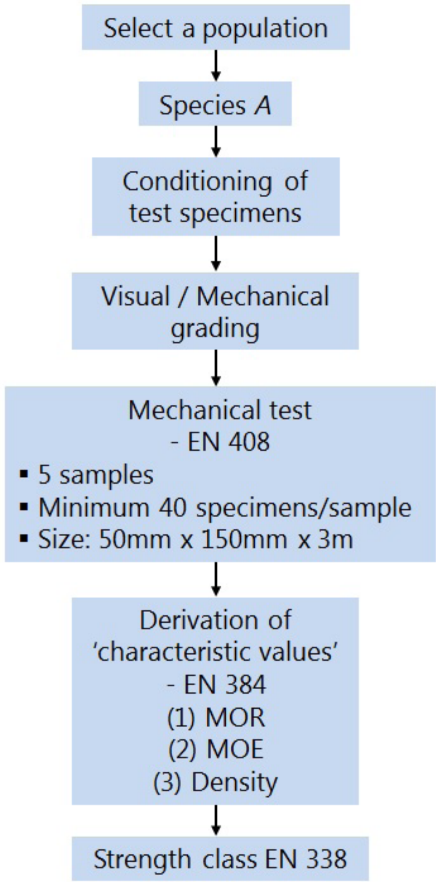
1. The method is applied only for hardwood species.

2. The conversion factor may be derived when both small clear and structural size data are available for at least three similar species.

3. For the small clear data, the number of specimen in a sample shall be at least 40 from a minimum of five trees, and the test method shall be the same in all cases.

The factors obtained will basically be in the form of ratio values and are permitted to be applied to species where only small clear specimen data exist. Characteristic values determined in this way shall be reduced by 10%.

Route Map 1 To allocate a timber species into a strength class



Remarks

- A population can be a single grade timbers of one species or narrow species group (Wong 2002), e.g. SSG kulim (*Scorodocarpus borneensis*), ASG mengkulang (*Heritiera* spp.).

- The ISO/IEC 17025 accreditation for EN 408 testing scope will be an added advantage in terms of the reliability of test results.

- The standard does not specify how samples are differentiated. Possible criteria are single cross-section size, single area within the larger area of the population, single sawmill or single supplier (Mansfield-Williams 2010).

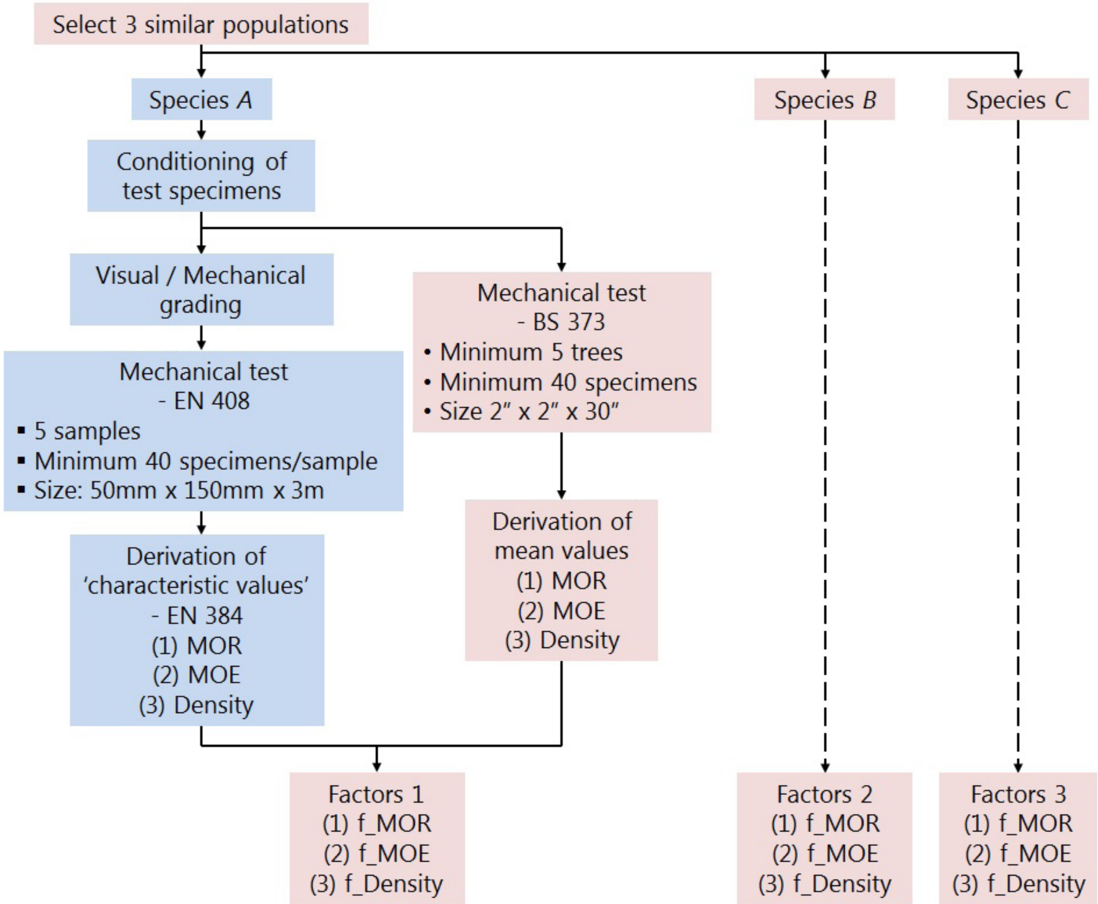
- Three reference values are required to incorporate a timber population into EN 338 strength classes system, i.e. characteristic bending strength, characteristic modulus of elasticity and density.

Current R&D

- Three indigenous timber species have been tested according to EN 408 namely penaga, kulim and sesendok. Only one sample was tested for each species.

- The capacity of Timber Engineering Laboratory, FRIM to conduct the assessment and to obtain the ISO/IEC 17025 accreditation for EN 408 scope is being considered.

Route Map 2 To derive the conversion factors



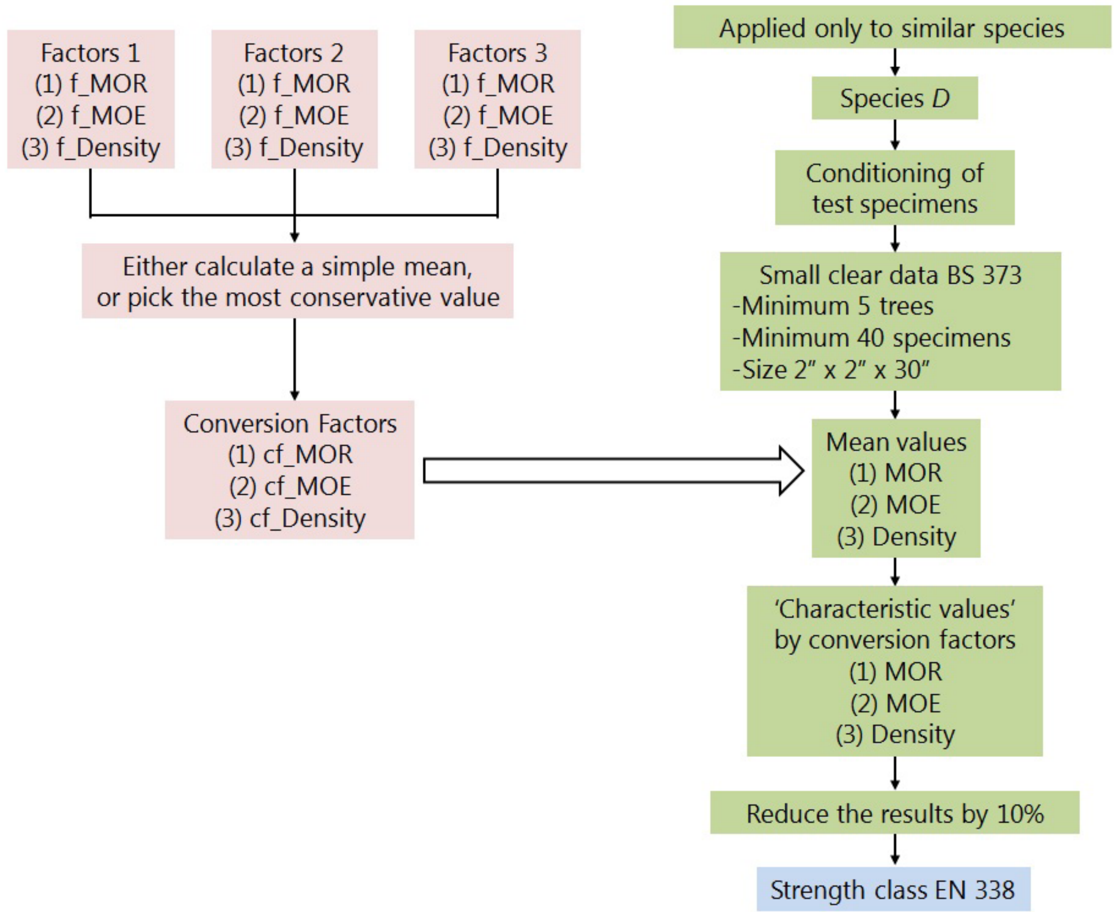
Remarks

- Data must be available for at least three similar species, e.g. similar MOR, similar SG (MS 544).
- The more number of similar groups demands for additional sets of samples.
- Data of small clear specimen test of some species were by now satisfactory (Lee et al. 1993).

Current R&D

- A statistical method of determining similar species was demonstrated by Mohd Jamil et al. (2012).
- A small number of Malaysian timber species are by now incorporated in the EN 338 classification (EN 1912). Thus, as an initial attempt, it is possible to derive several conversion factors without requiring any destructive testing.

Route Map 3 To apply the conversion factors on timbers without structural size test results



Remarks

- Three sets of data give three possible factors for each property. The standard does not state how the factor should be picked. Possibilities include a simple mean value or the most conservative value.

- Characteristic values derived through conversion factors shall be reduced by 10%.

Current R&D

- More BS 373 data of 2 inches specimen are being gathered to suit the requirement of minimum 40 specimens of at least 5 trees.

SUMMARY

In conclusion, Route Map 1 is the way forward to allocate a timber species into a strength class based on direct derivation of characteristic values from the results of bending test of structural size specimens. Route Map 2 is the method to develop conversion factors correlating bending test results of structural size and small clear specimens. Route Map 3 is the way to apply the conversion factors on timbers without structural size test results. Hopefully, these route maps will assist efforts to incorporate Malaysian timbers into the European strength class system.

REFERENCES

BS 373. 1957. Reconfirmed 2019. *Methods of Testing Small Clear Specimens of Timber*. British Standards Institution, London.

EN 338. 2016. *Structural Timber – Strength Classes*. European Committee for Standardization, Brussels.

EN 384. 2016+A1. 2018. *Structural Timber – Determination of Characteristic Values of Mechanical Properties and Density*. European Committee for Standardization, Brussels.

EN 408:2010+A1. 2012. *Timber Structures – Structural Timber and Glued Laminated Timber – Determination of Some Physical and Mechanical Properties*. European Committee for Standardization, Brussels.

EN 1912. 2012. *Structural Timber – Strength Classes – Assignment of Visual Grades and Species*. European Committee for Standardization, Brussels.

Lee YH, Engku ARC & Chu YP. 1993. *The Strength Properties of Some Malaysian Timbers*. Timber Trade Leaflet No.34. Malaysian Timber Industry Board, Kuala Lumpur.

Mansfield-Williams H. 2010. *Assistance With a Route to CE Marking for Malaysian Structural Timber.* Report TE//F10260. TRADA Technology Ltd, High Wycombe.

Mohd Jamil AW, Mohd Zamin J & Mohamad Omar MK. 2012. Statistical technique for grouping tropical timbers into similar strength groups. *Modern Applied Science* 6(3): 73–80.

MS 544. 2001. *Code of Practice For Structural Use of Timber: Part 2 – Permissible Stress Design of Solid Timber*. Department of Standards Malaysia, Putrajaya.

MS 1714. 2003. *Specification for Visual Strength Grading of Tropical Hardwood Timber*. Department of Standards Malaysia, Putrajaya.

Wong TM. 2002. *A Dictionary Of Malaysian Timbers*. Second edition. Revised by Lim SC & Chung RCK. Malayan Forest Records 30. Forest Department Peninsular Malaysia, Kuala Lumpur.

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