STRENGTH GRADING OF TIMBER IN EUROPE WITH REGARD TO DIFFERENT GRADING METHODS

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ABSTRACT

KEYWORDS: Material safety factor, Visual grading, Machine grading, Growth areas, Test procedures

1 BACKGROUND

Engineering properties of structural timber are guaranteed by grading of the raw material. Timber characteristics influencing the performance are either estimated visually or by machine. The chosen method affects the prediction quality. Knowing about the differences between and within the two methods is of high interest for several stakeholders: Grading machine producers, civil engineers, and the sawmilling industry. The knowledge about resulting properties and the share of useable material is helpful in the marketing process of machines, design processes for buildings, and managerial decisions in the industry. Besides these economic interests, effective grading procedures contribute to a sustainable use of wood.

The major part of structural timber on the European market is graded visually. While for machine graded timber European standards are commonly used, visual grading is done mainly based on national standards. The harmonized European standard for strength grading of structural timber with rectangular cross section EN 14081-1 lists some of the parameters which can influence grading results: different species or groups of species, geographic origin, different dimensional requirements, varying requirements for different uses, quality of material available, and historic influences or traditions. Substantial testing programs were carried out trying to cover these influences in order to establish machine settings and to check the applicability of visual grading standards. Today 27 machine types are approved; all major national visual grading standards can be applied. Thus all major species can be CE-marked and the accessibility to the European market is given.

The current status quo in the grading scene is unsatisfactory as different requirements for machine and visual graded timber exist. The historical development in Europe led to different rules for initial type testing or factory production control depending on the grading method. Different material characteristics for equal timber grades have to be expected.

The presented work is giving an overview of the latest developments in the field of strength grading in Europe. It is showing the effect of different grading methods on timber properties. As a second parameter yields are compared in order to judge the efficiency of the different methods. Parameters influencing the grading results are considered.

The latest developments in standardization are considered and their influence on the grading results is shown. A proposal for consistently good grading results independent of the grading method is included.

2 MATERIALS AND METHODS

Although several economically important timber species are considered, Norway spruce from Central, Eastern and Northern Europe is in the focus of the analysis. A total of 8487 spruce specimens were tested, split almost equally in bending and tension tests.

All pieces were graded visually and by machine. For visual grading the most important European grading standards DIN, BS and INSTA are used. For machine grading the dynamic modulus of elasticity is used as the prediction parameter. The destructive tests have been performed according to EN 408 and EN 384.

The data is analysed separately for bending and tension tests. Calculations were done for different regional zoom levels: 1. Europe (considering all data). 2. Central Europe and Eastern Europe. 3. Countries. For visually graded timber the analysis is also focusing on the used cross-sections. For visual graded timber the data is not only separated for different growth regions but also for different height classes. Additionally, the different options for

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determining strength, stiffness, and density values according to EN14358 (Calculation of characteristic 5-percentile values and acceptance criteria for a sample) are evaluated and compared to the previously used calculation method.

3 RESULTS

Figure 1 illustrates how the visual grading results can be influenced by the width of the timber.

![Figure 1: Influence of the timber width on the visual grading result – example for the German standard. N=2447.](image)

The example, of the German standard DIN, shows that the share of the lower grade, S7 (red), and reject (black) is negligible for pieces with a width above 100mm due to the applied grading rules. Similar effects can be found for other rules. Therefore, resulting characteristic values for the higher strength classes do not reach the assigned characteristic values in several cases. The influence of the cross-section is strong compared to the influence caused by the origin. Detailed results are available for different visual grading standards, cross-sections and timber origin.

All assigned characteristic values for timber (in Europe), were calculated using a non-parametric approach. Recently European standards were changed and several options for the calculation were introduced. Figure 2 shows how this affects the calculated 5th percentile bending strength values (MOR) and the connected machine settings. Looking at the example of the most common machine grade C24 (required MOR 24 MPa), the old setting for the machine (dotted red line) of 9600 could be lowered to a setting of 9200 (blue line) if the proposed log normal parametric approach was used.

![Figure 2: Influence of the calculation of the 5th percentile strength value on the settings of a grading machine. N=4331.](image)

This means that a total of 87% (log normal) instead of 81% (non-parametric) of the sawfalling material can be declared as C24. Therefore, the timber quality within C24 will decrease due to the change of the calculation method. The effect on machine settings can change depending on the grading method and the number of pieces available.

4 CONCLUSIONS

Two batches of timber assigned to the same strength class only rarely show the same distribution of strength, stiffness and density values. For timber as a natural material this is not further surprising. However, systematic differences which are caused by the grading method should be minimized. At least, the declared characteristic values should be reached in both cases. This is not true in several cases. Very large or small cross-sections lead to strong variations for visual graded timber. Also, the origin of the timber has a major influence on the characteristic values for visual as well as for machine grading. Recent changes in the standards, concerning the calculation of characteristic values, can further increase the difference between visual and machine grading. Independent of the grading method a uniform, final check of the grading result is necessary. Where weaknesses of the method are known, e.g. influence of the cross-section for visual grading, additional checks are required. Harmonizing the requirements for both grading methods will increase the share of machine graded timber on the European market.