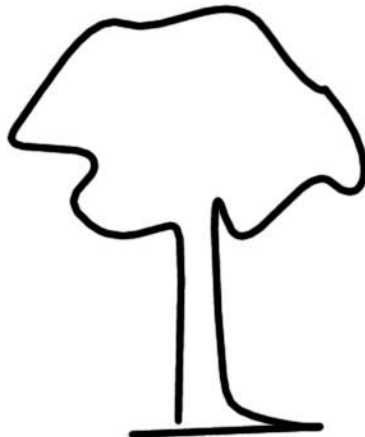


PORTABLE LUMBER GRADER
Software and hardware guide
Version 2.0



FAKOPP
Enterprise

Introduction

Structural lumber strength classes are determined by EN-338 norm. The Portable Lumber Grader is designed to grade lumber according to the above norm, that handles two different species classes like: deciduous (D) and coniferous (C) including poplar. Grading is based on the modulus of elasticity (MOE) and the average specific gravity of the lumber. Portable Lumber Grader system determines the MOE and specific gravity as quick as possible, 1 second/lumber.

The system components are: PC, balance, microphone and the Portable Lumber Grader software. The steps of the grading are:

- 1/ loading the balance
- 2/ hitting the end of the lumber by a hammer
- 3/ results appears on the screen and at the same time a voice message tells the result.

Installation

Installation of the software

1. Please check your PC or laptop computer. The following requirements are essential.

- operation system: Windows 95/98/ME/2000
- processor speed: 100 MHz, (higher speed results quicker grading)
- monitor resolution: min. 600*800 pixel
- 16 bit (or higher) sound card installed properly, better resolution doesn't effects the grading process
- free RS-232 serial port (if you have only USB port a converter is necessary)
- 1 Mbytes free space on your hard disk.

2. If your computer fulfils the above requirements, you can install the Portable Lumber Grader software. Please run „install.bat” file. Installation simply copies the files to your hard drive. Portable Lumber Grader is not a free software. The legal user's name appears on the grading window. After the successful installation please run the „DYNAMOE.exe” file.

Hardware installation

1. Connect the microphone jack to your soundcard's microphone connector,
2. Connect the RS-232 plug to your PC and the balance plug to the balance amplifier,
3. Connect the balance amplifier to the mains.
4. Place the microphone near to the end of the lumber

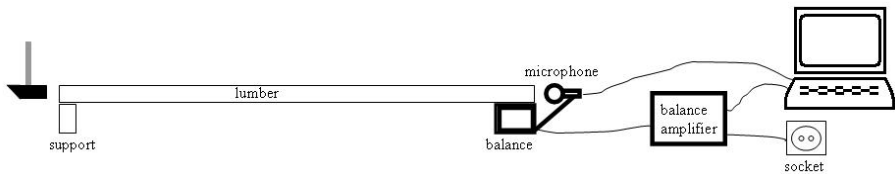


Fig.1. The Portable Lumber Grader set-up

5. Run „DYNAMOE.exe” and press balance button then select your balance comport. Usually serial mouse is using COM1 port, if you have a PS2 mouse or touch pad, COM1 is free. After a correct installation the proper read out of the balance appears on the screen. When balance is unloaded press the tara button and the readout turns to 0g.
6. Microphone settings are correct if the grading window shows the microphone wave in the left upper frame. If no signal, you need to activate the microphone input on your computer by following the instructions below:

Start menu

click Run

type: sndvol32 and click OK

select Settings/Options

select Recording, check microphone if the check box is empty and click OK

check microphone if the box is empty and apply maximum volume

The settings window

Filling out the settings window is an important preparatory step of the grading process. Only the proper settings result correct grading!

Potable Lumber Grader Settings

Length	87	cm
Width	6	cm
Height	4	cm
Trigger level	50	%
CKDR	0,1	
Moisture difference	0	%

Species group

Coniferous Deciduous

Balance GRADING

Write to file

Fig. 2. The settings window

Dimensions

Enter the nominal dimensions of your lumber using cm unit. (for special request we provide English unit software) Use decimal point for precise description of length, thickness and width.

Trigger level

The software makes difference between the background noise and the grading signal. The trigger level set correctly if automatic evaluation starts only if the longitudinal vibration is generated by a hammer impact. The pre-set value of the trigger level is 50%. If you set 0%, continuous, and

meaningless test will be performed. If you set 100%, trigger function and grading is blocked. When the background noise is high, the recommended trigger level value is 80%.

Concentrated Knot Diameter Ratio (CKDR)

The knot diameter is a distance between the two tangential lines parallel to arises (longitudinal direction) of a lumber surface in which the knot exists. If a knot diameter not less than 2.5 times as much as its smallest diameter, it shall be considered to have one half of its actual measured diameter.

The knot diameter ratio (KDR) is a percentage of the diameter of a knot to the width of a lumber surface in which it exists. The concentrated KDR (CKDR) is the sum of KDR concerning the knots existing in any 15 cm length of a piece of the lumber. The highest - considering 4 faces - CKDR represents the piece of lumber. The CKDR value is between 0 and 1.

Moisture difference

Sometimes the moisture content of the lumber at the grading process is different from the moisture content in service condition. We call moisture difference the following term:

moisture difference = actual moisture content – future moisture content in service condition

The unit is %. The best case if no moisture difference between actual a service condition is.

Species group

Select the appropriate wood species group (deciduous or coniferous) by the check box. Poplar species belongs to the coniferous group.

Write to file

If the “Write to file” box is checked, report file is created automatically. The measured MOE, density and dimensions is saved after each hammer impact. The file name is given automatically, like:

moe2002_12_10_08_45.txt

After “moe” actual year_month_day_hour_minutes is given automatically. File is created when the Portable Lumber Grader software has started. You can read the report file in excel. The structure of the report file: MOE[Gpa] density[kg/m³] widtw[cm] thicknes[cm] length[cm]

At the bottom of the settings window you find two buttons: Balance and Grading buttons.

Balance window

COM port selection

Please select your com port. In case of proper setting, the actual weight appears in the centre of the window (if the balance amplifier is connected to the mains and RS232 cable connected to your PC), other case you get “COM error” message. The default port is COM1. In case of all cable connected and no balance data, please change com port number, check all the four. **Before using the system press TARA while balance is empty!**

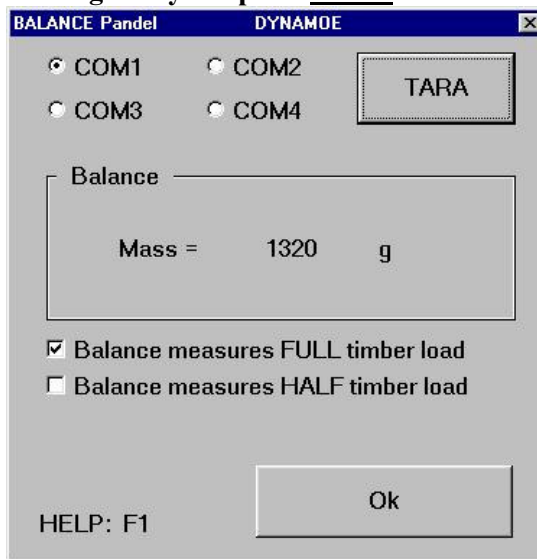


Fig. 3. The Balance window.

Balance mode

Here you can select the full weight or the half weight mode. In half weight mode, one end of the lumber is placed on the balance, other end is placed on a support. This set-up is shown on figure 5. and photo below. Precise mass determination possible only if the lumber lies horizontally on the balance. In the full weight mode, the full lumber is placed on the balance. This mode is recommended for light and short lumber or specimen, See figure 4.



Fig. 4. The balance measures full timber load. Recommended setup for short (below 2m) lumber.



Fig. 5. The balance measures half timber load. This setup is demonstration only, recommended for long ($l > 2m$) lumber.

Tara

At the centre of the balance window the actual weight appears in g unit. Please check the balance. If the unloaded balance shows some weight (this is normal) please press tara button (top right corner of the window). After pressing the tara button the read out turns to zero.

Grading window

The grading window is an information window, where the vibration, the Fourier spectra, the measured and calculated MOE, concentrated knot diameter ratio, specific gravity, dimensions and the grade appears on the screen. The spectra consist of 512 points. The only button is the “Back to settings”

Grading process

The grading process is simple. The appropriate grade appears on the screen after the end of the lumber hit by hammer. The evaluation time depends on the length of the lumber and the speed of your computer, but usually 1 second only. In the practice most of the grading time goes by loading and unloading the balance manually. The result is available via voice message. If no voice message please check the volume of your speaker and sound card settings.

INI file

You can change some parameter in the “dynamoe.ini” file. If the measured data is strange instead of grade number a “STRANGE” message will appear on the screen. The first 4 parameters sets the “strange” parameters. Next parameter is related to the clarity of the spectra. The last two parameters sets the region of interest in the spectra. The content of the file is:

```
strange_c_moe=25.0
strange_c_den=1100.0
strange_d_moe=28.0
strange_d_den=1500.0
hitagain=8
winlow=51
winhigh=250
```

Parameter	Explanation
strange_c_moe	If coniferous MOE[Gpa] is higher than the given value evaluation is strange
strange_c_den	If coniferous density[kg/m ³] is higher than the given value evaluation is strange
strange_d_moe	If deciduous MOE[Gpa] is higher than the given value evaluation is strange
strange_d_den	If coniferous density[kg/m ³] is higher than the given value evaluation is strange
hitagain	The evaluation is done only, if the spectra is clear. Clarity of the spectra is measured by the following parameter called „hitagain” = amplitude of the tallest peak divided by the average amplitude of the whole spectra. If the measured hit again parameter is less than the given value, the result will be HIT AGAIN. If you are working in a noisy environment please set lower value. You can eliminate this function by setting value 1.
winlow	Only part of the spectra is used for the longitudinal vibration frequency determination. The spectra consist of 512 points. In this range you found the peaks of the

	longitudinal vibration, mode number 1 and 2 (sometimes 3). Software selects the highest peak automatically. For the proper MOE measurement we need to select the peak of the mode number 1. The tallest is not always the mode number 1. The “winlow” parameter sets the low value of the region of interest. Lowest possible value is 10, highest value is “winhigh” -2.
winhigh	The “winhigh” parameter sets the high value of the region of interest. Lowest possible value is “winlow”+2, highest value is 511. In the spectra window, two vertical lines- hanging from the top - indicates the region of interest.

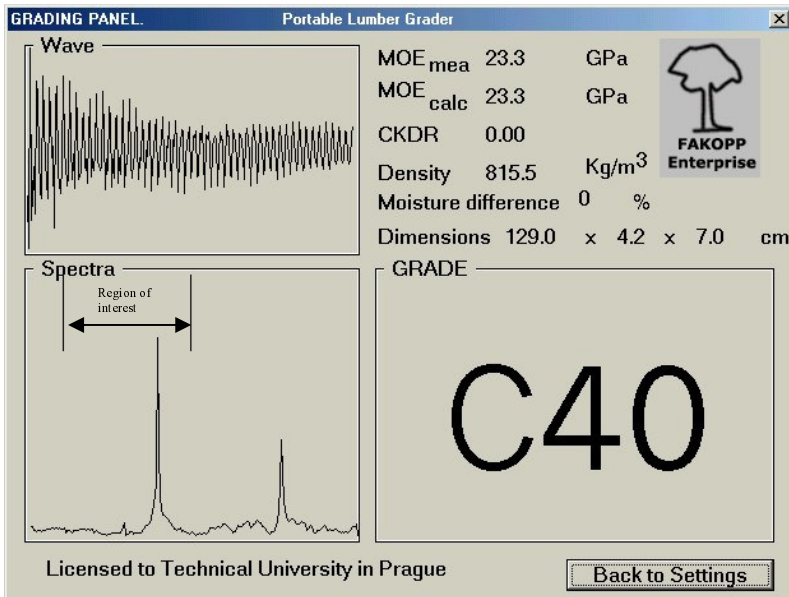


fig. 4. The grading window

File structure

dynamoe.doc	Software and hardware guide
dynamoe.exe	Grading software
dynamoe.ini	Ini file for setting 7 basic grading parameter
logo.bmp	image

vol Library:

c14.wav	sound file representing the grade in file name
c16.wav	sound file representing the grade in file name
c18.wav	sound file representing the grade in file name
c22.wav	sound file representing the grade in file name
c24.wav	sound file representing the grade in file name
c27.wav	sound file representing the grade in file name
c30.wav	sound file representing the grade in file name
c35.wav	sound file representing the grade in file name
c40.wav	sound file representing the grade in file name
d30.wav	sound file representing the grade in file name
d35.wav	sound file representing the grade in file name
d40.wav	sound file representing the grade in file name
d50.wav	sound file representing the grade in file name
d60.wav	sound file representing the grade in file name
d70.wav	sound file representing the grade in file name
hitagain.wav	sound file representing "hit again"
oog.wav	sound file representing "out of grade"
strange	sound file representing "starnge"

Hitting mode

1/ the power

The read out is not sensitive to the power of the hit, but the weak hit makes low signal, below the trigger level and this case no grade result. Extremely powerful hit accelerates the lumber and may hit or destroy the microphone. Please find your optimum hitting power in between.

2/ the direction

Grader evaluates the longitudinal vibration, so we need to generate longitudinal wave. The proper hitting direction is parallel to the long axes of the lumber.

3/ the technique

There is no special hitting technique. Do not press the lumber, let the hammer spring back. Do not apply double hit like first testing the direction by a small then a normal hit.

4/ the hammer weight

The hammer weight is important. Usually the lighter is better, but for larger lumber we need heavier hammer. Roughly 0.1 – 3 % of the lumber weight is the proper hammer weight.

5/ which end

We can select which end of the lumber will be hit. When we hit the microphone end, special attention need to pay to the microphone integrity.

Technical data

Balance:

- dimensions, 250 x 75 x 90 mm
- capacity: 125 kg
- resolution: 10g, hysteresis max. 90g
- output: RS232 signal
- powered by 220 V AC (110V is selectable inside the balance amplifier)

Microphone:

- unidirectional
- sensitivity: -56 dB (0dB = 1V/mbar at 1000 Hz)
- frequency range: 100-15000 Hz
- operational temperature 5 – 40 C°

Hammer weight:

- 0.5 – 3% of the lumber weight

Grading principle:

- mass, CKDR and MOE determination,
- grading table identical to EN-338 norm
- grading time is about 1 second
- Grading software is a windows based software
- The PC or lap-top is not a part of the Portable Lumber Grader package

The requirements for the PC or laptop

- operation system: Windows 95/98/ME/(2000)
- processor speed: 100 MHz, (higher speed results quicker grading)
- monitor resolution: min. 600*800 pixel
- 16 bit (or higher) sound card installed properly, better resolution doesn't effects the grading process
- free RS-232 serial port (if you have only USB port a converter is necessary, enclosed)
- 1 Mbytes free space on your hard disk

Limitations:

- The actual lumber dimension is within the nominal (given in settings panel) +/-2% interval.
- Lumber mass is less than the balance capacity *2.
- Lumber length: 0,5m – 10 m.
- Automatic grade marking system is under development, not available at the moment, marking of the lumber is the duty of the operator.

Principle

Specific gravity determination

Nominal dimensions are given via key board, mass is measured by the balance. Specific gravity is determined by the following term:

$$\rho = \frac{m}{l * w * h * (1 + u/100)}$$

where ρ : specific gravity
l: length
w: width
h: height
u: moisture difference in %

The measured Modulus Of Elasticity (MOE_{mea}) determination

The EN-338 norm is dealing with static MOE. The Portable Lumber Grader software determine the dynamic MOE first then apply a correction factor to calculate the static MOE. The following term defines the MOE:

$$MOE_{mea} = \frac{m}{l * w * h} (2lf)^2 0.92(1 + u/50)$$

where f : frequency of the longitudinal vibration
u: moisture difference in %. If $u > 18$ than $u=18$.

The calculated Modulus Of Elasticity (MOE) determination

The calculated MOE takes into account the effect of knots using the highest concentrated knot diameter ratio CKDR.

$$MOE = MOE_{mea} - 6.2CKDR$$

The grading algorithm

Grade decision is made by the following tables. Values are the lower limit of a given grade. Grade evaluation is done according to MOE and specific gravity separate, and the final grade becomes the lower one.

For coniferous species group the following table is used:

Grade	C14	C16	C18	C22	C24	C27	C30	C35	C40
MOE (GPa)	7	8	9	10	11	12	12	13	14
ρ (kg/m ³)	290	310	320	340	350	370	380	400	420

For deciduous species group the following table is used:

Grade	D30	D35	D40	D50	D60	D70
MOE (GPa)	10	10	11	14	17	20
ρ (kg/m ³)	530	560	590	650	700	900

The Portable Lumber Grader software is written by FAKOPP Enterprise Bt.

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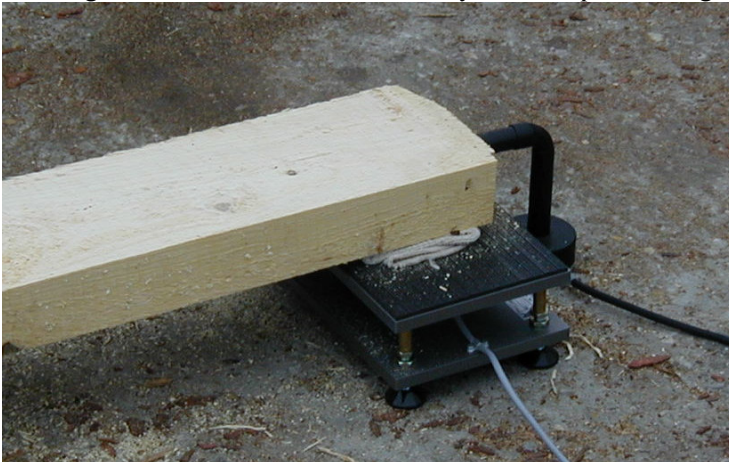
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Grading soft wood lumber at a lumber yard in Sopron, Hungary.



The balance and the microphone.