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Acoustic properties of Scots Pine wood and genetic background

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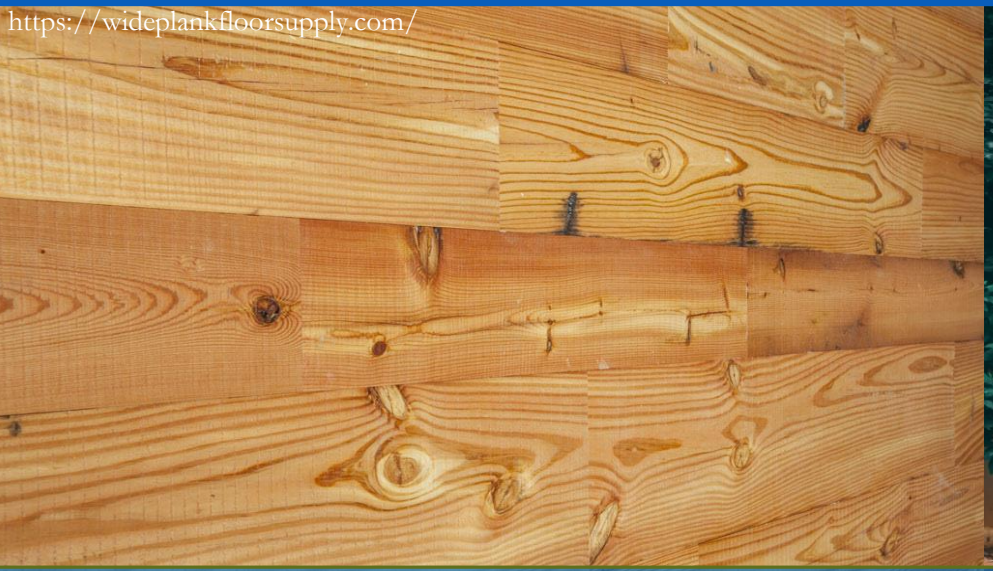
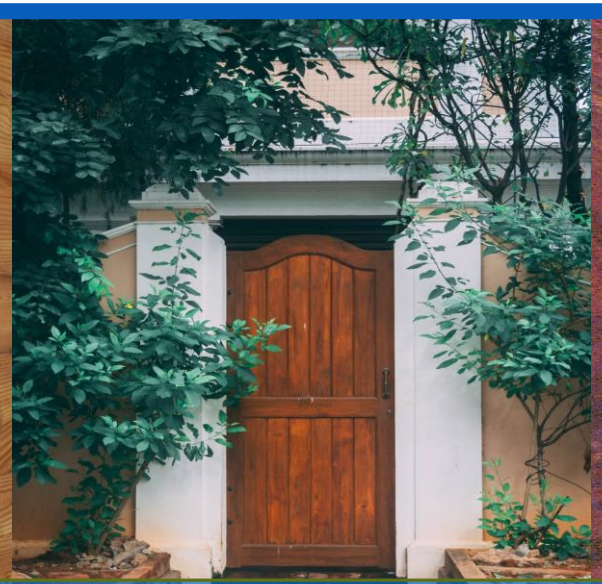
The aim of the work

The mechanical and physical properties of wood predispose this species to a wide range of applications. One of them is sound absorption, which is used in the production of windows, doors or floors. Wood conducts sound which also makes it an ideal material for building musical instruments.

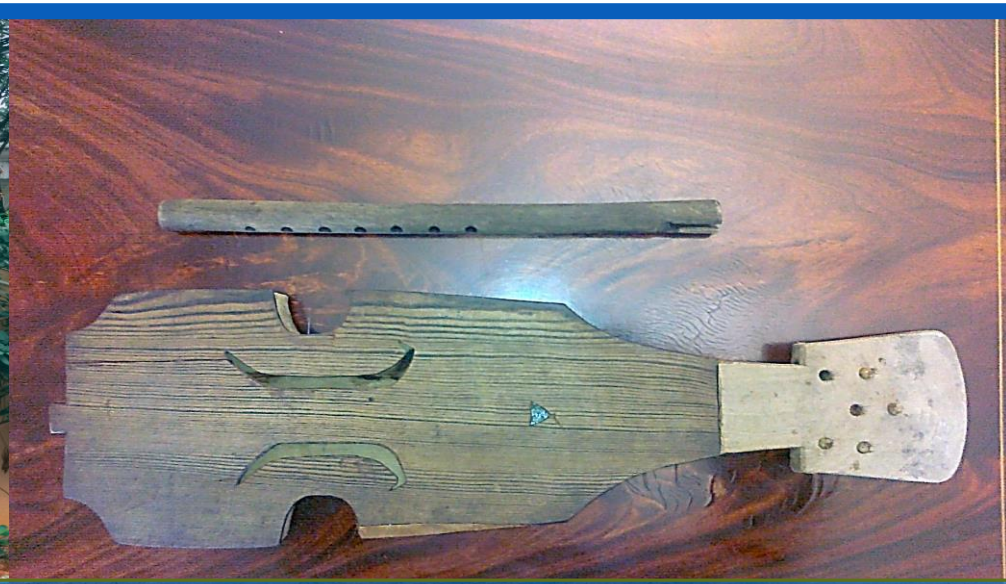
The results obtained allowed investigating the influence of genetic origin of Scots pine on its acoustic properties.



Floor made of pine wood



Door made of pine wood



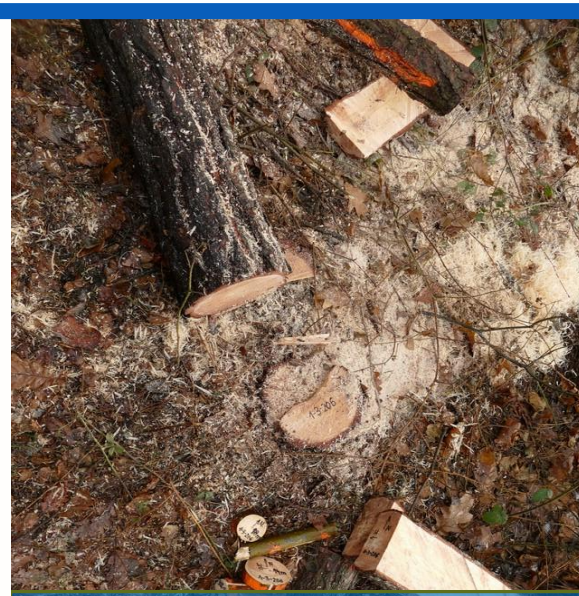
The soundboard of the vielles from Plock

Study site

The presentation contains results of research on technical quality of wood of selected genetic background of Scots pine growing on experimental plot located in central Poland in LZD Rogów.

Wood for the study came from the north-eastern and south-western parts of Poland and from the south and north of the country. The research material was obtained from 99 trees aged 52 years from the mixed broadleaved forest habitat (FMBF).

Scots pine growing on experimental plot located in central Poland in LZD Rogów

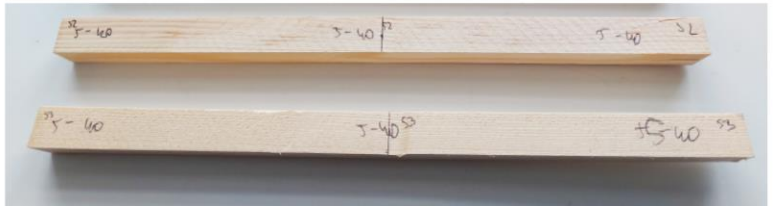


659 samples

The ultrasonic method

The samples were subjected to ultrasonic testing using the UMT-1 material tester from UNIPAN, working with specialist software for visualisation and analysis of measurement signals UMT-LINK.
The tests were carried out according to the original methodology.

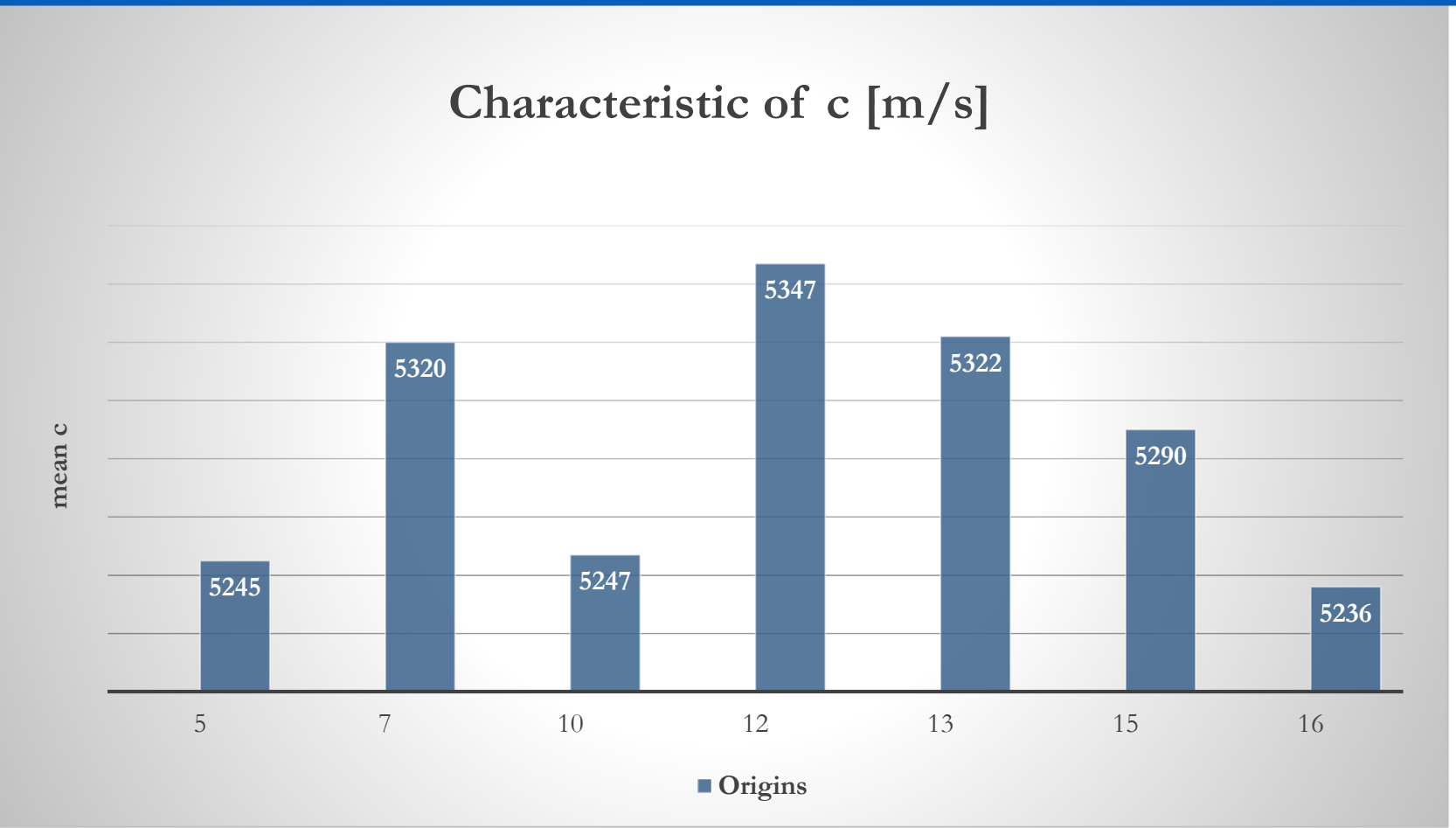
On the basis of the ultrasonic transit time measurements, the following were calculated: the speed of propagation of the acoustic wave in wood c [m/s], the dynamic modulus of elasticity along fibres E [MPa],
the acoustic resistance of wood Z [kN*s/m^3]
and the sound attenuation T [m^4/s*kg].
The results obtained allowed investigating the influence of genetic origin of Scots pine on its acoustic properties.



UMT-1 material tester from UNIPAN

Results

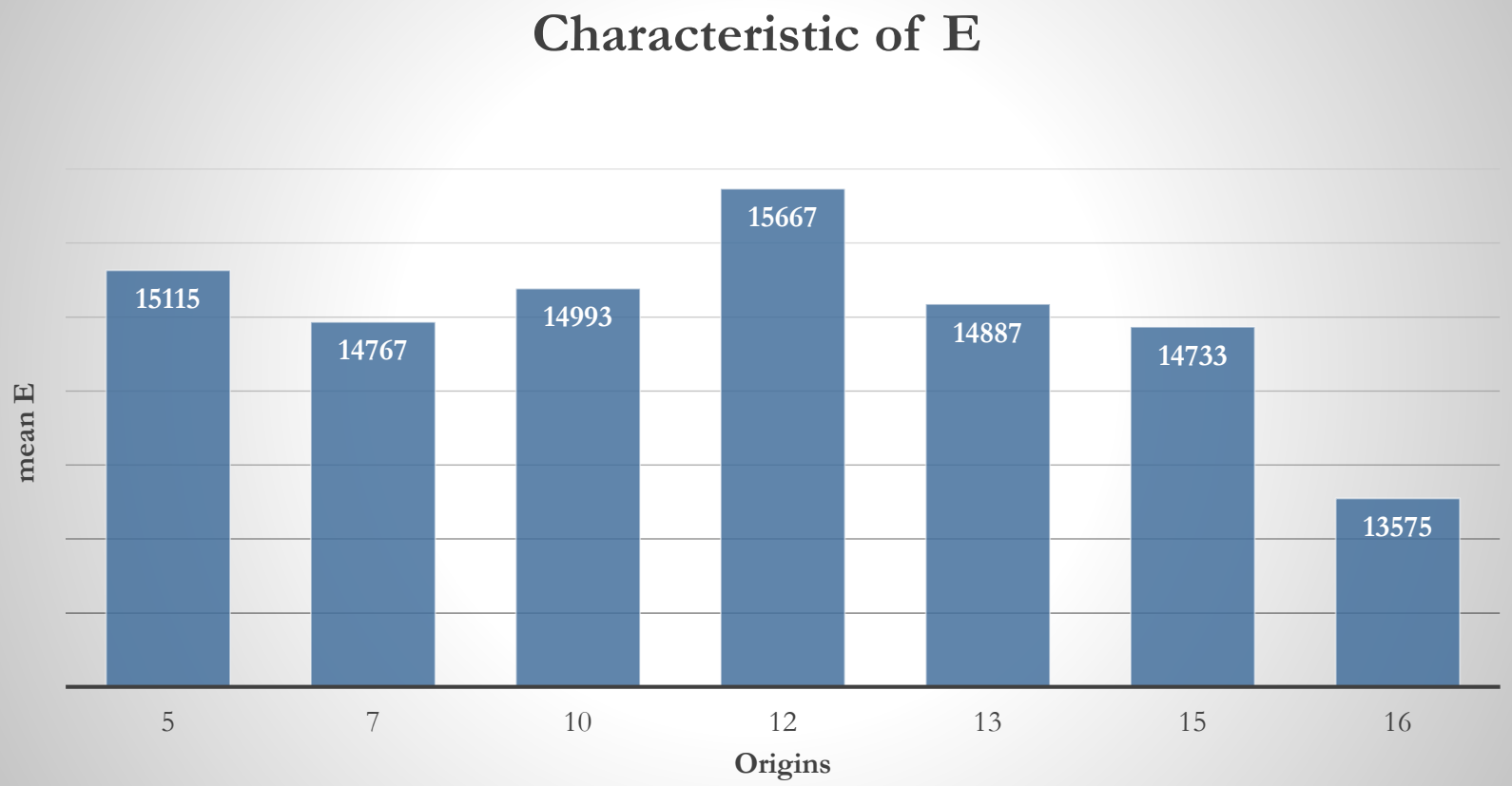
The speed of propagation of the acoustic wave in wood
c [m/s]



The highest mean c was obtained for trees from stand 12 (5347 m/s), and the lowest for stand 16 (5236 m/s).
The average of speed of propagation of the acoustic wave in wood for all of the studied material at Rogów Forest Experimental Station was 5289 m/s.

Results

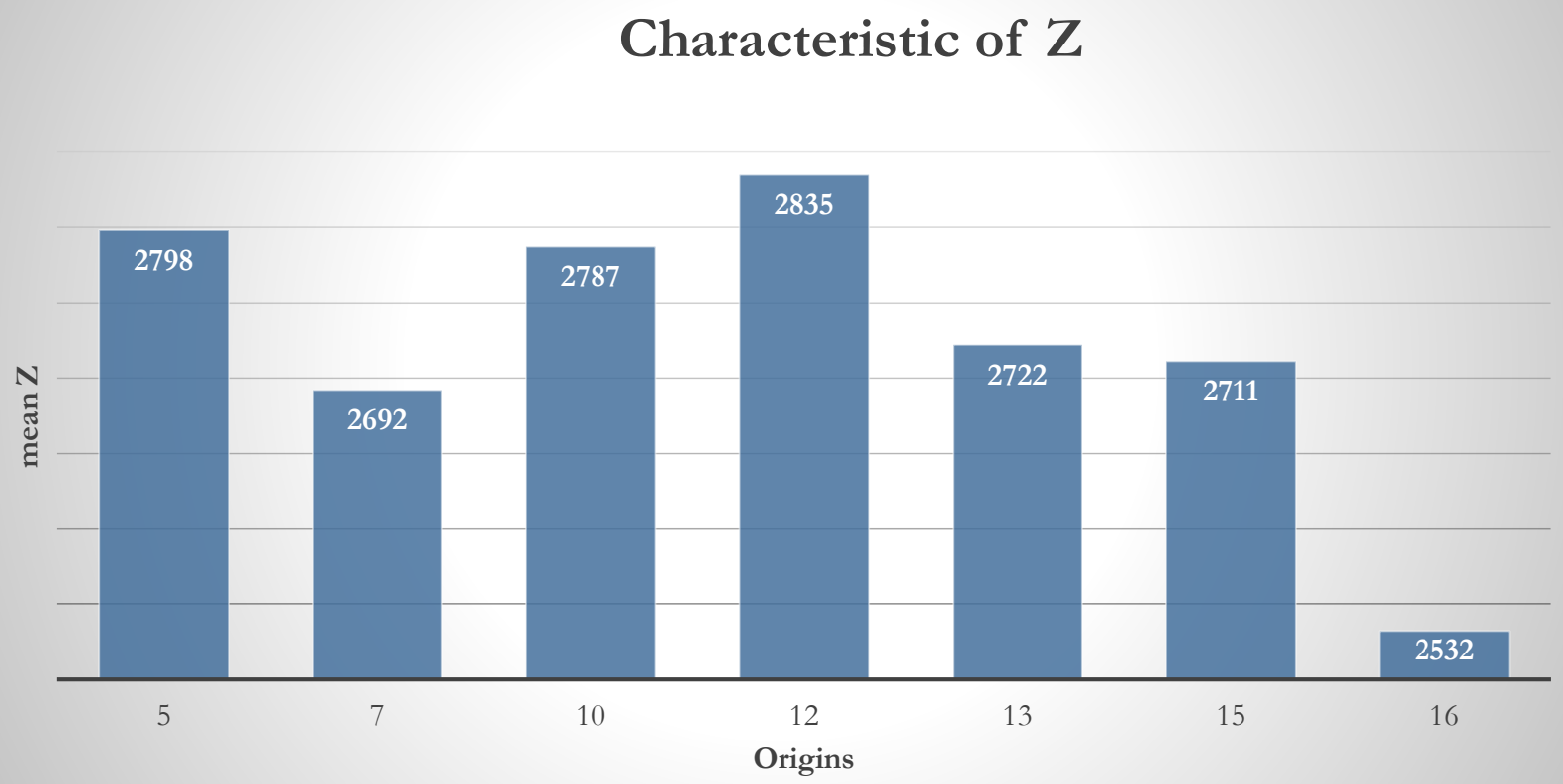
The dynamic modulus of elasticity along fibres E [MPa]



The highest mean E was obtained for trees from stand 12 (15667 MPa), and the lowest for stand 16 (13575 MPa).
The average of dynamic modulus of elasticity along fibres in wood for all of the studied material at Rogów Forest Experimental Station was 14860 MPa.

Results

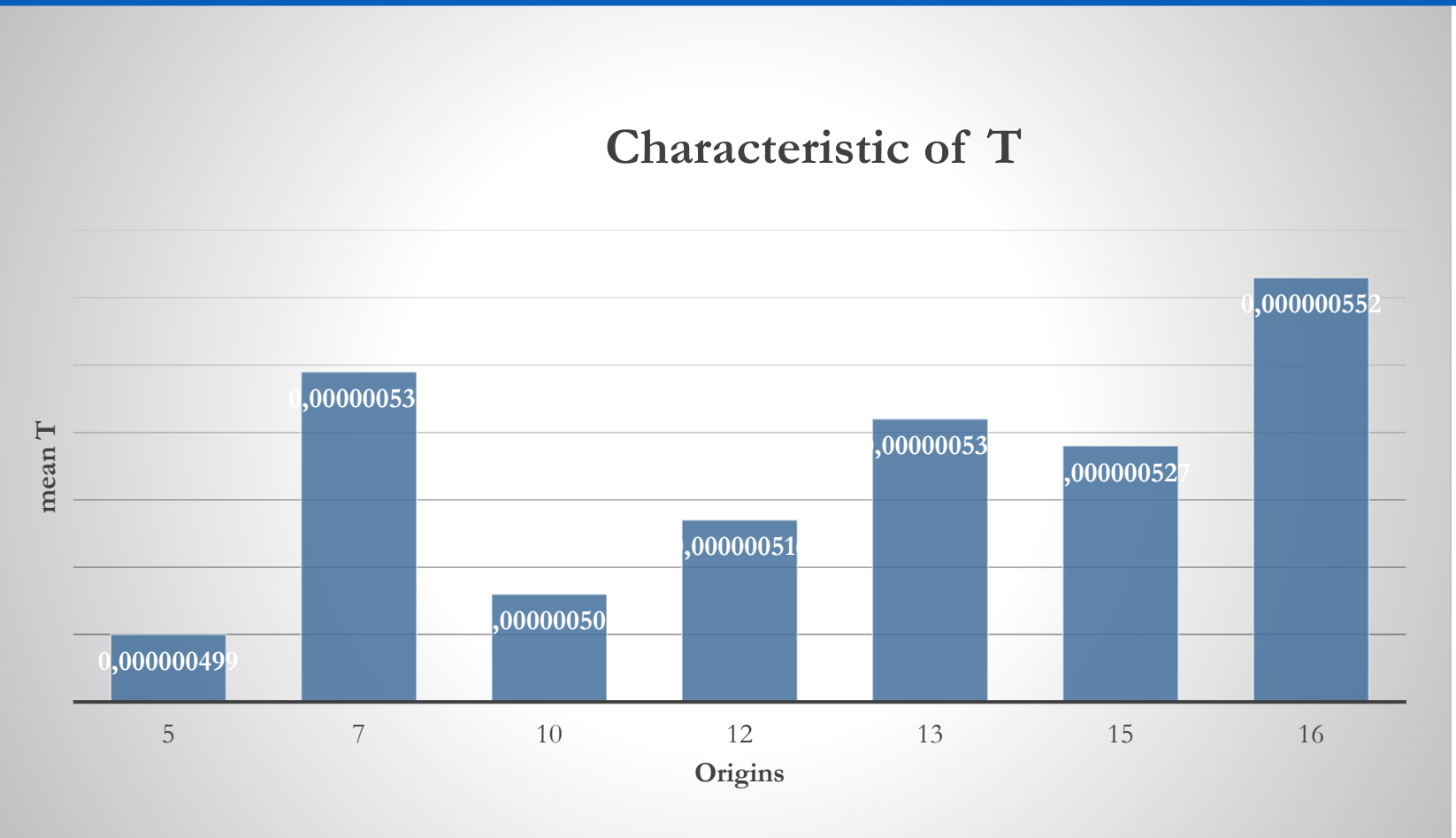
The acoustic resistance of wood
Z [kN*s/m^3]



The highest mean Z was obtained for trees from stand 12 (2835 kN*s/m^3), and the lowest for stand 16 (2532 kN*s/m^3).
The average of acoustic resistance of wood for all of the studied material at Rogów Forest Experimental Station was 2731 kN*s/m^3.

Results

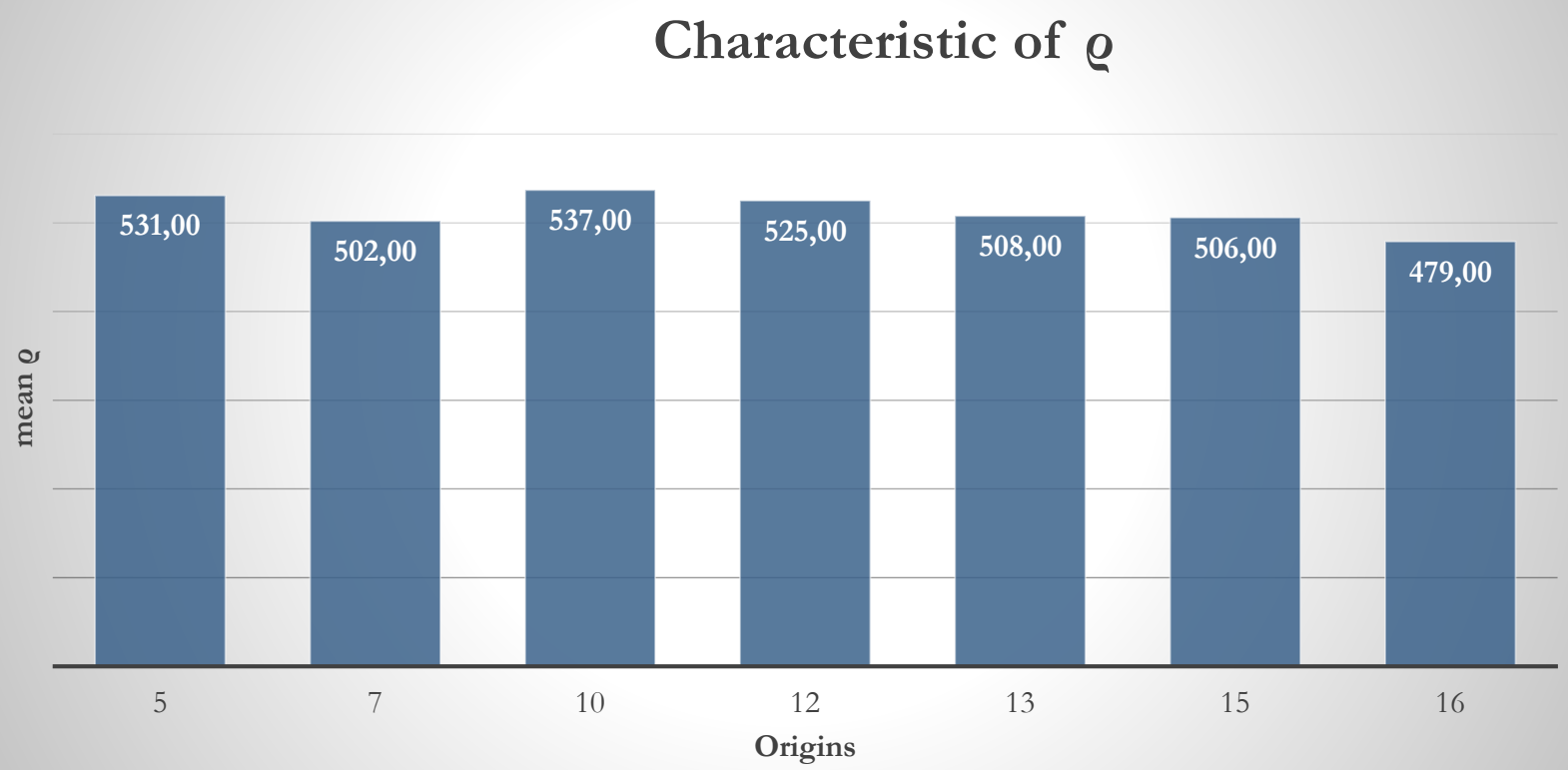
The sound attenuation
T [$m^4/s*kg$]



The highest mean Z was obtained for trees from stand 16 (55,2 * 10^{-8} $m^4/s*kg$), and the lowest for stand 5 (49,9 * 10^{-8} $m^4/s*kg$).
The average of sound attenuation in wood for all of the studied material at Rogów Forest Experimental Station was 52,3 * 10^{-8} $m^4/s*kg$.

Results

The wood density
ϱ [kg/m^3]



The highest mean ϱ was obtained for trees from stand 10 (537 kg/m^3), and the lowest for stand 16 (479 kg/m^3).
The average of sound attenuation in wood for all of the studied material at Rogów Forest Experimental Station was 514 kg/m^3.

Conclusions

There was no significant effect of origin on the speed of sound wave propagation, dynamic elastic modulus, or acoustic resistance. The influence of origin on sound attenuation was demonstrated. The highest mean value of sound attenuation was obtained by origin 16 (Nowy Targ – mountain origin) – $55.2*10^{-8}$ $m^4/s*kg$ and the lowest mean wood density – 479 kg/m^3.

The best values of the analysed acoustic properties were determined for wood from the Nowy Targ origin (16). It is characterised by good attenuation, insulation and low acoustic resistance, which predisposes this wood to applications such as: frame walls, building elements or acoustic screens.
Wood with high attenuation and low acoustic resistance is best suited for the construction of musical instruments.

Photo: Polish National Radio Symphony Orchestra in Katowice (Poland)