

Contents	2
Foreword	6
Non-destructive testing of timber	
Non-destructive survey of historic timber M.F. Drdácký, M. Kloiber	8
Low invasive diagnostics of historic timber M.F. Drdácký, M. Kloiber, M. Kotlínová	24
Semi-destructive techniques for in-situ evaluation of historic wood structures Bo Kasal, R. W. Anthony	42
Determination of elastic modules by means of compression test of a timber core J. Minster, M. Micka, P. Václavík	50
Prediction of Mechanical Properties by means of Radial Cores In Situ M. Kloiber, M. Kotlínová	56
Comparison of nondestructive and semi-destructive methods used on two types of wood M. Kotlínová, M. Kloiber, G. Vasconcelos, P. B. Lourenço, J. Branco	66
Technological surveys of treatments applied to historical timber Z. Slížková	78
Non-destructive testing of masonry	
Strategies for the assessment of historic masonry structures L. Binda, C. Maierhofer	86
Nondestructive testing and damage assessment of masonry structures M. P. Schuller	106
Overview of Non-Destructive Testing (NDT) Methods of Materials Evaluation P. J. Tikalsky	124

Testing of historic mortars on non-standard small size specimens M. F. Drdácký	130
Non-destructive diagnostics of shallow subsurface defects on masonry M.F. Drdácký, J. Lesák	140
Application of Optical Methods for Historic Structures Examination D. Vavřík, J. Bryscejn, I. Jandejsek, J. Jakůbek, J. Valach	148

Construction issues

Status and Needs for Historic Materials and Building Structures From the Construction Industry Point of View, U.S. Perspective E. P. Meade	156
Documentation and regulations of historic structures J. M. I. Encarnación	166
Structural aspects in the reconstruction of historic timber structures J. Kanócz	176
Optical properties of degraded historic stone and mortar surfaces J. Valach, D. Vavřík	182

Czech extended abstracts and texts

Nedestruktivní průzkum historických dřevěných konstrukcí M.F. Drdácký, M. Kloiber	188
Rentgen M. Drdácký, I. Jirovský	189
Vliv orientace a šířky letokruhů na šíření ultrazvuku ve struktuře dřeva M. Kloiber, M Kotlínová	192
Porovnání dynamického a statického modulu pružnosti poškozeného dřeva M. Kloiber, M Kotlínová	197
Šetrná diagnostika historických dřevěných konstrukcí M.F. Drdácký, M. Kloiber, M. Kotlínová	210
Polodestruktivní techniky pro hodnocení historických dřevěných konstrukcí in-situ B. Kasal, R. W. Anthony	220

Stanovení pružných modulů historického dřeva pomocí tlakové zkoušky jádrového vývrtnu J. Minster, M. Micka, P. Václavík	221
Porovnání nedestruktivních a semidestruktivních metod na dvou typech dřeva M. Kotlínová, M. Kloiber, G. Vasconcelos, P. B. Lourenço, J. Branco	225
Odhad mechanických vlastností historického dřeva z radiálních vývrtnů M. Kloiber, M. Kotlínová	226
Průzkum technologických stop na historických dřevěných konstrukcích Z. Slížková, M. Drdácký	233
Strategie hodnocení historických zděných konstrukcí L. Binda, C. Maierhofer	238
Nedestruktivní zkoušení a odhad poškození zděných konstrukcí M. P. Schuller, P.E.	239
Přehled nedestruktivních zkušebních metod pro hodnocení materiálů P. J. Tikalsky	241
Zkoušení historických malt na malých nestandardních tělesech M.F. Drdácký	242
Nedestruktivní diagnóza mělkých podpovrchových defektů M.F. Drdácký, J. Lesák	245
Aplikace optických metod na zkoumání historických prvků D. Vavřík, J. Bryscejn, I. Jandejsek, J. Jakůbek, J. Valach	249
Stav a nároky na historické materiály a stavební konstrukce z hlediska perspektivy amerického stavebního průmyslu E. P. Meade	250
Dokumentace a předpisy pro historické konstrukce J. M. I. Encarnación	251
Konstrukční aspekty restaurování historických dřevěných konstrukcí J. Kanócz	252

the material strength properties. Actually, wood hardness involves components of other mechanical characteristics (strengths) and it is reversely proportional to the moisture content, see Table 1. Of course, hardness is further dependent on the surface orientation. It is higher on the cross-section face than on the longitudinal faces. This difference attains 40% in coniferous wood and 30% in deciduous species. There is no or little difference between radial and tangential faces, see Table 1 [6]. Radial hardness is higher than tangential (about 5-10 %) in deciduous trees with significant amount of wood rays, as e.g. in oak or beech [7].

Table 1 Comparison of static hardness values for selected wood at various moisture content [6].

Wood species	Wood hardness in MPa					
	Cross-section		Radial face		Tangential face	
	12%	30%	12%	30%	12%	30%
Larch	43,5	20,5	29,0	13,5	29,0	14,0
Pine	28,5	13,5	24,0	11,0	25,0	11,5
Spruce	26,0	12,0	18,0	8,5	18,5	8,5
Acacia	97,0	57,7	68,0	40,5	78,0	46,5
Ash w.	80,0	48,0	59,0	35,0	67,0	39,5
Oak	67,5	40,0	56,0	33,5	49,0	29,0
Beech	61,0	36,5	43,5	25,5	44,5	26,5
Horn-beam	90,5	54,0	77,0	45,5	78,5	47,0
Lime-tree	26,0	15,5	17,5	10,0	18,0	10,5

From the Table 1 it follows that the static hardness changes by about 3% in relation to a relevant moisture content change of about 1%.

With laboratory devices other hardness measurement techniques may be applied. For example, the classical Brinell hardness test or the Janke hardness test modification. They do not differ in principle from the Piazza method described above.

As it has been already mentioned, the static indentation technique has a potential for in situ measurements of local compressive strength. Moreover, such measurements may be carried out in different depths and a change of material properties along the timber profile may be followed.

3 Surface dynamic indentation

The dynamic indentation uses a slender steel rod or pin of a given diameter, which is driven

into the wood by a dynamic force usually generated by releasing a compressed spring.

For practical measurements a set of commercially available PILODYN devices is used. This mechanical instrument has been developed in Switzerland and shoots a thin steel rod of 2.5 mm in diameter against the tested surface with a constant energy dependent on the stiffness of the spring of individual devices. There are typical devices with 6J, 12J and 18J stiffness, and one specific type 4JR offering repetition of shooting. Different spring stiffness is utilized for wood density or degradation level [8]. The PILODYN device enables to measure the depth of penetration of the driven rod into the wooden surface, (Figure 3). The typical range of measurement covers depth between 0 and 40 mm and the result is displayed on the scale of the device.

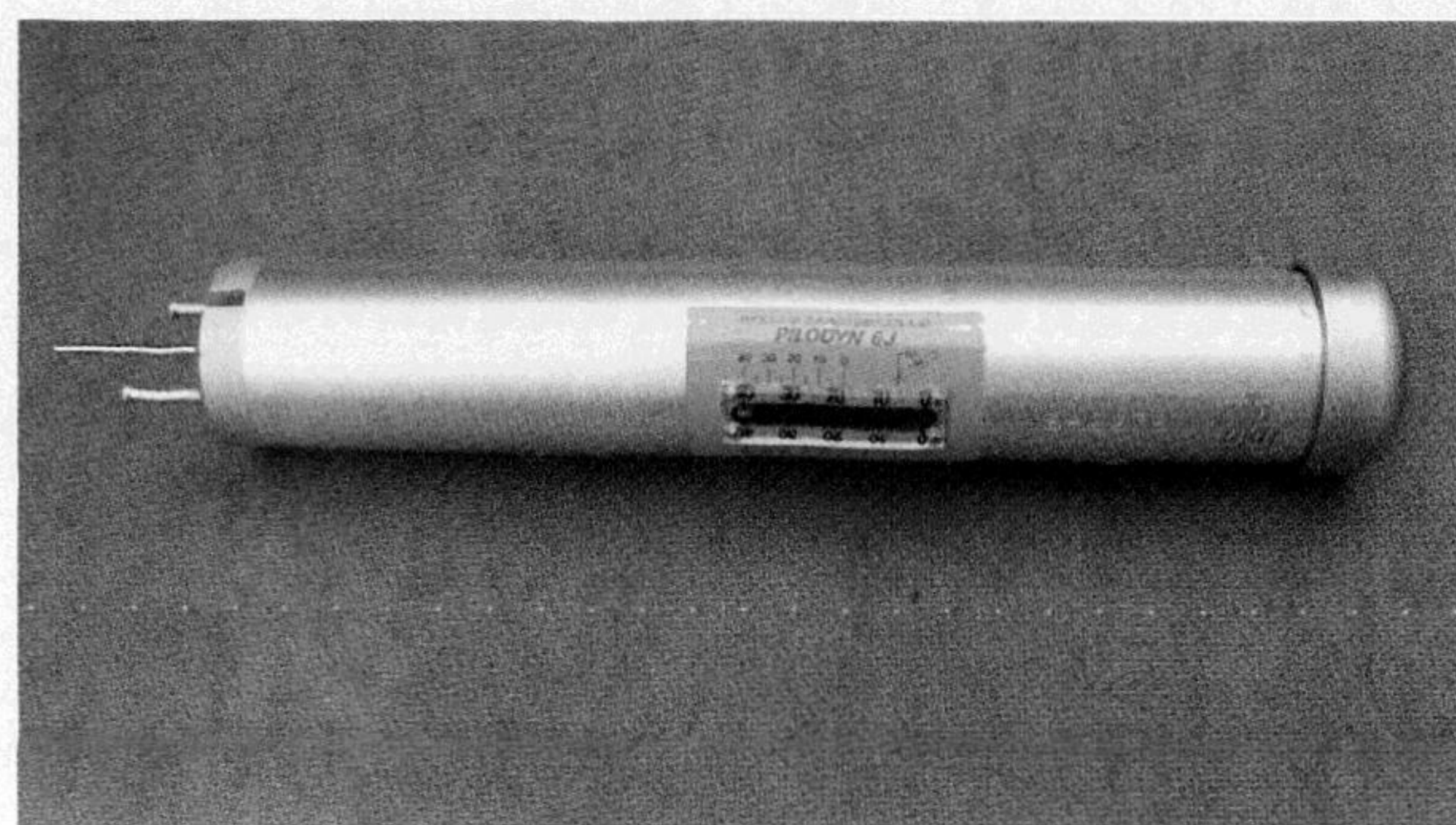


Figure 3 Dynamic indenter Pilodyn F6J Forest.

The depth of penetration correlates quite well with material density [9], [10]. The density is one of the key material characteristics of wood which is useful for prediction of other material characteristics as well as it is indispensable for interpretation of other physical measurements, e.g. the velocity of sound propagation. The measurement of density is quite precise. Correlation coefficient for dependence density on the depth of penetration varies between 0.74 and 0.92 according to Görlacher [9], in relation to number of measurements and species, which calls for calibration. Developed empirical relations are influenced mostly by moisture content [11], [12], [13]. For example, for spruce the following 5% regression formula (2) can be used [14]:

$$\rho_{12} = -0.027102 t_{\rho_{12}} + 0.727987 \quad (2)$$

$$t_{\rho_{12}} = t_{\rho} (1 - 0.007 \Delta w) \quad (3)$$