Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 88, 2014: 212-219
(Ann. WULS - SGGW, For. and Wood Technol. 88, 2014)

Wood shingles in contemporary construction – how shall their utility be assessed? Part 2

ANNA POLICIŃSKA-SERWA, MARZENA JAKIMOWICZ, KRZYSZTOF KUCZYŃSKI, ANDRZEJ KOLBRECKI

Abstract: The durability and quality of wood shingle roof coverings is influenced by many factors resulting from the characteristics of the product itself, its installation, weather conditions as well as proper and regular maintenance. In this paper (in part 2), the issues of the correct execution of roof coverings of wood shingles are considered, following detailed tests of roofing with regard to the safety of use of roofs and resistance to the propagation of flame.

Keywords: wood shingles, requirements for shingles, roof coverings, roofs, contemporary wood shingles, construction in wood, technical approvals.

INTRODUCTION

In Poland, covering roofs with wood materials was almost completely abandoned and substituted with roofing paper, Eternit, metal sheeting, cement or ceramic tiles in the end of 1960s. The growing trend of living in a possibly most natural environment, observed in the recent years, has brought the revival of traditional building products, including wood shingles. Wood shingles on the roof often serve to showcase the status and taste of the building's owner. Modern roof coverings made of "tongue and groove", "lath" or "chip" type wood shingles must meet relevant standards not only in terms of the quality of the roofing material (shingles) itself, but above all they should be safe in use. The issues of safety are governed by EU and domestic regulations [14, 15, 16, 17]. This part (2) of the paper describes the rules of laying shingles based on modified traditional techniques, taking into account current legal and technical standards.

RULES OF LAYING WOOD SHINGLE ROOFING

Roofing made of "tongue and groove", "lath" and "chip" type wood shingles shall be laid by specialist companies, complying with the requirements for their installation in accordance with the technical design prepared for a specific building and taking into account the provisions of Polish building regulations, including in particular the Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions with which buildings and their locations should comply (Journal of Laws No 75/2002, item 690, as amended), the requirements of the Technical Approval (for shingles) and guidelines for their application specified in the manufacturer's manual.

Roof coverings made of "lath" and "tongue and groove" type shingles of coniferous wood species (pine, spruce, larch, fir and red cedar) or of deciduous species (oak and aspen) (dimensions – see table in part 1), laid on battens spaced at 60–500 mm intervals or on a perforated boarding with plank spacing of 50–100 mm (each subsequent layer offset by 60–500 mm), have class B_{roof} (t_1) as per PN-EN 13501-5+A1:2010 in terms of external fire performance. Roof coverings made of "chip" type shingles of coniferous wood species (larch) or of deciduous species (oak and aspen) (dimensions – see table in part 1), laid perpendicular to the roof eaves (each subsequent layer offset by 50–180 mm) or in a herringbone pattern, at an angle to the roof eaves (each subsequent layer offset by 50–180 mm, depending on the angle of the laying pattern) on battens spaced at 60–400 mm intervals or on a perforated

boarding with plank spacing of 50–100 mm have class B_{roof} (t_1) as per PN-EN 13501-5+A1:2010 in terms of external fire performance.

Examples of shingle patterns on roof pitches are shown in Figures 1, 2 and 3.

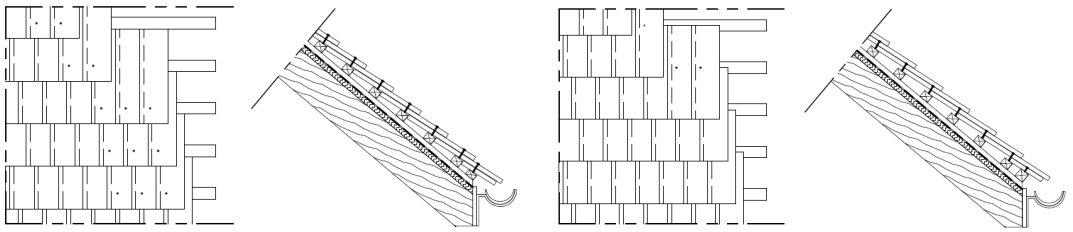

Figure 1 “Tongue and groove” shingle laying pattern.

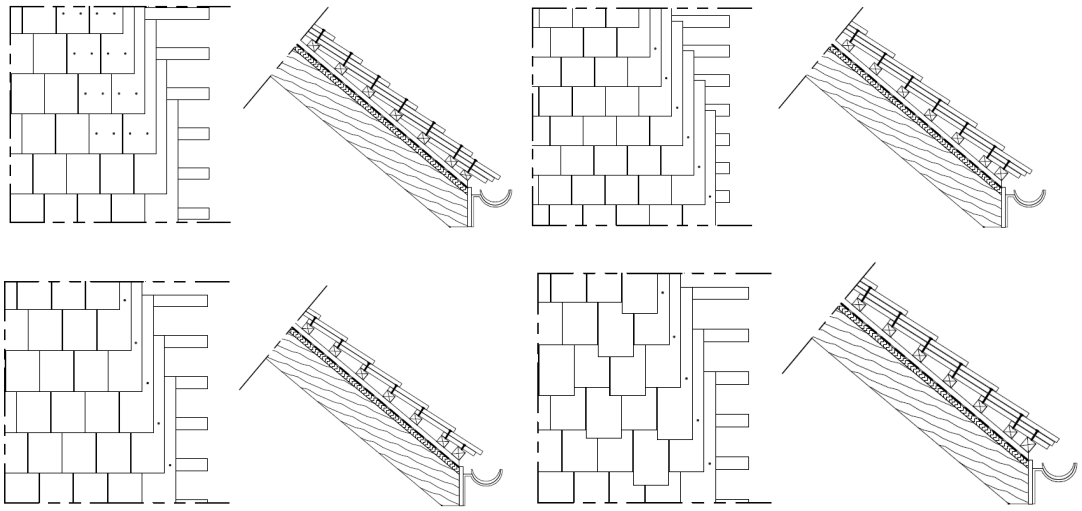

Figure 2 “Lath” shingle laying pattern.

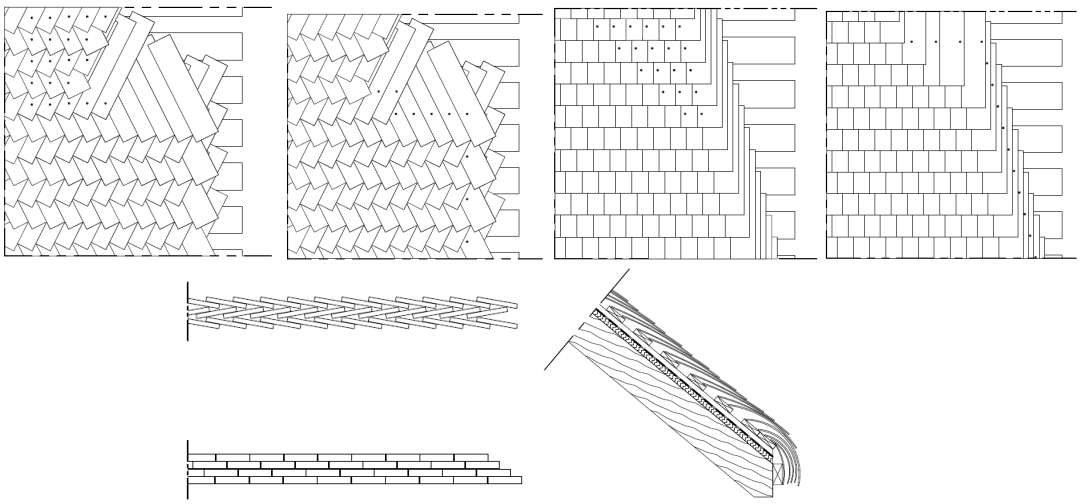

Figure 3 “Chip” shingle laying pattern.

The pitch of the roof shall be more than 27^o. However, making roof coverings on roof pitches of 20^o to 27^o is also possible, provided that a waterproofing membrane is laid underneath the cladding.

Shingles are fastened to the roof structure using battens on rafters, counterbattens nailed to rafters with boarding or on counterbattens nailed to rafters with boarding protected with a waterproofing layer, leaving a ventilation gap at least 2 cm wide. The spacing and dimensions of battens and counterbattens shall be adjusted to the rafter spacing, length and type of shingles and the method of their laying (i.e. perpendicular or at an angle to roof eaves, taking into account the number of layers).

Roof shingles are fastened using galvanised steel nails, smooth, round or square, in particular cases spiral, ring or grooved nails, galvanised or black. Using nails made of other metals is possible, but with certain restrictions (there is a risk of corrosion and discolourations, depending on the type of wood). The length of nails depends on the thickness of shingles and the number of layers and shall allow for connecting the components of the roofing system and at the same time avoid puncturing the waterproofing layer (if it is used). Using nails which are visible ("exposed") or hidden ("covered") after the installation of shingles is practised. Installation using covered nails is considered better in terms of roof appearance, as fastening with "exposed" nails tends to "push out" (pull out) nails from shingles during the natural and cyclic wood swelling and drying periods, which occur in changing weather conditions. This phenomenon also occurs in the case of "covered" nails, but it is not that evident (sometimes it is invisible) due to the force exerted by shingles located above the nailed piece. In this shingle laying method, the stress observed in individual shingles (pushed out with the nail) is distributed more evenly. Both techniques are acceptable in terms of technical standards. After laying, only a fragment of the inferior part of shingles, the "visible" part, can be seen. Installing cladding on surfaces inclined at 90^{o} can also be done using staples. Staples shall be at least 3 cm longer than the total thickness of the fastened layers.

In order to ensure imperviousness and resistance to positive and negative wind pressure, resistance to impact of soft or hard objects and flame propagation resistance, shingles must be laid on the roof in accordance with the guidelines specified in the tables below.

The relationship between the wood species of shingles, shingle's performance level (see part 1) and roof pitch is presented in Table 1.

Table 1 The relationship between wood species, performance level and roof pitch

Wood species	**Performance levels* for shingles laid on roof slopes of pitches:**			
	27° to 34°	**35° to 70°**	**71° to 90°**	**80° to 90°**
Coniferous wood species				
Larch	AB	ABC	ABC	ABCD
Red cedar	AB	ABC	ABC	ABCD
Pine	AB	ABC	ABC	ABCD
Fir	AB	ABC	ABC	ABCD
Spruce	-	-A**	AB**	ABC
Deciduous wood species				
Oak	AB	ABC	ABC	ABCD
Aspen	AB	ABC	ABC	ABCD
* performance levels A, B, C and D are specified in Part 1 of the paper ** only split				

A part of the lower shingle is covered by the shingle located above. The length of the visible part depends on shingle length and the number of layers in the roof covering.

The relationship between shingle types, requirements for the number of layers in the roofing and the length of shingles for specific applications is shown in Tables 2 to 9. Note: only the requirements for selected maximum lengths are specified in the tables.

Table 2 Relationships between the number of layers in the roof covering, the length of "tongue and groove" shingles and roof pitch

No	Shingle length, rated, mm	Length of the visible shingle part ("exposed section") after laying on roof slope for different pitches and number of layers in roof covering, mm					
		27° to 90°				80° to 90°	
		3 layers		2 layers		1 layer	
		"Exposed section" length	Overlap	"Exposed section" length	Overlap	"Exposed section" length	Overlap
1	650	200	50	260 (300*)	40	550	100
2	600	185	45	260 (280*)	40	500	100
3	550	170	40	260	30	450	100
4	500	155	35	235	30	420	80
5	450	140	25	210	30	370	80
6	400	125	25	185	30	320	80

Table 3 Relationships between the number of layers in the roof covering, the length of "Białowieża" lath shingles and roof pitch

No	Shingle length, rated, mm	Length of the visible shingle part ("exposed section") after laying on roof slope for different pitches and number of layers in roof covering, mm					
		27° to 90°				80° to 90°	
		4 layers		3 layers		2 layers	
		"Exposed section" length	Overlap	"Exposed section" length	Overlap	"Exposed section" length	Overlap
1	650	155	30	200	50	200 (305*)	40
2	600	145	20	185	45	200 (280*)	40
3	550	130	30	170	40	200 (255*)	40
4	500	120	20	155	35	230*	40
5	450	105	30	140	30	210*	30
6	400	95	20	125	25	185	30
* the maximum length of the visible (exposed) part of the shingle after laying on a 2-layer roof pitch shall not exceed 200 mm, except for the cases of reconstructing historical roof coverings, small architectural structures etc., where longer visible areas are acceptable.							

Table 4 Relationships between the number of layers in the roof covering, the length of rectangular or wedge lath shingles and roof pitch

No	Shingle length, rated, mm	Length of the visible shingle part ("exposed section") after laying on roof slope for different pitches and number of layers in roof covering, mm					
		27° to 90°				80° to 90°	
		3 layers		2 layers		1 layer	
		"Exposed section" length	Overlap	"Exposed section" length	Overlap	"Exposed section" length	Overlap
1	650	155	30	200	50	200 (305*)	40
2	600	145	20	185	45	200 (280*)	40
3	550	130	30	170	40	200 (255*)	40
4	500	120	20	155	35	200 (230*)	40
5	450	105	30	140	30	200 (210*)	30
6	400	95	20	125	25	185	30
* the maximum length of the visible (exposed) part of the shingle after laying on a 2-layer roof pitch shall not exceed 200 mm, except for the cases of reconstructing historical roof coverings, small architectural structures etc., where longer visible areas are acceptable.							

Table 5 Relationships between the number of layers in the roof covering, the length of "chip" shingles (laid perpendicular to the eaves) and roof pitch

No	Shingle length, rated, mm	Length of the visible shingle part ("exposed section") after laying on roof slope for different pitches and number of layers in roof covering, mm					
		27° to 90°				80° to 90°	
		3 layers		2 layers		1 layer	
		"Exposed section" length	Overlap	"Exposed section" length	Overlap	"Exposed section" length	Overlap
1	510	120	30	155	45	155 (230*)	50
2	460	105	40	140	40	155 (210*)	40
3	410	95	30	125	35	155 (185*)	40
4	360	80	40	105	45	155	45
5	310	70	30	90	40	135	40
6	260	55	40	75	35	115	40
7	210	45	30	60	30	90	30
8	180	40	20	50	30	75	30
9	130	25	30	35	25	50	30
* the maximum length of the visible (exposed) part of the shingle after laying on a 2-layer roof pitch shall not exceed 155 mm, except for the cases of reconstructing historical roof coverings, small architectural structures etc., where longer visible areas are acceptable.							

Table 6 Relationships between the number of layers in the roof covering, the length of "chip" shingles (laid perpendicular to the eaves and in compliance with the rules of the following system: the third chip does not overlap with the first one along the shorter side) and roof pitch

No	Shingle length, rated, mm	Length of the visible shingle part ("exposed section") after laying on roof slope for different pitches and number of layers in roof covering, mm					
		27° to 90°				80° to 90°	
		4 layers		3 layers		2 layers	
		"Exposed section" length	Overlap	"Exposed section" length	Overlap	"Exposed section" length	Overlap
1	510	120	30	155	45	155 (230*)	50
2	460	105	40	140	40	155 (210*)	40
3	410	95	30	125	35	155 (185*)	40
4	360	80	40	105	45	155	45
5	310	70	30	90	40	135	40
6	260	55	40	75	35	115	40
7	210	45	30	60	30	90	30
8	180	40	20	50	30	75	30
9	130	25	30	35	25	50	30
* the maximum length of the visible (exposed) part of the shingle after laying on a 2-layer roof pitch shall not exceed 155 mm, except for the cases of reconstructing historical roof coverings, small architectural structures etc., where longer visible areas are acceptable.							

Table 7 Relationships between the number of layers in the roof covering, the length of "chip" shingles (laid perpendicular to the eaves and in compliance with the rules of the following system: the third chip overlaps with the first one along the shorter side) and roof pitch

No	Shingle length, rated, mm	Length of the visible shingle part ("exposed section") after laying on roof slope for different pitches and number of layers in roof covering, mm		
		27° to 90°		80° to 90°
		8 layers	6 layers	4 layers

		"Exposed section" length	Overlap	"Exposed section" length	Overlap	"Exposed section" length	Overlap
1	510	120	30	155	45	155 (230*)	50
2	460	105	40	140	40	155 (210*)	40
3	410	95	30	125	35	155 (185*)	40
4	360	80	40	105	45	155	45
5	310	70	30	90	40	135	40
6	260	55	40	75	35	115	40

Table 8 Relationships between the number of layers in the roof covering, the length of "chip" shingles (laid at an angle of 60° to the eaves and in compliance with the rules of the following system: the third chip overlaps with the first one along the shorter side) and roof pitch

No	Shingle length, rated, mm	Length of the visible shingle part ("exposed section") after laying on roof slope for different pitches and number of layers in roof covering, mm					
		27° to 90°				80° to 90°	
		4 layers		3 layers		2 layers	
		"Exposed section" length	Overlap	"Exposed section" length	Overlap	"Exposed section" length	Overlap
1	510 (450)*	105	30	140	30	155 (210)**	30
2	460 (400)	95	20	125	25	155 (185**)	30
3	410 (350)	80	30	105	35	155	35
4	360 (300)	70	20	90	30	135	30
5	310 (250)	55	30	75	25	115	30
6	260 (200)	45	20	60	20	90	20
7	210 (150)	30	30	45	25	65	20
8	180 (120)	25	20	35	15	50	20

* the length of the visible part of the shingle when laid at an angle of 60° to the horizontal
** the maximum length of the visible (exposed) part of the shingle after laying on a 2-layer roof pitch shall not exceed 155 mm, except for the cases of reconstructing historical roof coverings, small architectural structures etc., where longer visible areas are acceptable.

Table 9 Relationships between the number of layers in the roof covering, the length of "chip" shingles (laid at an angle of 60° to the eaves and in compliance with the rules of the following system: the third chip overlaps with the first one along the shorter side) and roof pitch

No	Shingle length, rated, mm	Length of the visible shingle part ("exposed section") after laying on roof slope for different pitches and number of layers in roof covering, mm					
		27° to 90°				80° to 90°	
		8 layers		6 layers		4 layers	
		"Exposed section" length	Overlap	"Exposed section" length	Overlap	"Exposed section" length	Overlap
1	510 (450)*	105	30	140	30	155 (210*)	30
2	460 (400)	95	20	125	25	155 (185*)	30
3	410 (350)	80	30	105	35	155	35
4	360 (300)	70	20	90	30	135	30
5	310 (250)	55	30	75	25	115	30
6	260 (200)	45	20	60	20	90	20
7	210 (150)	30	30	45	25	65	20
8	180 (120)	25	20	35	15	50	20

* the length of the visible part of the shingle when laid at an angle of 60° to the horizontal
** the maximum length of the visible (exposed) part of the shingle after laying on a 2-layer roof pitch shall not exceed 155 mm, except for the cases of reconstructing historical roof coverings, small architectural structures etc., where longer visible areas are acceptable.

SUMMARY

The rules of laying wooden roofing have been established basing on the results of laboratory research [11] carried out in compliance with relevant provisions of the Construction Law and Regulations, the analysis of the technical condition of preserved

historical roof coverings in open-air ethnographic museums and available reference materials. Research results are discussed and presented in [11].

- Waterproofing properties of a two-layered roofing made of "tongue and groove" and "lath" shingles and three-layered "chip" shingles laid at angles from 90^0 to 22^0, sprinkled with water in the amount of 2.0–3.0 l/m^2 as per PN-EN14963;

- peel strength (resistance to negative wind pressure) of the roofing (as above) as per PN-EN 13963:2006;

- resistance of the roofing (as above) to the impact of hard (mass – 1 kg, fall from 1 m) or soft and heavy material (mass 50 kg, fall from 2.4 m) according to the Technical Report TR 001';

- shingles are made of non-dried wood. Depending on the laying technique, the moisture content of shingles during installation shall be up to 24% (tongue and groove and lath) or even approximately 28% (chip).

The analysis of the research results have led to the conclusion included in [11] that shingle roofing provides efficient protection against precipitation within the specified limits and against the penetration of water (no water marks were observed on the bottom side of shingles). Roofing hit by a hard object, which simulated hail, did not show signs of damage which could affect its performance, except for just a few small and shallow dents. Roofing hit by a soft object (simulating the impact of a human body) has also remained continuous and showed no signs of damage affecting its performance or safety of use.

Tests carried out by the Fire Research Department of the Building Research Institute in accordance with PN-EN 13501-5+A1:2010, method 1 have demonstrated that a roof with a suitable pitch covered with shingles of wood species without fire treatment, which are laid in compliance with the recommendations, can be classified as B_{roof} (t_1) fire retardant as per the Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions with which buildings and their locations should comply (Journal of Laws No 75, June 2002, item 690, as amended).

Wood shingles can be used for covering roof pitches of more than 27^o without the need of using a waterproofing layer. In particular cases (e.g. small architectural structures, extensions, finishing of buffers, dormers etc.), shingles can also be laid on roof pitches of 20^o to 27^o, but waterproofing must then be laid under the covering. The durability of roofing on pitches smaller than 27^o is probably lower, and if waterproofing is not used, shingle covering will not provide proper protection against rain or melting snow. Basing on the observations of existing roofing, there is a noticeable and clear link between roof pitch and roof covering performance. The larger the angle of roof slope, the better performance of roof covering can generally be observed.

Increasing the visible area after the installation (spreading shingles in the roof covering) is not possible due to the decrease in the technical performance of the covering, which is hard to assess and which may result in an increased exposure to water leakage through the roof slope, the risk of biological degradation caused by moisture collected in the periods of melting snow, a decrease of impact resistance with regard to soft and hard objects, as well as resistance to positive and negative wind pressure and worse fire safety performance

The method of fastening shingles to battens/counterbattens must ensure proper ventilation of the bottom part of shingles during use. Apart from the quality of shingles, preserving a ventilation gap of not less than 2 cm is the most influential factor determining the durability

of the roofing. A roof covering without an unobstructed ventilation gap (providing air access) is prone to fast biological decay.

Compliance with the rules of laying technique and the quality of the roofing material affects roof covering's durability. The appearance of the roofing depends on the skills and accuracy of the contractor, on the quality of the shingles and on the evenness and final shape of roof slopes.

REFERENCES

[1] Jan Heurich, Przewodnik dla cieśli Warszawa, Geberthner i Wolff, 1871
[2] Hermann Phleps, Holzbaukunst, DER BLOCKBAU, Faci blattverlag, Karlsruhe, 1942
[3] Z. Mielnicki, Ustroje budowlane, Katowice 1946
[4] Z. Mączeński, Poradnik budowalny dla architektów, Budownictwo i Architektura, W-wa 1954
[5] W. Żenczykowski, Budownictwo ogólne, t.1, Arkady 1964
[6] Praca zbiorowa, Mały ilustrowany słownik budowalny, Arkady, Warszawa, 1971
[7] V sympozjum Drevne Kompozitne materialy, Zbiór referatów, cz. 1 rodzaje gontów, cz. II wytwarzanie gontów. M. Jabłoński, A. Korczewski, J. Siedliacik, Zvolen 2004.
[8] Z. Mielczarek, Zabytkowe budownictwo drewniane w Polsce, Praca zbiorowa, Wyd. Uczelniane Politechniki Szczecińskiej. Szczecin 2008;
[9] E. Dobrowolska, M. Jabłoński, K. J. Krajewski, Przemysł Drzewny nr 3. 2009, str. 25-27,
[10] Tandos B. Styl zakopiański i zakopiańszczyzna, Ossolineum, Wrocław 2009
[11] A. Policińska–Serwa, M. Jakimowicz, Wooden shingles in modern construction industry. Annals of Warsaw University of Life Science – SGGW, Forestry and Wood Technology (84) 2013, 170-175.
[12] Prawo budowalne (Dz. U. nr 243, poz. 1623 z 2010r z późn. zm.)
[13] Rozporządzenia Ministra Infrastruktury z dnia 12 kwietnia 2002 (Dz. U. nr 75 z czerwca 2002, poz. 690 z poźn. zm)
[14] Rozporządzenie Ministra Infrastruktury z dn. 11.08.2004 w sprawie sposobów deklarowania zgodności wyrobów budowalnych oraz sposobu znakowania ich znakiem budowalnym (Dz. U. nr 198, poz. 2041, z późn. zm.)
[15] Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki Morskiej z dnia 5.07.2013 (poz. 926) zmieniające rozporządzenie w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie.
[16] DIN 68119 (1996) Holzschindeln

Streszczenie: *Gonty drewniane we współczesnym budownaictwie.* Cz. 2 Artykuł podaje propozycje kryteriów oceny właściwości gontów drewnianych z określonych gatunków drewna oraz zasady wykonywania pokryć dachowych respektujących współczesne uwarunkowania prawne i normalizacyjne

Correspoding authors:

Building Research Institute
ul. Ksawerów 21, 02-656 Warsaw
Anna Policińska-Serwa, MSc Eng. a.serwa@itb.pl
Marzena Jakimowicz, MSc Eng. m.jakimowicz@itb.pl
Krzysztof Kuczyński, PhD k.kuczynski@itb.pl
Andrzej Kolbrecki, PhD a.kolbrecki@itb.pl