

Wood shingles in contemporary construction. Part 1 - Properties of shingels.

ANNA POLICIŃSKA-SERWA, MARZENA JAKIMOWICZ, KRZYSZTOF KUCZYŃSKI

Abstract: Wooden roof coverings are one of the oldest technical solutions, used over the centuries. As industry and new technologies developed, they were marginalised, until – in the end of the 20th century – they became a niche product without any economic significance, used locally, as a vernacular tradition in some regions, sometimes on economic grounds. Together with the marginalisation of wood shingle coverings, the tradition of transferring craft knowledge about shingles and shingle laying techniques was abandoned. This is one of the reasons why shingles were considered a regional product, with little economic significance and which requires no standardisation procedures. Increasing awareness of the impact of environmental conditions on the quality of life, the trend of contact with nature and with its least processed materials has resulted in an unexpected growth of interest in ancient house finishing techniques, which applied not only to wooden houses (which had been in vogue already a few years earlier). Investors are now willing to use traditional materials and techniques, but only those which, apart from having qualities proven over centuries, e.g. regarding their appearance, can meet their expectations as regards current standards for the safety of use, durability and the principles of quality verification.

In the course of the development in the Building Research Institute of the proposals for the rules of verification of shingle quality and the principles of installing roof coverings made of wood shingles, current standards and regulations have been considered. This paper consists of two parts.

Part 1 includes a proposal of shingle type classification and our proposal for the requirements with which wood shingles produced and used in modern construction shall comply.

In Part 2, the rules of laying wood shingle roofing are proposed.

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

INTRODUCTION

Wood shingles are probably one of the oldest natural roof coverings. Covering roofs with wood shingles (in different versions) was known in many countries, but as new materials and roofing techniques were introduced and cities developed, the popularity of shingles declined. Around mid-20th century, shingle coverings were still used as a regional tradition in foothill areas or for economic reasons locally in Podlasie or Mazowsze and on roofs of historic churches and ethnographic museums. Buildings covered with shingles tens of years ago can still be seen, which provides evidence for the fact that the traditional craft of the past – the technique of shingle production and installation, based almost exclusively on traditions and transferred orally – could be a basis for works performed to high technical standards. Limited demand for shingles and their installation caused a natural decline in the number of specialised craftsmen, who also had no successors. The knowledge transferred traditionally from generation to generation, with hardly any reference made to literature, proved insufficient.

Technical literature regarding engineering structures made of wood or wood technology from the 19th and the beginning of the 20th century features short fragments about shingles. However, they are usually encyclopaedic by nature, as the actual expertise could be found somewhere else – in the hands and skills of craftsmen. Although some handbooks from the second half of the 20th century note the existence of shingles, the information provided is very superficial and has no practical importance due to the fact that this material was hardly ever used on a larger scale. As there are not enough specialists skilled in the traditional craft and no detailed information in literature, the unexpected renaissance of traditional roof coverings (not only on wooden houses) sees the lack of proper expertise in the methods of acquiring and preparing wood for shingles, the selection of suitable wood types and the techniques of shingle production, storage and installation. Faced with the challenge brought by the new sociological trend of longing to live in harmony with nature, in conditions and in the environment that is as pristine as possible, which also means longing for roofs covered with shingles, the Building Research Institute elaborated proposals for the criteria of shingle assessment and the rules of their installation that can be used for the purposes of technical approvals. During the preparation of the

assessment criteria for shingles and roofs, the few remaining craftsmen were contacted and the available literature was studied, including the DIN [16] standard and dispersed [17] information materials regarding cedar shingle production techniques in Canada and in the USA.

National and European regulations [12,13,14] establish the rules valid in the Member States for placing construction products on the market – including wood shingles, which are used more widely and therefore not considered a regional product anymore. Legal regulations are formulated in order to ensure access to the market for materials and products compliant with the requirements of safety and convenience of use, including the rules of their verification and assessment criteria assigned to the products. According to the provisions of [14, 15], shingles used nowadays require a declaration of conformity with Technical Approval or – in justified cases – must meet the requirements of a relatively complicated procedure of individual admittance in place of the requirements with which regional products shall comply.

In order to determine the requirements for shingles and roofing, available literature was studied, current technical condition of roof coverings made more than ten or even tens of years ago (mostly in rural areas and in ethnographic museums) was checked, regulations in force were analysed and numerous test were performed. Those observations and analyses have led to the conclusion that the verification of the suitability of currently produced products for use must cover their physical and mechanical properties and the methods of their installation. Shingles of different shapes and production methods were tested in the laboratories of the Building Research Institute, then models of roof coverings were prepared and tested with regard to the safety of use – which allowed for the assessment of compliance of contemporary roofs (including skylights) with relevant requirements.

Part 1 of the paper presents the proposed investigation methods and the requirements for shingles needed for their objective technical assessment, which later formed the evidence base for the preparation of the national technical approval.

TYPES OF SHINGLES, PRODUCTION TECHNIQUES AND REQUIREMENTS

Shingles are thin, profiled slats made of specific, selected wood types – coniferous (larch, red cedar, pine, fir, Douglas fir, spruce) and deciduous (oak, acacia, aspen, alder).

Examples of shingle shapes divided into types are shown in Figures 1, 2 and 3.

The study was performed using hand-split, sawn and split and sawn wood shingles, as well as shingles in the form of chips. Shingles of a “tongue and groove” (Fig. 1), “lath” (Fig. 2) and “chip” (Fig. 3)

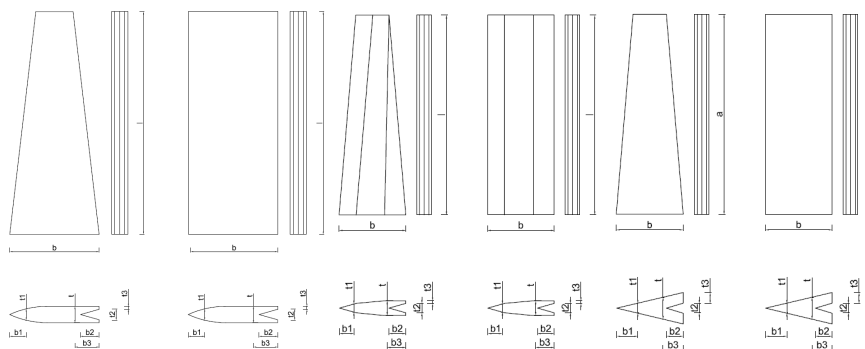


Figure 1 Examples of the shapes of “tongue and groove” shingles

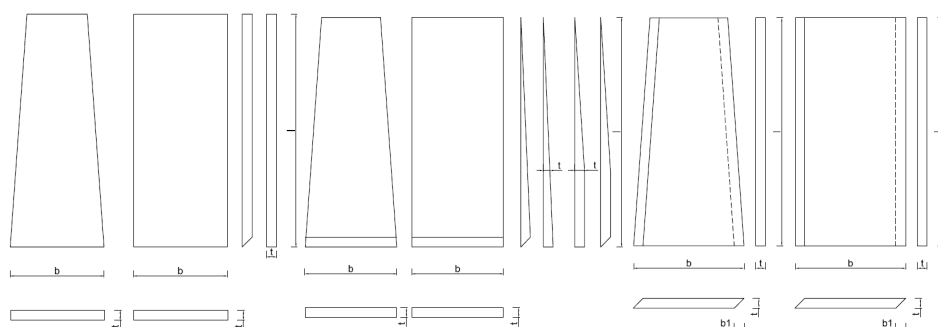


Figure 2 Examples of the shapes of “lath” shingles

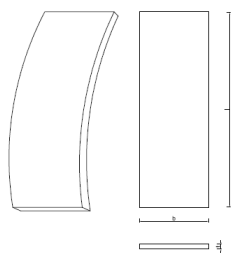


Figure 3 The shape of “chip” shingles

The requirements regarding the dimensions for specific shingle types (independent of the way they are produced) are presented in Table 1 and Table 2.

Table 1 Dimensional range of shingles

No	Properties	Requirements	
		“tongue and groove” shingles	“chip” shingles
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
1	Shape	as per Figures 1 – 3	
2	Length (<i>l</i>), mm	120 ÷ 650	130 ÷ 510
3	Thickness (<i>t</i>), mm ¹⁾	20 ÷ 30	4 ÷ 7
4	Width (<i>b</i>), mm	60 ÷ 120	40 ÷ 200
5	Geometric characteristics, mm:		
	– tongue length (<i>b</i> ₁)	20 ± 2 ²⁾	-
	– shingle thickness (<i>t</i> ₁) at a distance <i>b</i> ₂ = 20 mm from the tongue edge	11 ± 2 ²⁾	-

Table 2 Dimensional range of “lath” shingles

No	Properties	Requirements			
		“lath” shingles			
<i>1</i>	<i>2</i>	<i>3</i>			
1	Shape	as per Figures 2			
2	Length (<i>l</i>), mm	< 250	250 - 300	301 - 450	450 - 600
3	Thickness (<i>t</i>), mm ¹⁾	≥ 7	7 – 9	> 9	9 – 12
4	Width (<i>b</i>), mm	50 - 140		50 - 180	
5	Geometric characteristics, mm, from the tongue of shingles “ <i>bialostocka</i> ”	20 ± 2 ¹⁾			

Following an analysis of the appearance of shingles in preserved buildings and the requirements of [16] and [17], a division of shingles into 4 groups assigned to different performance levels was elaborated. Shingles are assigned to corresponding groups basing on the assessment of more than ten characteristics. General tests of wood recommended for the production of shingles have shown that the characteristic Brinell hardness for wood shall not be lower than 22 MPa, the characteristic density for deciduous wood not lower than 450 kg/m³ and for coniferous wood – not lower than 350 kg/m³. The aforementioned values correspond to wood moisture content of approximately (22±4)%. Wood for shingle production comes from straight-grain sections between the whorls. Performance levels for shingles are determined independent of the method of their production, i.e. they are the same for split, split-and-sawn and sawn shingles.

Split shingles are still produced using traditional methods, using an axe and a shave. The production of split and sawn shingles is partially mechanised – mechanical tools to some extent substitute hand splitting and profiling. Properly made split-and-sawn shingles show no differences in water permeability, but their durability compared to split shingles is still unknown, as they have not been tested under natural conditions. Sawn shingles are made using machines only. They are usually made of straight-grain board sections which comply with the requirements for wood characteristics (as above), the shape of shingles and performance levels.

Performance levels for specific shingle types are listed in Tables No 1, 2 and 3.

Table 1 Performance levels for “tongue and groove” shingles

Item	Properties / characteristics	Wood species			
		coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir deciduous: oak, aspen
		Level A	Level B	Level C	Level D
1	2	3	4	5	6
1	Knots	unacceptable	healthy and tight at the distance from the base of more than 60% of the length	healthy and tight of a diameter ≤ 20 mm along the entire shingle length	healthy and tight along the entire length. knot holes at the distance from the base of more than 60% of the length
2	Resin blisters	unacceptable	unacceptable passing through	not passing through in the visible area passing through at the distance from the base of more than 60% of the shingle length	acceptable
3	Sapwood	unacceptable along the entire length			acceptable
4	Colour	acceptable colour variations resulting from the process of wood working, storage and natural wood characteristics (including point blue stain resulting from the process of wood working and storage, as well as discolourations from the process of the production and installation of roof covering – e.g. contact between steel or other metals and wood)			different colours are acceptable
5	Bio-corrosion, decay	unacceptable			
6	Foraging traces of insects	unacceptable			
7	Cracks	acceptable, provided they do not decrease suitability for use			
8	Traces of shingle processing – burrs and defects during working (splitting, cutting, sawing, planing)	marginal provided they do not decrease suitability for use		provided they do not decrease suitability for use	acceptable
9 ¹⁾	Deviation in width (shingle of the same rated width)	± 2% of the width of the rated dimension	± 3% of the width of the rated dimension	± 6% of the width of the rated dimension	± 10% of the width of the rated dimension
10 ¹⁾	Deviation in length	(-5 /+20) mm	(-5 /+25) mm	(-5 /+30) mm	(-10 /+30) mm
11 ¹⁾	Deviation in thickness (from drying)	(-2 /+2) mm	(-2 /+2) mm	(-2 /+3) mm	(-3 /+3) mm
12	Deviation from the squareness between the base and the side (not specified for wedge shingles)	≤ 5% of the width	≤ 8% of the width	≤ 10% of the width	≤ 15% of the width
13	Deviation from parallelism of the sides (not specified for wedge shingles)	≤ 2% of the shingle length	≤ 3% of the shingle length	≤ 4% of the shingle length	≤ 5% of the shingle length
14	Deformations: surface warp	deviation in surface profile ≤ 2% of the sum of shingle length and width	deviation in surface profile ≤ 4% of the sum of shingle length and width	deviation in surface profile ≤ 5% of the sum of shingle length and width	

Item	Properties / characteristics	Wood species			
		coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir deciduous: oak, aspen
		Level A	Level B	Level C	Level D
1	2	3	4	5	6
15	Deviations in grain direction at a distance of 300 mm from the “foot” of the shingle	≤ 40 mm from the line parallel to the side edge	≤ 50 mm from the line parallel to the side edge	not specified	not specified
16	Open core	unacceptable			acceptable
17	Wood with lightning scars or from windfall	unacceptable			
18 ²⁾	Wood grain inclination	from 90° to 30°	from 90° to 30°	not specified	
19 ²⁾	Maximum width of annual growth rings in cross-section	4 mm	6 mm	10 mm	not specified
¹⁾ dimensional deviations larger than those specified (allowable) can occur in no more than 10% of timber elements in the batch ²⁾ for aspen shingles, the number of growth rings in cross-section and wood grain inclination is not specified					

Table 2 Performance levels for “lath” shingles

Item	Properties / characteristics	Wood species			
		coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir deciduous: oak, aspen
		Level A	Level B	Level C	Level D
1	2	3	4	5	6
1	Knots	unacceptable	healthy and tight at the distance from the base of more than 70% of the length	healthy and tight of a diameter ≤ 20 mm along the entire shingle length	healthy and tight along the entire length. knot holes at the distance from the base of more than 70% of the length
2	Resin blisters	unacceptable	unacceptable passing through	not passing through in the visible area passing through at the distance from the base of more than 70% of the shingle length	acceptable
3 - 10		so as to table 1			
11 ¹⁾	Deviation in thickness (from drying)	(-1 /+2) mm	(-2 /+2) mm	(-2 /+3) mm	(-2 /+2) mm
12-19		so as to table 1			
¹⁾ dimensional deviations larger than those specified (allowable) can occur in no more than 10% of timber elements in the batch					

Table 3 Performance levels for “chip” shingles

Item	Properties / characteristics	Wood species			
		coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir deciduous: oak, aspen
		Level A	Level B	Level C	Level D
1	2	3	4	5	6
1	Knots	unacceptable	healthy and tight at the distance from the base of more than 60% of the length	healthy and tight of a diameter ≤ 20 mm along the entire shingle length	healthy and tight along the entire length. knot holes at the distance from the base of more than 60% of the length
2	Resin blisters	unacceptable	unacceptable passing through	- not passing through in the visible area - passing through at the distance from the base of more than 50% of the shingle length	acceptable

Item	Properties / characteristics	Wood species			
		coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir, spruce deciduous: oak, aspen	coniferous: larch, red cedar, pine, fir deciduous: oak, aspen
		Level A	Level B	Level C	Level D
1	2	3	4	5	6
3	Sapwood	unacceptable along the entire length			acceptable
4	Colour	acceptable colour variations resulting from the process of wood working, storage and natural wood characteristics (including point blue stain resulting from the process of wood working and storage, as well as discolourations from the process of the production and installation of roof covering – e.g. contact between steel or other metals and wood)			different colours are acceptable
5	Bio-corrosion, decay	unacceptable			
6	Foraging traces of insects	unacceptable			
7	Cracks	acceptable, provided they do not decrease suitability for use			
8	Traces of shingle processing – burrs and defects during working (splitting, cutting, sawing, planing)	accepted if marginal provided they do not decrease suitability for use		acceptable, provided they do not decrease suitability for use	acceptable
9 ¹⁾	Deviation in width (shingle of the same rated width)	± 2% of the width of the rated dimension	± 5% of the width of the rated dimension	± 8% of the width of the rated dimension	± 10% of the width of the rated dimension
10 ¹⁾	Deviation in length	(-5 /+20) mm	(-10 /+30) mm	(-15 /+35) mm	(-30 /+30) mm
11 ¹⁾	Deviation in thickness (from drying)	(-1 /+2) mm			
12	Deviation from parallelism of the sides	not specified			
13	Deformations: surface warp	not specified			
14	Deviations in grain direction	not specified			
15	Open core	unacceptable			acceptable
16	Wood with lightning scars or from windfall	unacceptable			
18	Wood grain inclination	not specified			
18	Maximum width of annual growth rings in cross-section	not specified			

¹⁾ dimensional deviations larger than those specified (allowable) can occur in no more than 10% of timber elements in the batch

SUMMARY

In the past, shingles (except for chips) were made of wood logged in late autumn or early winter and without impregnating agents. Even before logging, basing on the analysis of a bark sample, a skilled shingle craftsman could assess a tree's usability for making shingles.

In the past, shingles were produced locally and made of available wood species. Modern shingles are not a regional product anymore, and their shapes are not characteristic for a specific region (except for shingles used in open-air ethnographic museums).

The shapes, dimensions and technical performance levels proposed in this paper can be applied to shingles produced in any region. The requirements for shingles established considering formal and legal regulations can form a basis for determining data for technical approvals.

Apart from the clear specification of the requirements for shingle as a construction material, factors such as the method of installing roof covering, work technology and the amount of material used play an important role for the final performance of the roofing. Therefore, the rules of laying roof coverings made of wood shingles, developed by the Building Research Institute and presented in Part 2 of this paper, provide an important supplement to the study.

The subject of wood shingle roofing and its assessment is a new issue, and adjustments of some of the provisions included herein can be expected, but it seems that for the current expertise this paper presents a compendium of knowledge.

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Streszczenie: Artykuł składa się z dwu części. W cz. 1 podaje propozycje kryteriów oceny właściwości gontów drewnianych z określonych gatunków drewna zaś w cz. 2 propozycje zasad wykonywania pokryć dachowych. Zarówno zasady dotyczące gontów jak i pokryć dachowych z nich wykonanych opracowano uwzględniając wymagania Prawa budowlanego i Rozporządzeń w sprawie deklarowania właściwości użytkowych wyrobów budowlanych.

Corresponding authors:

Building Research Institute
Building Structures Department
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