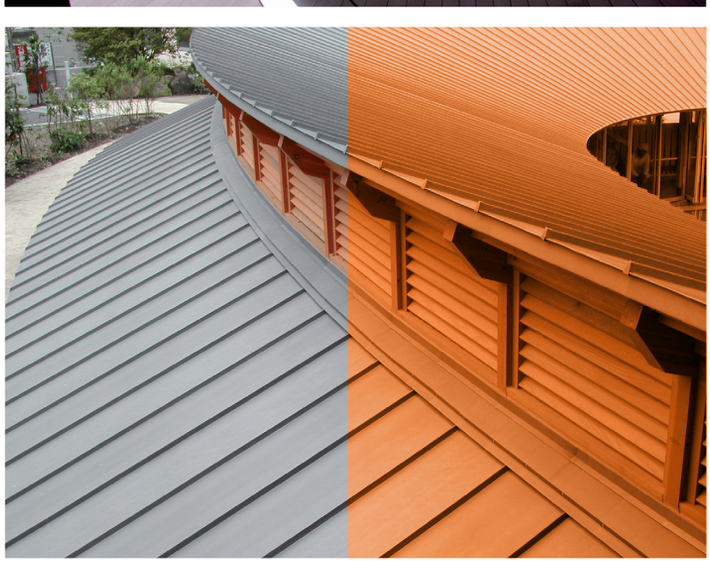
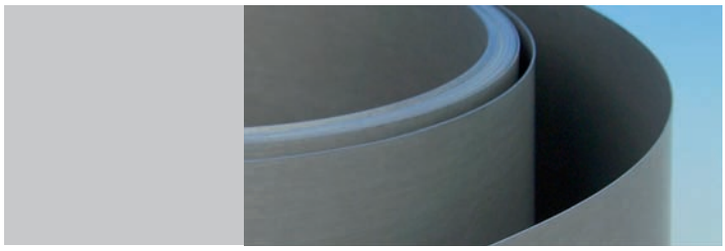
Zinc-titanium
Application Manual





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Zinc-titanium

Modern variety of metal with traditions

Zinc has been used as building material for almost 200 years. It is not only decorative but also exceptionally durable and reliable material – there are still functioning buildings with zinc covers made over a hundred years ago. In response to increasing requirements in the range of physical and mechanical parameters a technology of new generation of zinc-titanium has been developed.

Sheet made of zinc-titanium alloy is a special material both in technical and aesthetic point of view as it could be perfectly formed and shaped. With atmospheric conditions a protecting layer spontaneously forms on its surface. The layer assures high resistance to corrosion and give aesthetic appearance to the sheet. Zinc-titanium sheet chief qualities are: low coefficient of thermal expansion, good resistance to bending and high mechanical properties with good resistance to crawling, what is of special importance in case of rooftop with substantial sloping (i.e. attics, elevations). Thanks to those properties zinc-titanium sheet can be used for roof covers, elevations and protectors for different elements of a construction (parapet walls, cornices, window sills and the like) and for roof guttering system manufacturing.

Photo 1
Roof covering

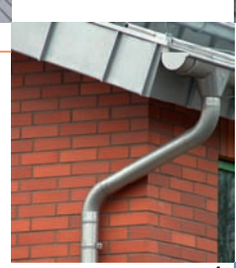
Photo 2
Roof works

Photo 3
Guttedring

Photo 4
Façades

1

2



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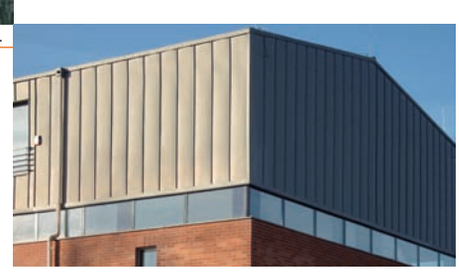

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Due to its plasticity and perfect susceptibility to shaping it can face up to the most complicated requirements of modern architectural projects or old buildings renovations.

Merits of zinc:

- over 80 years durability,
- resistance to corosion,
- no need for extra maintenance,
- plasticity, ease of joining and forming,
- perfect for soldering,
- lightness and incombustibility,
- suitability for recycling.

2. Description of a material

2.1. Chemical composition

Zinc-titanium sheet is produced of the highest quality zinc SHG according to **PN-EN 1179 standard** – „Zinc and zinc alloys. Original zinc", quality Z1, min. Zn content 99,995%, supplemented with alloy additions, and manufactured in the process of continuous casting and rolling, then cut into sheets and strips. The sheet is in conformity with **PN-EN 988 standard** – „Zinc and zinc alloys. Technical specification of flat rolled goods for building industry".

Tab. 1 **Mechanical and phisical properties of zinc-titanium**

	requirements of PN-EN 988 standard	Quality parameters ZM Silesia sheet	unit of measurement
Chemical composition			
Zinc (Zn)	99,995	99,995	%
Copper (Cu)	0,08 ÷ 1,0	0,08 ÷ 0,2	%
Titanium (Ti)	0,06 ÷ 0,2	0,06 ÷ 0,1	%
Aluminium (Al)	⩽ 0,015	⩽ 0,015	%
tolerances on dimensions of standard products			
thickness (sheets and strips)	±0,03	+0,00/-0,03	mm
width (sheets and strips) +2/-0 +1,0/-0,0	mm		
length	+10/-0	+3,0/-0,0	mm
rectilinearity	⩽ 1,5	⩽ 1,5	mm/m
flatness	⩽ 2,0	⩽ 2,0	mm
mechanical properties (along rolling direction)			
tensile strength R_m	⩾ 150	150-180	N/mm^2
lower yield point $R_{p0,2}$	⩾ 100	100-150	N/mm^2
elongation at break A50	⩾ 35	⩾ 40	%
unit elongation at creep	⩽ 0,1	⩽ 0,1	%
Vicker's hardness	–	⩾ 40	HV
physical properties			
density		7200	kg/m^3
melting point		420	°C
recristalization temperature		> 300	°C
thermal expansion linear coefficient (along rolling direction)		0,022	mm/(m*K)
thermal expansion linear coefficient (at right angles to rolling direction)		0,017	mm/(m*K)

2.2. Protective layer – patina

The most specific for zinc is its slow surface oxidation caused by weather conditions. It is a natural process typical for some metals. The layer called patina, arisen on the surface, protects metal against harmful outside factors. In case of small mechanical damages, e.g. scrapes made with tools, the surface regenerates (scars).

There are two stages of natural patina forming process on zinc-titanium sheet surface.
In the first stage zinc reacts with rainwater and zinc hydroxide forms on the surface. It could be visible as a white coating even after the first rain. In the second stage the zinc hydroxide reacts with carbon dioxide contained in air and forms thin, few micrometers thick, tight layer of zinc carbonate called patina which really well adheres to the ground and is insoluble in water. The speed of natural process of patina forming depends on many factors, such as local atmosphere composition, inclination of the element used and can last from few months to few years.

Tab. 2 **Approximate time of patina forming**

rural areas	more than 2 years
urban areas	1 ÷ 3
industrial areas	0,5 ÷ 1

Photo 5
Result of the natural process of patina forming

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2.3. Varieties and assortments

ZM 'Silesia' zinc-titanium sheet is offered in three varieties:

NATURAL

- **NATURAL** – the metallic and shining surface which will gradually turn to a natural light grey zinc patina in response to localised atmospheric conditions.

PRE-AGED GREY

- **PRE-AGED GREY** – a matt, light grey patina surface created as a result of chemical processes. It is recommended to use pre-aged material on elements such as facades.

PRE-AGED CARBON

- **PRE-AGED CARBON** – a graphite-black surface developed using a complex technological process. The contrasting dark patina provides a distinctive identity whilst harmonising with other building materials such as slate.

Below you can find dimensions of sheets and strips offered.

Dimensions of sheets

thickness mm	width mm	length mm	weight kg/m²
0,55	1000	2000 i 3000	4,0
0,60			4,3
0,65			4,7
0,70			5,0
0,80			5,8
1,00			7,2

Dimensions of strips **Tab. 3, Tab. 4**

thickness mm	width mm
0,60	200÷1000
0,65	
0,70	
0,80	
1,00	

Sheets are delivered in 1000 kg batches on wooden pallets. Strips in coils are placed on wooden pallets, horizontally or vertically depending on the weight of a coil. Material on the pallet is protected against moisture with plastic wrap. The weight of coils is between 100 and 4500 kg. The width can be chosen depending on project from the range given.

2.4. Transport and storage

Only clean, dry and canopied means of transport should be used for sheet. It must not be soaked during transport or storage as its contact with water can start the first stage of patina forming which results in white zinc hydroxide appearing on the surface of material. That phenomena is a natural process and is not treated as a fault of the material although it is not desirable during storage due to aesthetic reasons.

Short-term storage: On construction site coils should be stored under a canopy in their original packing on pallets. Pallets with coils must not be stacked up.
Long-term storage: Storage space for sheet should be dry and well ventilated with minimal temperature 0°C. Sheet stored should be protected against moisture and isolated from active chemicals.

2.5. Environment protection – recycling

Zinc-titanium elements of roof covers removed during modernization or renovation could be taken to scrap heap. Then they are recycled in mills without any harmful effects to environment. When processed it could be used as construction material of standard value. It coincides with present world tendencies in natural environment protection and materials recycling.

Essential rules of application 3.

On the stage of design of the building on which zinc-titanium is scheduled to be applied we should consider below parameters when the decision on individual elements' construction is to be taken:

- what will the building be used for
- shape and inclination of the roof
- location of the building with respect to the most frequent wind directions
- compound weather conditions i.e. climatic zones and influence of different atmospheric factors in the place of location.

3.1. Rainload

Zinc-titanium roof works have to protect building against atmospheric water (rain, snow, dew) and to channel it outside the building or to drain system.

Below construction orders help to achieve above goal:

- inclinations applying (concerning roofs, gutters and roof drains),
- turns up applying e.g. on eaves or walls,
- applying projections over the wall face and turns up against water e.g. firewalls, cornices, window sills.

Determining individual loads pursuant to domestic law regulations lies with designer.
In Europe they accord to:
EN 12056-3 – 'Gravitional drain systems inside buildings.
Chapter 3: Rain pipes, designing of a system and calculations.'

3.2. Wind and snowload

Roof and wall covers should be protected against tearing out by wind or overloading by snow with:

- stable construction,
- suitable mechanical clamps,
- sheet thickness in accordance with standards or recommendations,
- fastening to construction with appropriately suited elements, with special care for areas of danger such as: edges, corners, eaves, cornices and the like.

Determining individual loads pursuant to domestic law regulations lies with designer.
In Europe they accord to:
EN 1991-1-4:2005 – 'Effect on constructions. Part 1-4:
General effects – Wind effects'.
EN 1991-1-3:2005 – 'Effect on constructions. Part 1-3:
General effects – Snowload'.

Snow cover laying on zinc-titanium roof effects on it as follows:

- access of CO_2 is stopped, what makes patina creation impossible (in case of long, over 3 months laying),
- repeated cycles of freezing and melting brings about 'lakes' on the junction of the snow cover and bare sheet (specially in the eaves area), what can result in capillary water up pulling and seam joint leaking.

In the areas of heavy rains despite the roof slope it is advised to use tangled mats with drain and sealing tape for seam joints.

3.3. Joining with other materials

3.3.1. Metals

Elements made of different metals are not allowed to touch each other if it can cause contact corrosion or other unfavourable effects. In the presence of electrolyte (rain water, moisture contained in construction materials) there is a risk of electrochemical corrosion (creation of voltaic cells).

Acceptable and unacceptable joining of metals **Tab. 5**

	aluminium (Al)	lead (Pb)	copper (Cu)	steel	stainless steel	galvanized steel
zinc (ZN)	+	+	–	–	+	+

+ acceptable direct joining
– unacceptable direct joining

Copper ions of the falling water can cause corrosion on zinc-titanium sheet surface so relative to falling water direction the sheet should not be placed below copper material. Unprotected steel elements in turn corrode relatively quickly and can cause hardly removable rust-coloured moisture patches.

3.3.2. Bituminous materials

In case of direct contact of zinc-titanium sheet with water falling from bituminous surface an unfavourable phenomena called bituminous corrosion can occur. Such a situation take place when we use metal draining systems and roof works below roofs covered with bituminous materials such as roofing paper. Bituminous surface treated by UV rays, atmospheric moisture and chemical compounds contained in the air emits aggressive chemical compounds of acid reaction which can cause corrosion of zinc when in touch with sheet.
When bituminous materials are laid on sloping rooftop zinc-titanium sheet should not be placed below (relative to falling water direction).
In case of bituminous cover on flat roof gravel sprinkles can be used as protection against solar radiation and as a result against the possibility of creation of bituminous agents oxidation products. If it is not possible to eliminate zinc-titanium sheet contact with disintegration products of bituminous agents you can prevent bituminous corrosion covering the sheet surface with protective paint coat. Chlorinated rubber and recently more and more often products based on acrylic resins are used for protection of zinc-titanium sheet. Such coats however should be regularly checked and renovated if necessary as they are themselves exposed to age and corrosion processes.

3.4. Thermal expansion

Metals expand or shrink with the changes of temperature. With respect to climatic conditions in Europe we should expect temperature fluctuation (on roof surface) between -30°C and +70°C. During the installation of roof cover, elevation facing or draining system you should always consider that property of metal. When not considered it can result in serious damages of roof cover and leaking caused by tearing of the material or soldered join. Thermal expansion linear coefficient for zinc-titanium sheet amounts 0,022 mm/(m*K). So, 10-meter long strip put on the roof can expand / shrink of 22 mm. If strips are not installed in a way that enables 'moves' substantial tensions (reaching even up to 5 tons) can occur in material and cause its damages. The maximum advised space between the compensations of elongation you can find below.

Tab. 6 **Length of the elements of covering**

element	length, m
hanging gutters diameter up to 500 mm	12
roof cover	10
siding seal of the edge of a roof wall cover	8
frames of the edge of a roof	6

If there is a necessity of using elements longer than specified you should contact ZM „Silesia" SA technical advisor.

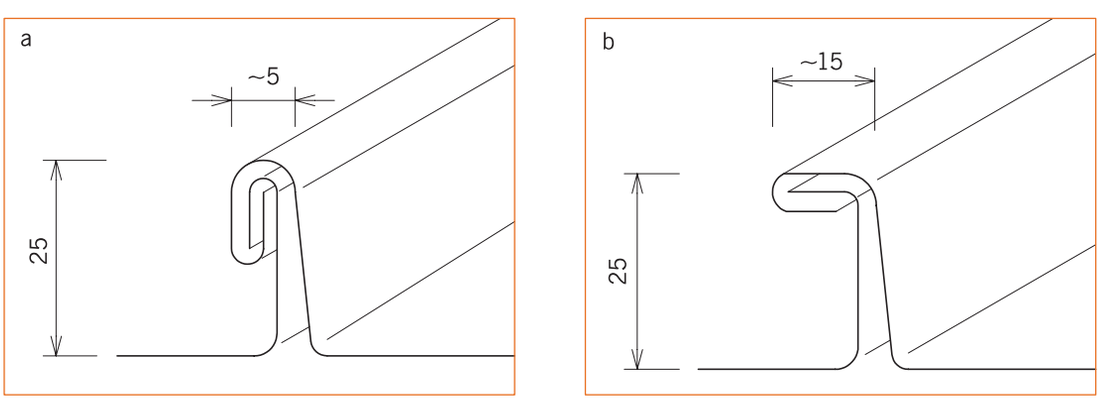
4. Application systems

The most frequently used techniques of zinc-titanium sheet application on roofs are as follows:
- double standing seam,
- angled standing seam,
- systems with wooden slat application,
- covering with small-size forms (scales, tiles and the like).

Above mentioned techniques can be broadly and without any problems used irrespective of architectonic shape of the building. When profiling machine is used you need less time for covering and it is more aesthetic.

4.1. Double and angled standing seam

Standing seams are made of strips of adequate thickness (most often 0,7-0,8 mm) and width from 400 to 700 mm. You should reserve a strip about 70-80 mm wide for each seam. For example in case of strip 670 mm wide effective width of covering is about 600 mm. Maximal advised length of a single strip is 10 m. When strips longer than 10 m are necessary you should contact ZM „Silesia" SA Technical Advisor.
It is also possible to use transversal joining of strips.

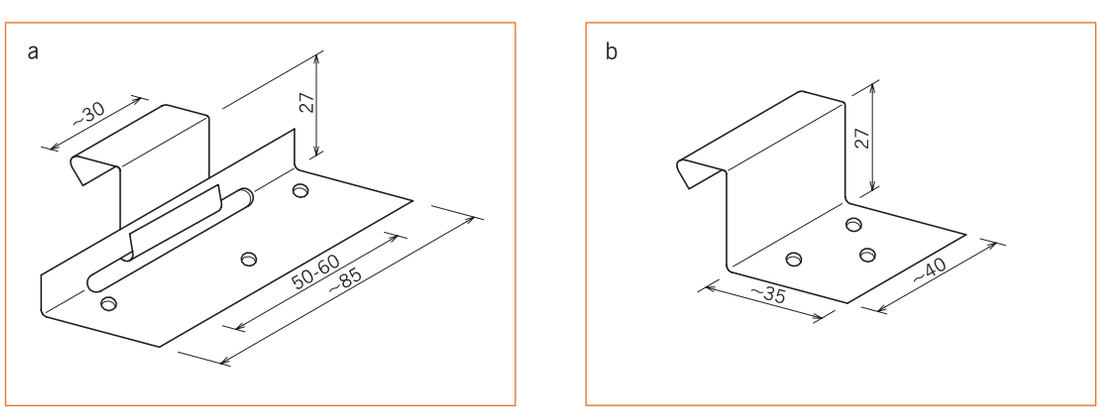


Drawing 1
Standing seam diagram:

a) double in case of inclination ⩾ 3°)

b) angle in case of inclination ⩾ 25° or siding

Double standing or angled seam system claim for special fastening with fixed or sliding clips. The clips are made of zinc-titanium sheet of 0,8 mm thickness.



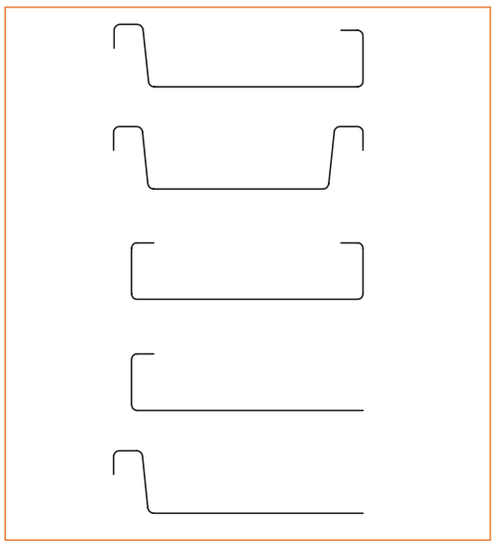
Drawing 2
Types of clips:

a) sliding clip for machine-made panels

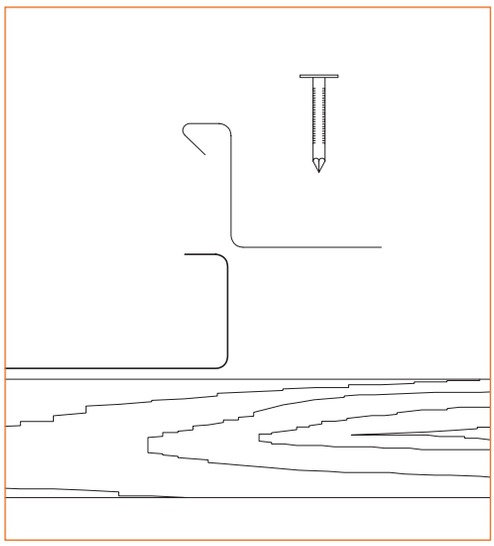
b) fixed clip for machine-made panels

Below you can see the sequence of the process of seam making from pre-formed panels with the use of sliding and fixed clips.

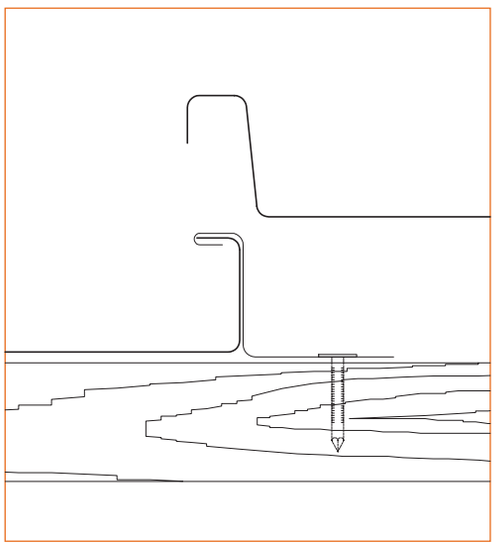
Drawing 3
Sequence of assembly of the covering made from machine--made panels



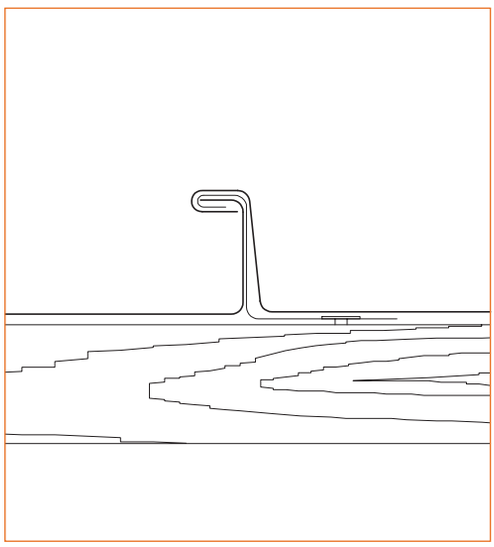
a) shapes of the panels pre-formed on profiling machines with rolls



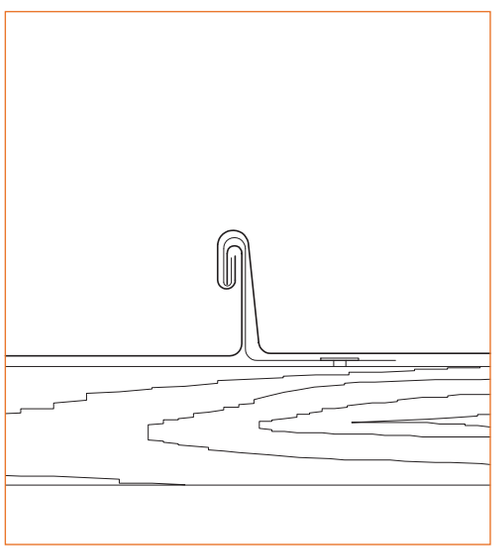
b) indirect fastening of the panel with the clip



c) the following panel placing



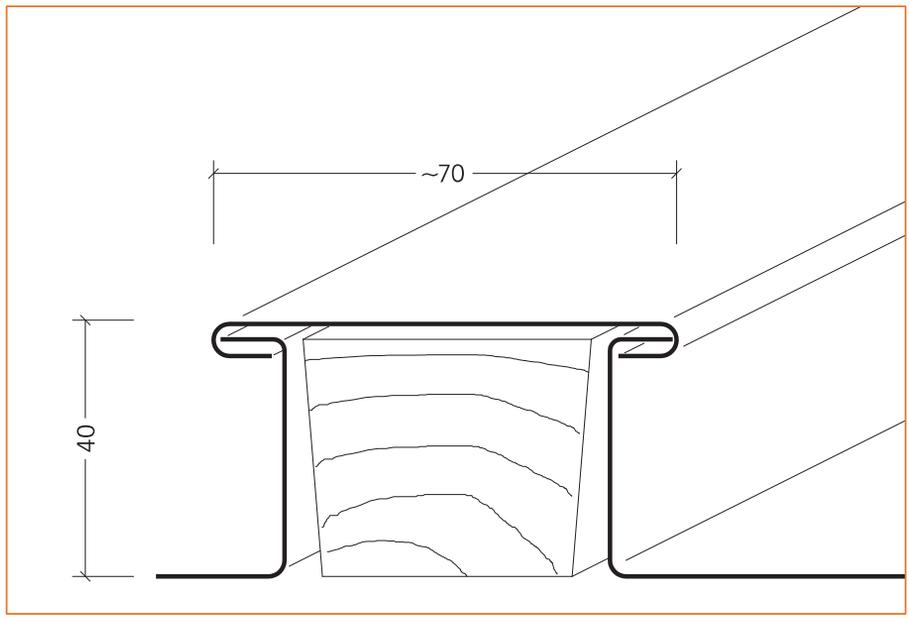
d) hand- or machine-made closing to angled standing seam



e) closing to the double standing seam

4.2. Slat systems

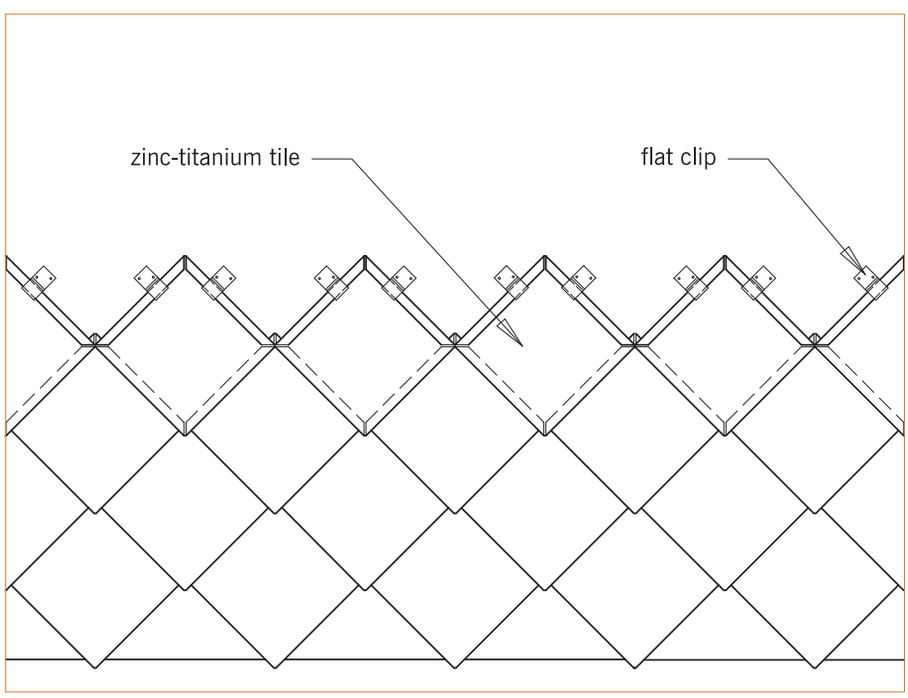
There are some local varieties of application systems which base on slat. The characteristic feature of that system is wooden slat of square or trapezium cross-section in longitudinal joining and vertical bendings off joined to it. Berlin variant of the system with slat is used in different varieties for roof covering (3° to 7° inclination with additional protection) and sidings. Basic details of roof finishing in slat systems are mainly the same as in standing seam system.



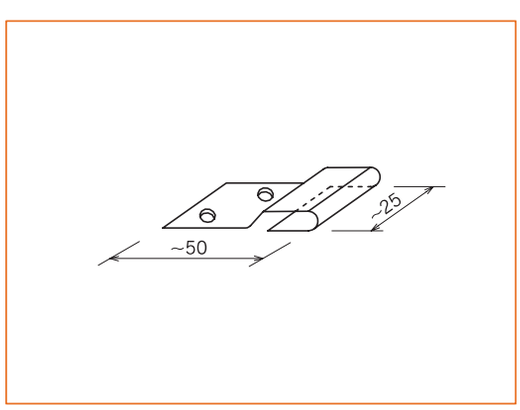
Drawing. 4
Diagram of longitudinal joining – slat

4.3. Small-size elements – tile system

Covering with small size forms is used both for roofs (with minimal inclination 25°) and for sidings. Most often used elements are of square shape but rhombuses and rectangles are also used.
Elements hooked to each other with edges bended minimum at 25 mm make a kind of mosaic of identical pieces joined by means of flat clips.
The system can be used both for small and big flat and arched surface.



Drawing. 5
Diagram of tile system

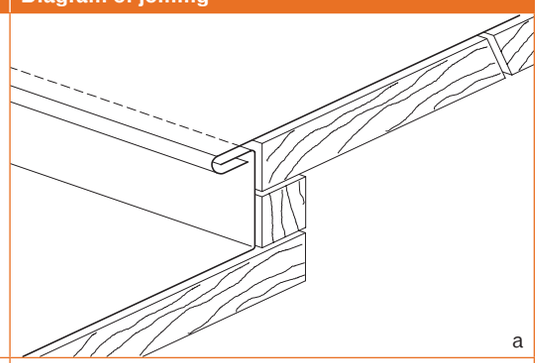
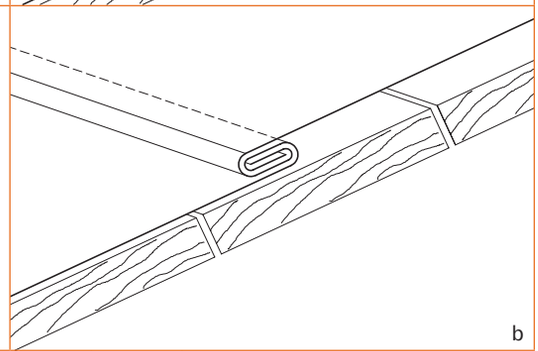
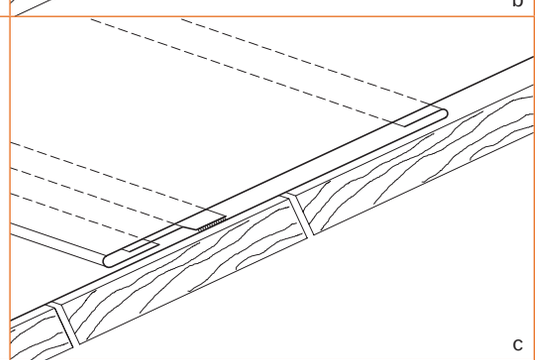
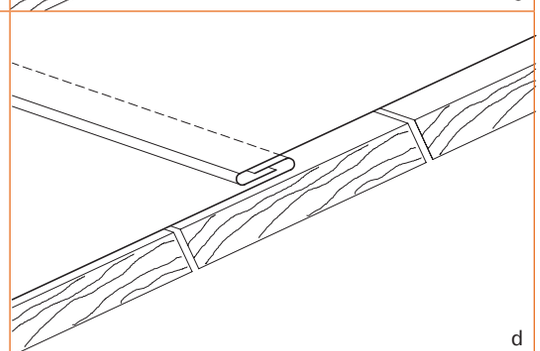
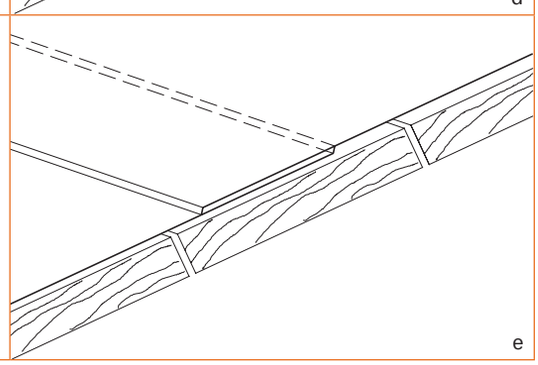


Drawing. 6
Flat clip

4.4. Transversal joints

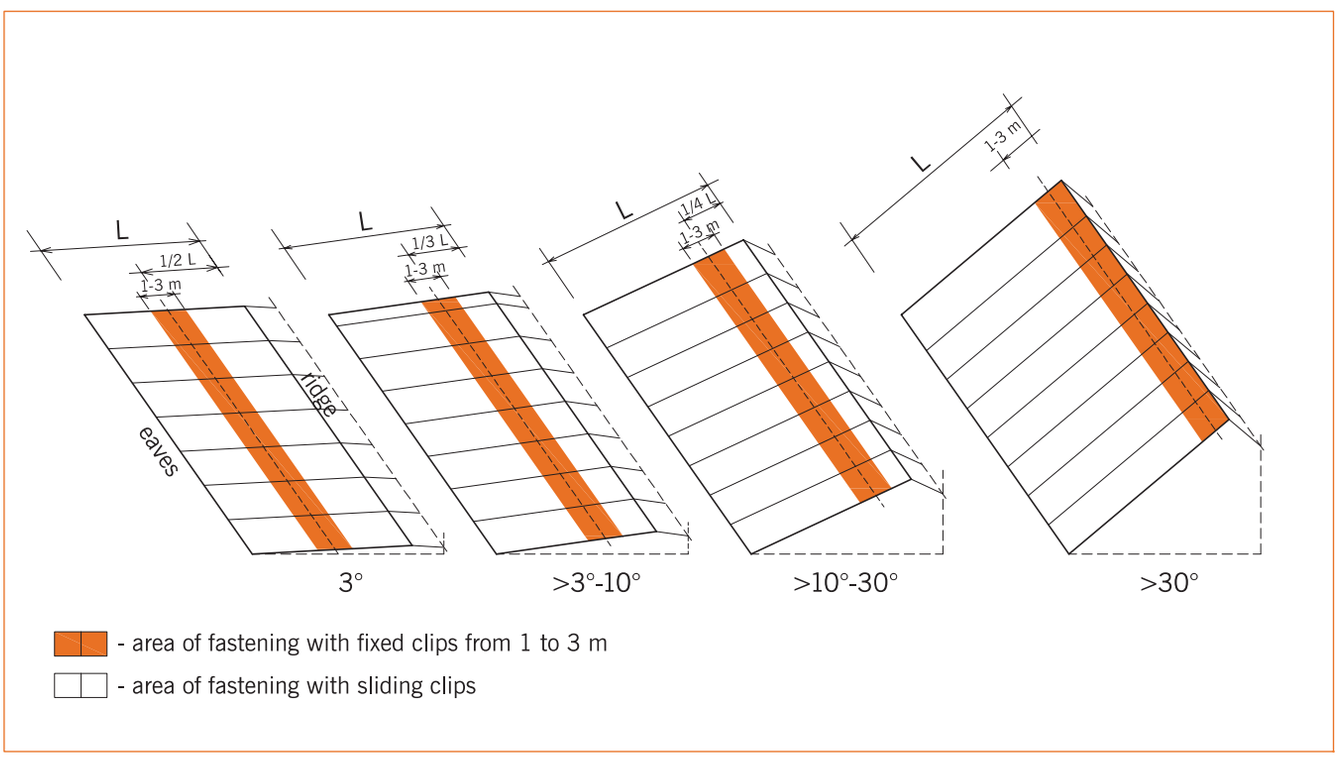
When rooftop length exceeds the length of sheet strip possible to be used in that very case an adequate transversal joining should be applied. Type of the joining should be chosen with consideration of the roof inclination and structure. Transversal joining should be accomplished in a way that allows free water run-off and complete rain-tightness of the cover. If necessary flat clips can be used for transversal joining.

Tab. 7 Transversal joining

Description	Inclination	Diagram of joining
stepped joint 'fault' used for small inclinations	⩾3°	 a
double lying seam joint used mainly for covers 'made of sheets', they should not be used for long panels	⩾7°	 b
joint with hooking slat, the slat should be soldered on its whole length	⩾10°	 c
single lying seam joint, used also for sidings	⩾25°	 d
fold joint, edges bended to avoid capillary effect, rarely used and not recommended	⩾45°	 e

4.5. Fastening of the covering

Double standing seam system and slat systems demand zinc-titanium strips to be fastened in a way that allows compensation of the length changes on ridge and eaves. Fixed and sliding clips should be situated with respect to roof inclination, to places where the elements pass through the hipped roof ends and to the length of the strips. In case of zinc-titanium roofs it is required to use sliding clips for strips longer than 3 m. The diagram below shows in simplified way areas of fastening the fixed clips depending on the inclination of hipped roof ends.



Drawing 7
Diagram of fixed clips placing depending on roof inclination

As the fastening elements directly touch the zinc – titanium roof covering, clips and other fastening elements (nails, screws and the like) should be selected very carefully. First of all attention should be paid to electro-chemical conformity of the materials that are in touch with each other.
For the clips steel galvanized (corrugated) nails 2,8x25 mm or stainless steel screws 4x25 mm are recommended. Copper or not galvanized nails are prohibited.

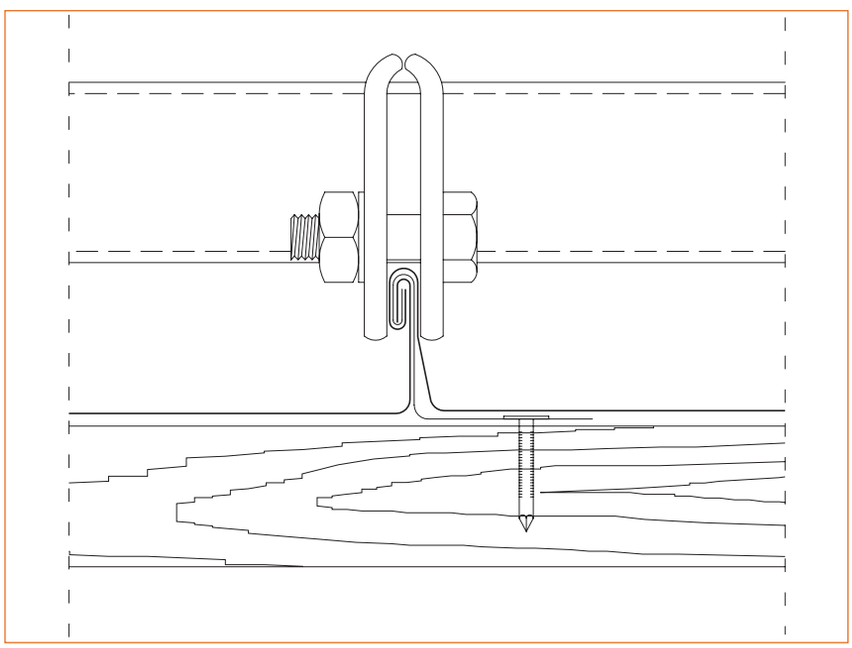
Type, quantity and the way of fixing the fastening elements to a substructure should be select with respect to expected load on the construction (strength of a winter suction and pressure). To prevent tearing off the roof covers and the façades because of winter impact adequate solutions should be considered as early as the project is being designed and they should be consequently applied. Zinc-titanium outer cover resistant to winter should be fastened with advisable quantity of clips per m^2 which should be placed at a specified distance from each other. On the rooftop there are different areas of wind load: central, corner and borderline with different requirements in that subject.
The chart below shows the dependence of clips quantity per m^2 and their distance from each other on the height of rooftop, taking the width of strips under consideration.

Tab. 8 **Quantity and distance between clips depending on the building height and the width of a strip**

height of rooftop, m width of a strip		up to 8				from 8 to 20			from 20 to 100	
		~500	~580	~630	~730*	~520	~590	~620	~520	~590
thickness of a sheet, mm		0,70	0,70	0,70	0,80	0,70	0,70	0,70	0,70	0,70
central area	number of clips, items/m²	4	4	4	4	4	4	4	4	4
	distance, mm	500	500	400	400	500	500	500	500	500
border area	number of clips, items/m²	4	4	4	4	6	6	6	8	9
	distance, mm	450	450	350	350	350	350	300	250	200
corner area	number of clips, items/m²	7	7	7	7	10	10	10	13	13
	distance, mm	300	300	250	250	200	200	150	150	150

* advisable thickness of the sheet 0,80 mm

4.5. Safety accessories



Drawing 8
The way of safety accessories fastening to the seam

Among the most frequently used safety accessories we should quote snow guards, which allow the roof ends remain free from snow overhangs and stop the slipping of big frozen snow-lumps. It is of crucial importance in the areas of heave snows and in case of roofs situated within routes. Frequently used are also the accessories that allow walking on the rooftop such as benches and chimney-sweep's stairs. There are different implementations depending on the accepted solution but it is recommended to use clamp holder fixed to the seam. Kind of material the accessory is made of should be compatible to the kind of covering material.

In case of zinc-titanium applied in seam system accessories should be made of aluminum or stainless steel and fixed to the seam. In the point of fixing an increased number of clips (minimum two claps one by one) and extra protection (sealing tapes in the area of fixing) should be applied. Direct fixing to the substructure throughout the zinc-titanium covering material is unacceptable due to thermal moves of the material.

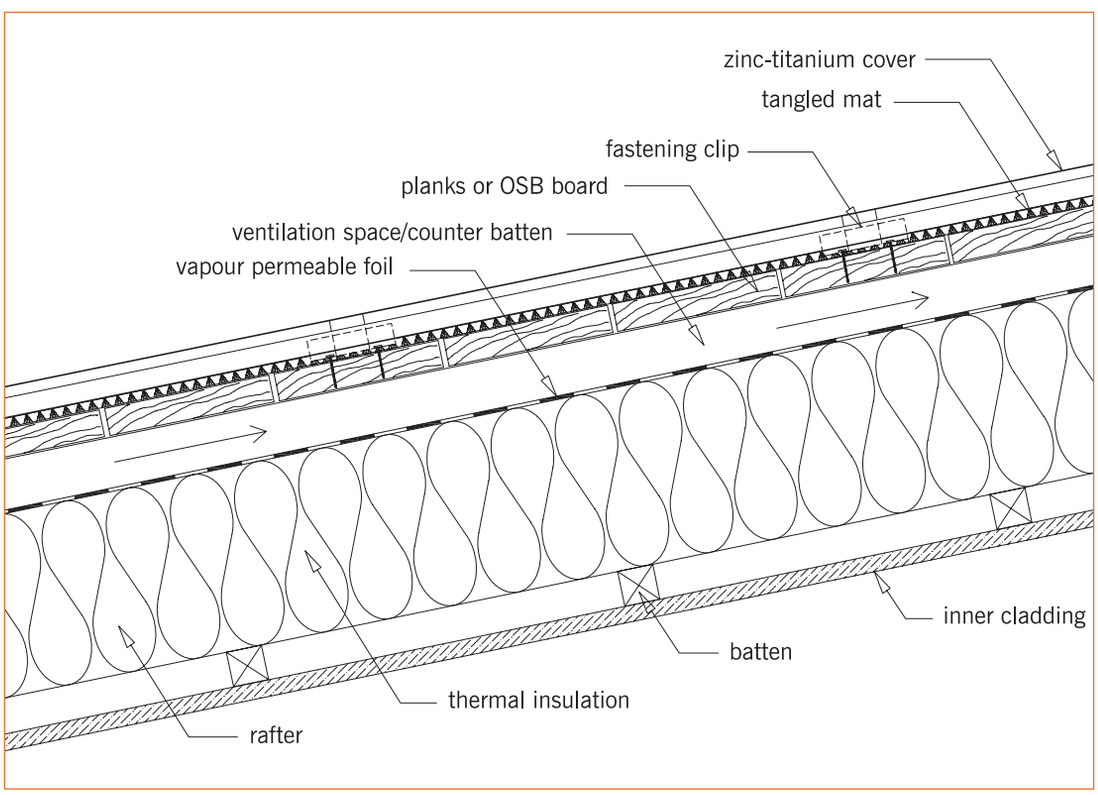
5. Essential rules of construction

5.1. Construction of the roof

Roof should perform some building functions: first of all carrying and protective but also architectural. The construction of the roof should correspond with the covering material that would be applied.

5.1.1. Ventilated roof

Considering building physics the most adequate construction for zinc-titanium covering is a two-ply partition – so called cold roof. The inter layer performing the insulating function is separated from the outer draining water layer with transition air zone. In that case dampness diffusing from the inside of a building blows away with air flowing from eaves to a ridge.

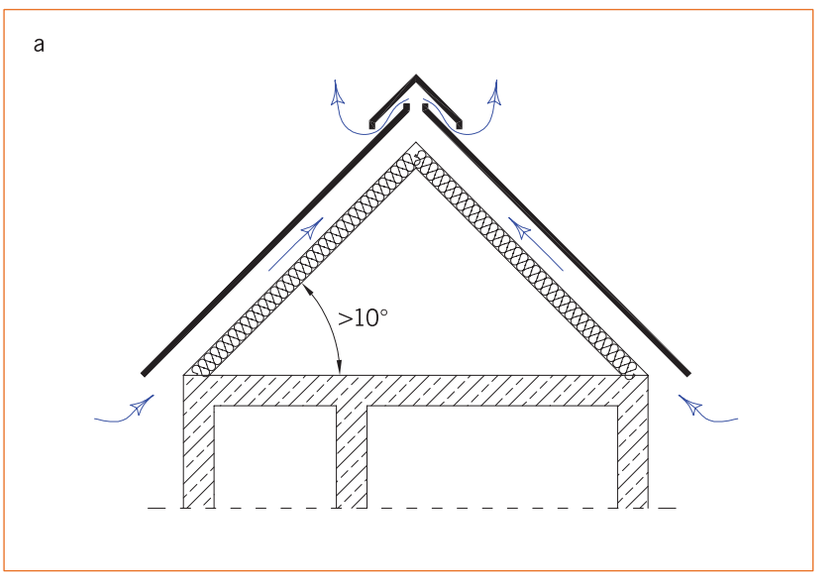


Drawing 9
Arrangement of the layers in ventilated constructions

For typical solutions dimension of ventilating sections can be selected basing on data shown in chart 9. But the height of inlets, outlets and ventilating channel for each specific building should be counted by building physicist. It is especially for buildings of increased humidity (swimming pools, skating rinks, air-conditioned buildings) or for complicated roofs with small inclination.

For a condensate that creates under the metal cover from technological and atmospheric humidity a suitable outlet needs to be created. The best solution is to ensure natural flow of air in the roof partition (air flow caused by lift force).

Drawing 10
Rules of ventilation of a roof:
a) eaves – ridge
b) eaves – eaves



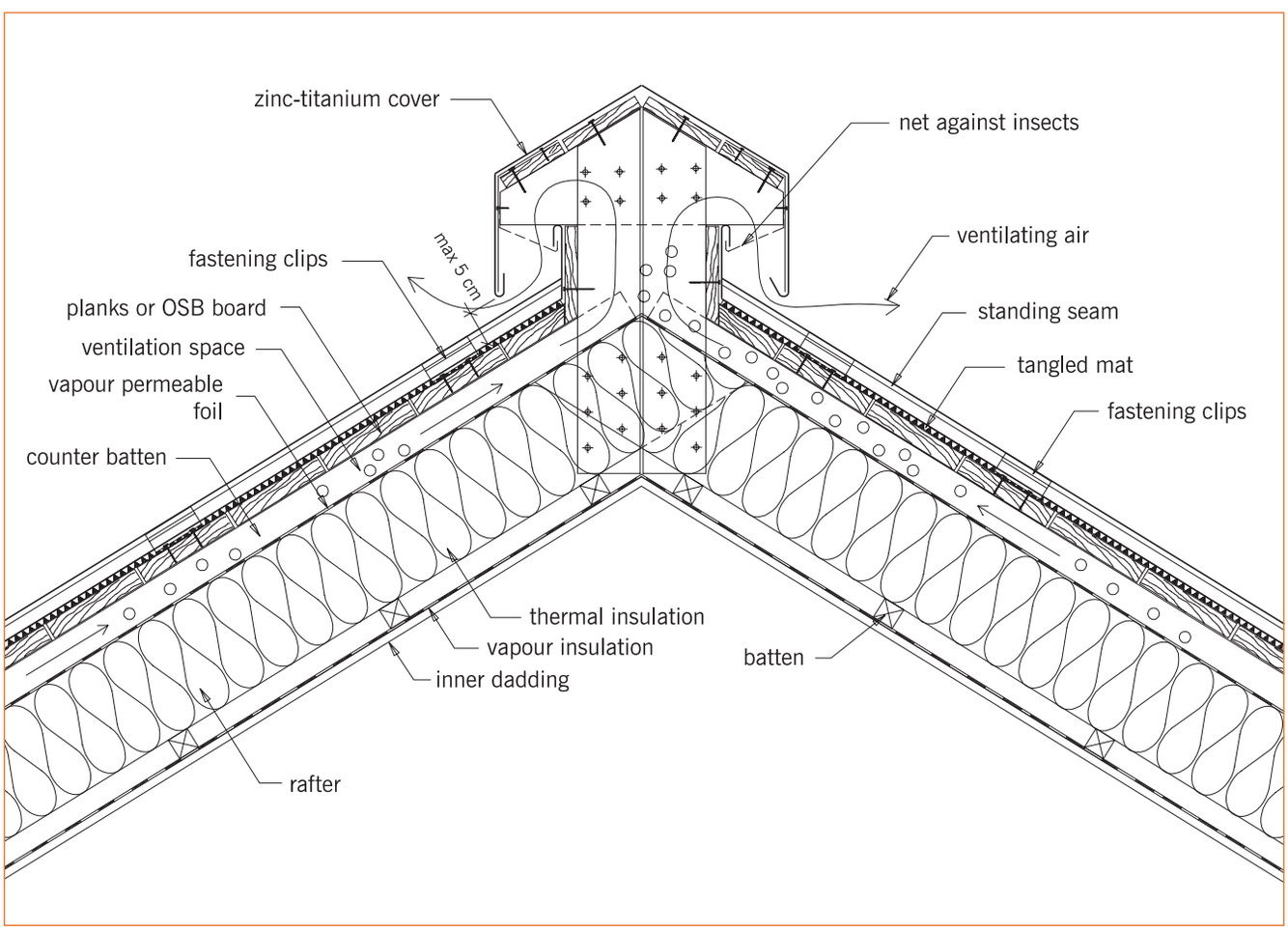
For efficient ventilation the minimal dimension of ventilating section should be defined with respect to roof inclination. At the same time ventilating air inlets should be placed in the lowest possible roof point whereas outlets in the highest one. From the mechanics point of view max. a triple turn of ventilating air route is acceptable.

Advisable height of ventilating slit **Tab. 9**

Roof inclination, °	Heigh of ventilating slit, cm	Minimal diameter of supplying hales	Minimal diameter of removing holes
		(with reference to roof area)	
3 – 7	10	1/500	1/400
over 7 – 15	8	1/500	1/400
over 15 – 25	6	1/500	1/400
over 25	4	1/500	1/400
Façade		**(with reference to façade area)**	
90	2	1/1000	1/800

5.1.1.1. Ridge

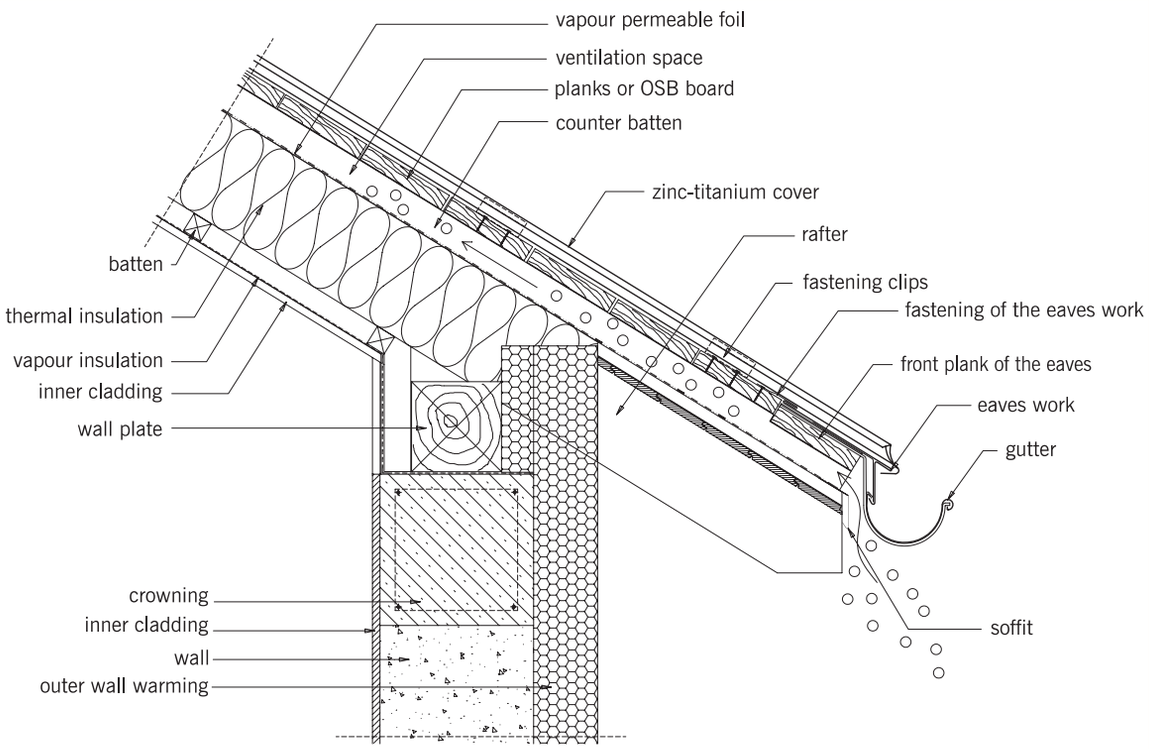
The layout of ridge should enable air free circulation in both ventilating covers of a roof. With that aim a minimum 5 cm slit is left between the together getting planks placed on both pieces of a roof. Furthermore, protection against insects and small birds is necessary what also enables the free flow of air through ventilation slits on the whole roof length.



Drawing 11
The layout
a ventilating ridge

5.1.1.2. Eaves

Roof eaves should enable air free ventilating flew on the whole wideness of the roof. Section area of min 200 cm^2 on each meter of the roof ensures air flow under the roof.

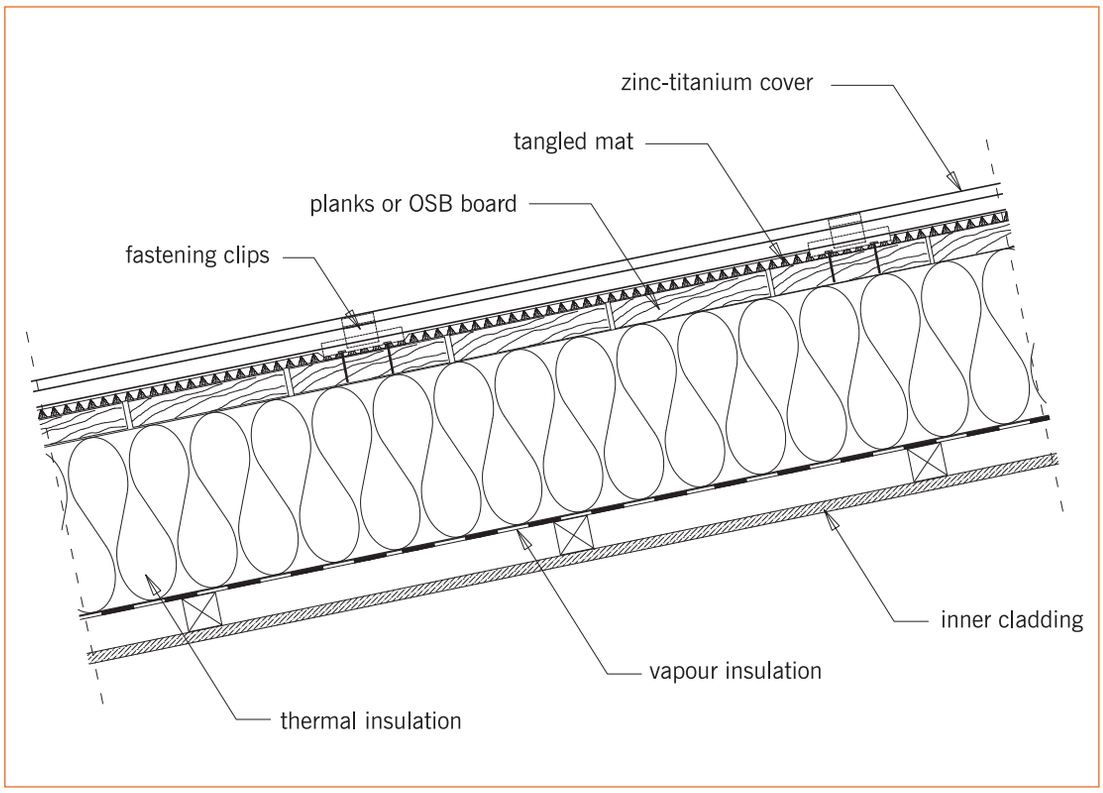


Drawing 12

Accomplishment of eaves that enable air in fly

5.1.2. Non-ventilated structure

Another solution for roof construction is single-ply non-ventitated roof, so called warm roof.



Drawing 13
Arrangement of layers in non-ventilated construction

The matter of principle in case of non-ventilated roof is insulating materials protection against humidity. All materials built in roof have to be absolutely free from humidity. Storage and installation should proceed in dry-air condition. Special attention should be paid to materials that are the thermal isolation of a roof. They must not be moistured during construction works.
Steam isolation is a substantial element of non-ventilated roof construction. Its main function is preventing humidity flow from areas exposed to it inside building to isolated areas of a roof (thermal isolation). When steam isolation in roof partition is omitted or made without adequate care (lack of folds seal, breakdowns) the thermal isolation of a roof becomes saturated with water and its isolation efficiency falls.
Non-ventilated roofs are specially recommended when differences between humidity inside and outside building are relatively small (industrial buildings, warehouses etc.) In case of constructions such as swimming pools, skating-rinks etc., it is essential to assure adequate ventilation inside so that the risk of steam condensation on inner surface of roof cover (ceiling) is minimized.

There are advantages and disadvantages on both presented roof constructions. Both are effective and perform their functions if they are properly designed and made. Joining of both constructions on one building is not ruled out. In that case it is necessary to separate tightly one part of the roof from another.

5.2. Roof inclination

It is not recommended to use zinc-titanium on horizontal roofs or those with inclination lower than 3° (5%), except for the covers on small areas, at most several m^2 (firewalls, attics, cupolas, details of roof finish etc.)
Depending on roof inclination the application of zinc-titanium coverings is specified as below:

- inclination from 3° (~5%) to 7° (~12%)
  It is always necessary to use protection in the form of tangled mat with drainage and sealing tape for seam joinings which secure extra protection against humidity.

- inclination from 7° (~12%) to 15° (~27%)
  It is always necessary to use protection in the form of tangled mat with drainage.

- inclination from 15° (~27%)
  Tangled mats are required depending on the kind of substructure for installation

5.3. Substructures

Zinc-titanium used in seam system needs for covering substructures with distance between individual elements (planks, chipboards etc.) up to 10 mm. The substructures takes over static load and should be designed with respect to the value and the kind of load. Furthermore the substructure has to be stable, durable, flat, clean and devoid of sticking out elements that can harm the sheet (nails, solidified cement mortar etc.)

Before zinc work starts the surface of a roof should be examined by roof contractor. It is his responsibility to consider whether the bed is suitable for placing zinc-titanium sheet cover on it.

5.3.1. Wooden planks

The best substructure for zinc-titanium are sawn timber planks with pH reaction at 4.5÷7.0. That condition is fulfilled by conifer timber such as fir, spruce or pine and beech and poplar. Because of acid reaction it is forbidden to use oak or red cedar timber. Thickness of planks should go in the range from 20 to 40 mm, whereas their width from 80 to 140 mm with length from 2 to 6 m. In case of façades it is recommended to narrow the width of planks to 100 mm.
Attention should be paid to the humidity of planks, because when too moisture wood (over 20%) is used, the adverse effect of prints on the cover can occur, caused by nails sliding out of drying up wood. It is also recommended that the difference of thickness between the planks is not bigger than 2 mm not to cause marks on the cover. Application of tangled mats can minimize the prints effect caused by uneveness of the wooden sheating (see p. 5.4).

Photo 8
Wooden sheating

8

With accordance to regulations wooden elements for building have to be impregnated in the scope of fire protection, against technological wood pests and mycetes, mould, etc. Means of wood protection contain different chemical compounds (water soluble metal salts) that can have corrosive effect on sheet. When means with salts are used you should apply divisive layers – tangled mats.

5.3.2. Wooden derivative boards

Wood derivative boards e.g. OSB or plywood of different kinds always need for tangled mat under the zinc-titanium sheet cover. The thickness of boards used is 16 to 22 mm, depending on accepted span between rafts and estimated loads.

5.3.3. Concrete

It is unacceptable to apply zinc-titanium sheet directly on concrete substructure. Each time you need to use tangled mat directly under sheet. For clips fastening you can use stretcher pins, couplers and screws but it is always advised to check the quality of concrete workmanship.

5.3.4. Gypsum plaster

Contact with gypsum plaster substructure is absolutely forbidden even when tangled mats are used.

5.3.5. Cement mortar

Fresh mortar (lime and cement) can cause corrosion action due to its heavy alkaline character. So all covering works with zinc-titanium sheet can be started not earlier then platering is finihed to avoid arising of stains. When plastering is finished all remains (e.g. solidified cement mortar) should be removed.

5.4. Separating layers – tangled mats

We can distinguish two kinds of mats: with and without drainage layer. The main layer is a three-dimensional matrix structure made of entangled polyamide or polypropylene filaments of different density (depending on the manufacturer). As drainage layer the highly vapour permeable foils are most frequently used. When the mat is to be used as separating layer it was to have some specific features:

- lack of the possibility for moisture accumulation
- three-dimensional structure of min 5 mm height
- temperature resistance of the range from -30 to + 100°C

The main function of separating layers in shape of tangled mats is evacuation of the moisture of the bottom side of metal covering. Additionally tangled mats protect from:

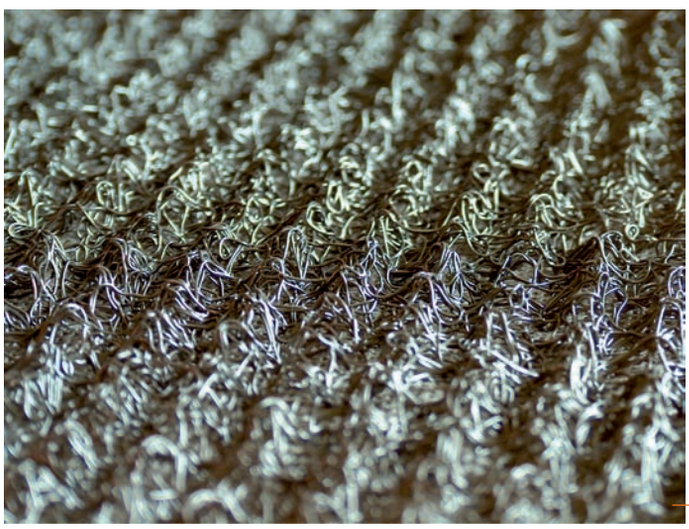
- influence of means used for wooden sheating planks impregnation
- rain impact noise
- rub off caused by the substructure
- influence of alkaline substances (e.g. remainings of cement mortar)

Tangled mats with drainage protect also the installation substructure and thermal insulation against soaking of moisture from vapour condensation on the bottom of the zinc-titanium covering. Using tangled mat with drainage you can also temporary protect the substructure and building construction against atmospheric conditions (rain, snow, sun) in the period of few months (depending on the manufacturer specification).

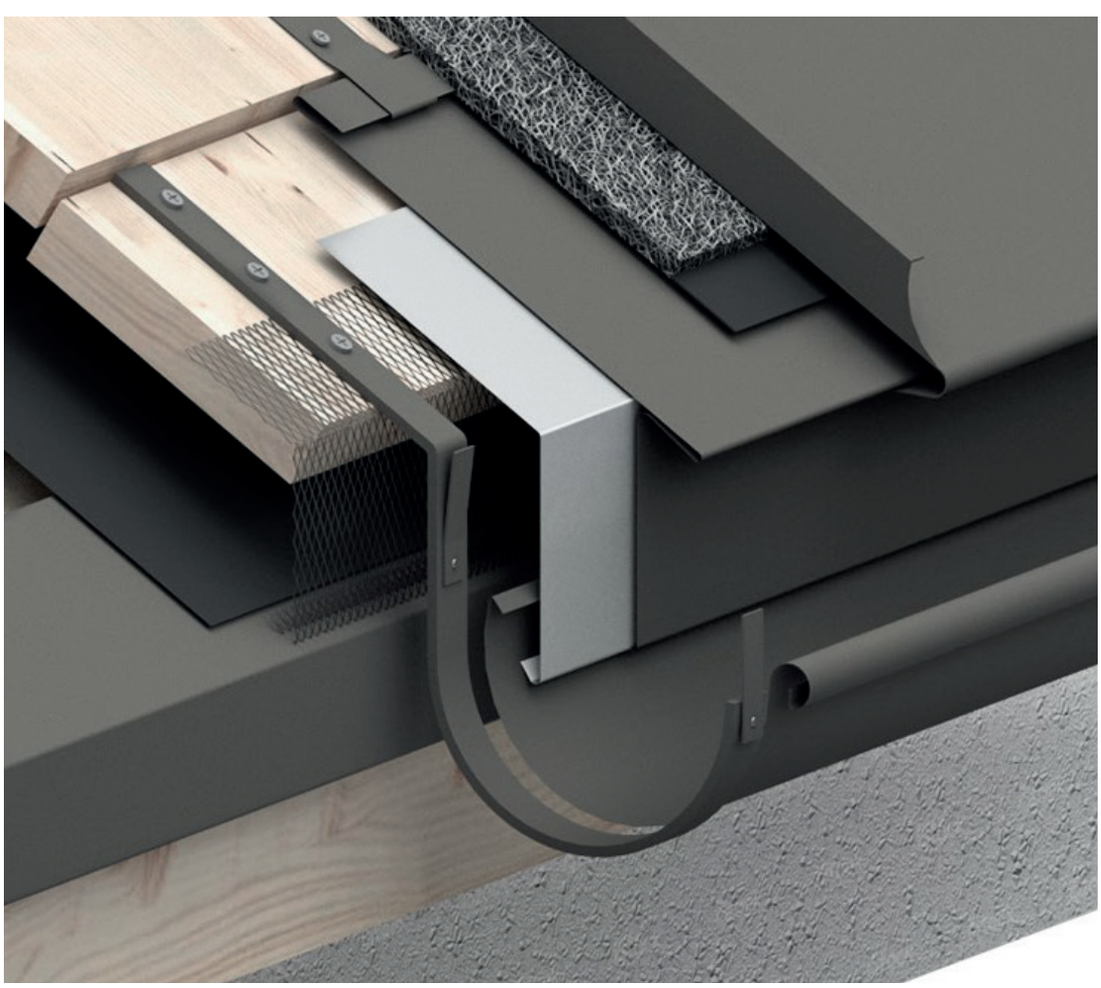
Among tangled mats typically used it can be mentioned:
Enkavent, Grid-sec, and tangled mats with integrated drainage layer: Permo-sec, Delta-Trela or equivalent that meet above conditions.

It is forbidden to use directly under zinc-titanium an underlay with accumulates moisture, i.e. roofing paper, felt, fiber, etc., because there is a danger of long-lasting retention of moisture between the zinc-titanium covering and material of that kind.

Photo 9
Tangled mat with drainage



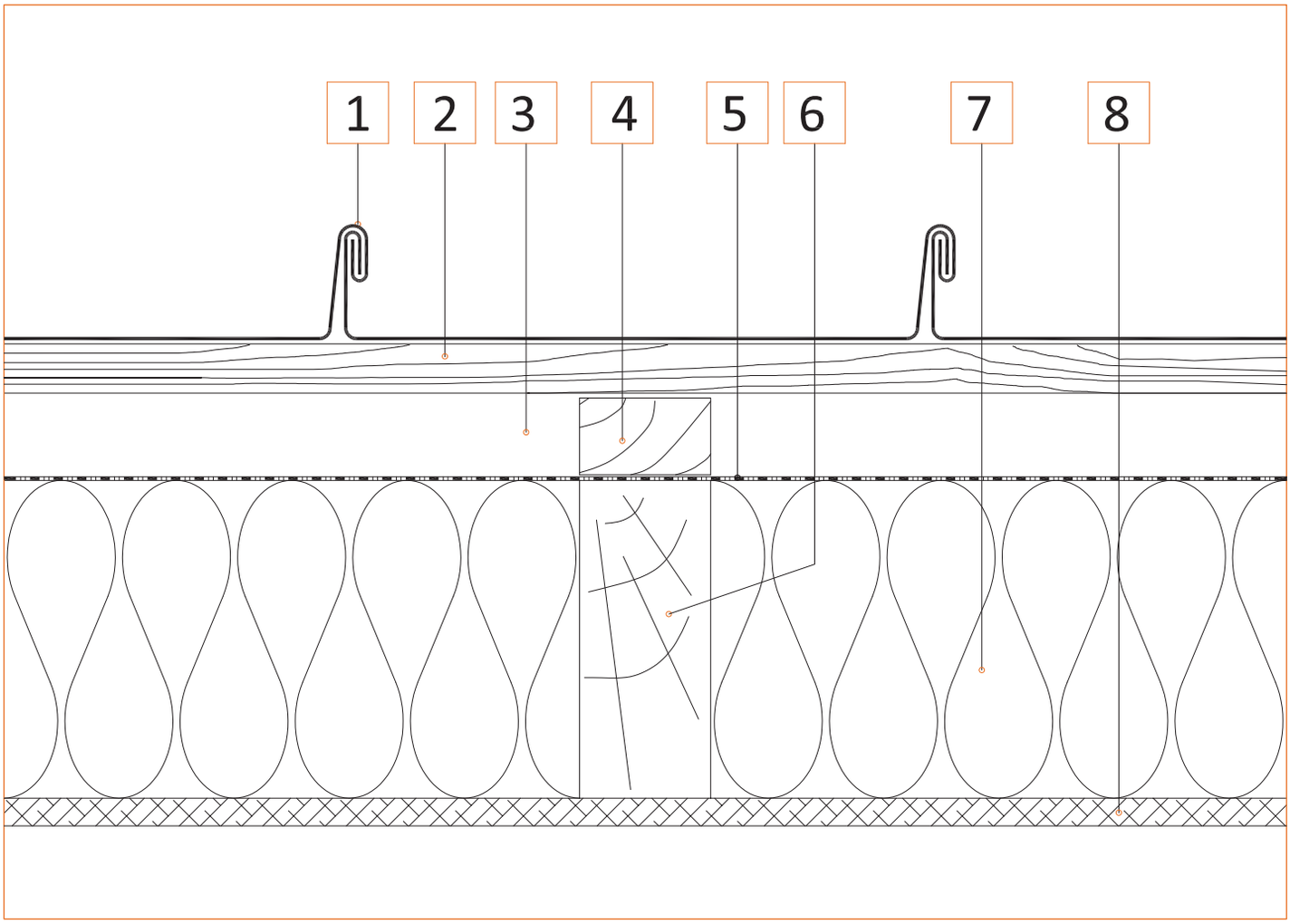
9



6. Technical charts

Due to continuous development of covering systems, ZM „Silesia” S.A. reserves the right to innovate and improve without earlier notification.
The status of knowledge and technology on the year 2009.

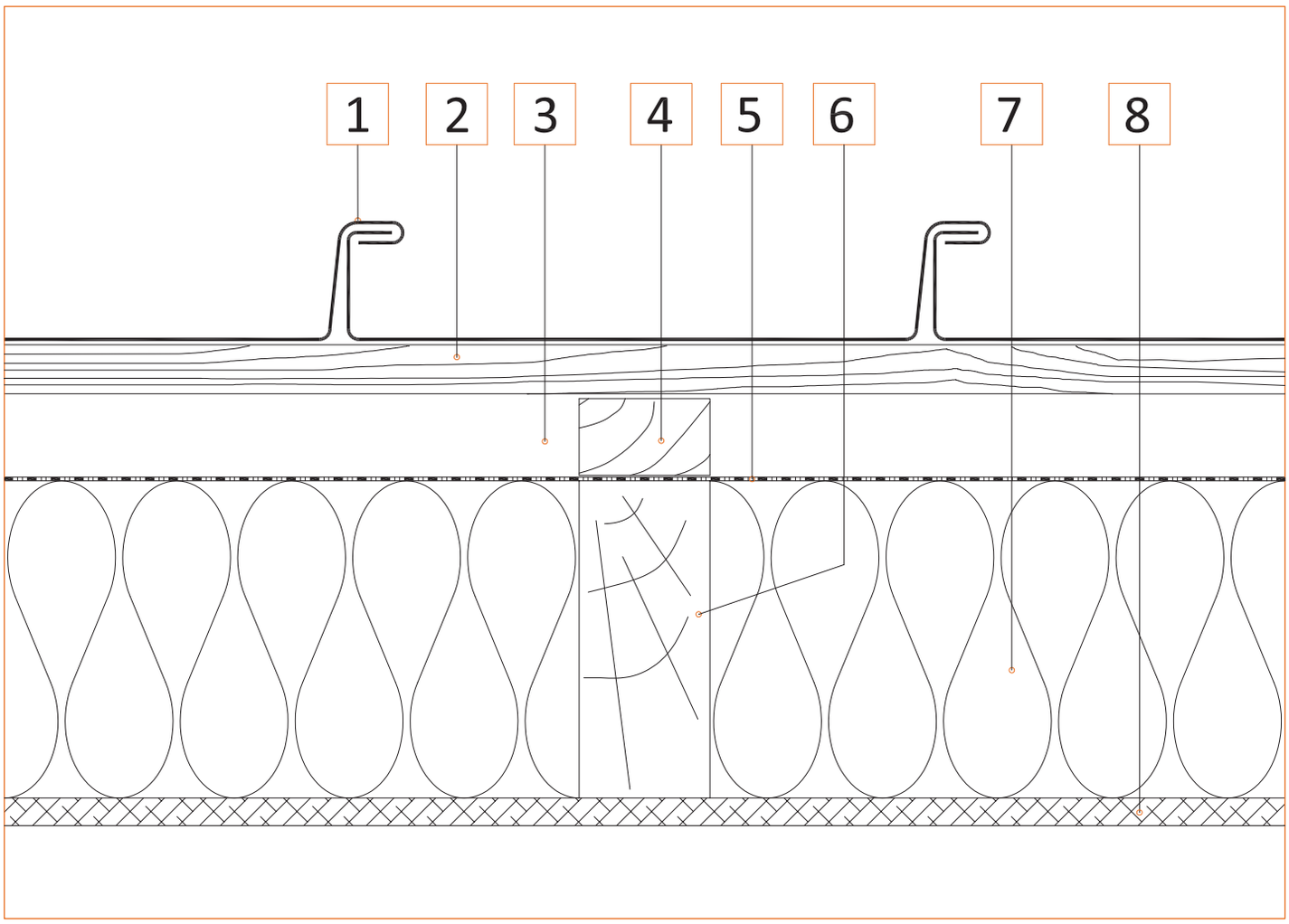
Technical chart: double standing seam



1 – zinc-titanium; 2 – substructure; 3 – ventilation space; 4– counter batten;
5 – vapour permeable foil; 6 – rafter; 7 – thermal insulation / ; 8 – inner cladding

Application	roof coverings
Dimensions: height, mm effective width, mm thickness, mm load, kg/m^2	 ~ 25 ~ 400; 500; 600 (there is a possibility of getting another width of cover of the range from 250 to 700 mm) 0,65; 0,70; 0,80 ~ 5,6 (for advised thickness 0,70 mm)
Roof inclination:	– advised over 7° – acceptable from 3° – from 3° to 7° requires for tangled mat with drainage and sealing tape inside seam – from 7° to 15° requires for tangled mat with drainage – over 15° tangled mat usage depends on the kind of installation bed
Shape of roof:	flat, convex, concave and other non-standard
Kind of under-construction:	– ventilated – non-ventilated
Finishing of surface:	bright-rolled or pre-aged
Substructure:	– planks (in case of fire protecting impregnation use tangled mats) – big-size boards e.g. OSB, plywood (use tangled mats) – concrete (use tangled mats)
Fastening:	depending on the length of panels use fixed or sliding clips fastened to the bed depending on its kind with nails, screws or stretcher pins (galvanized or stainless steel)
Documents of reference:	material: EN 988 panel for covering: EN 506:2002

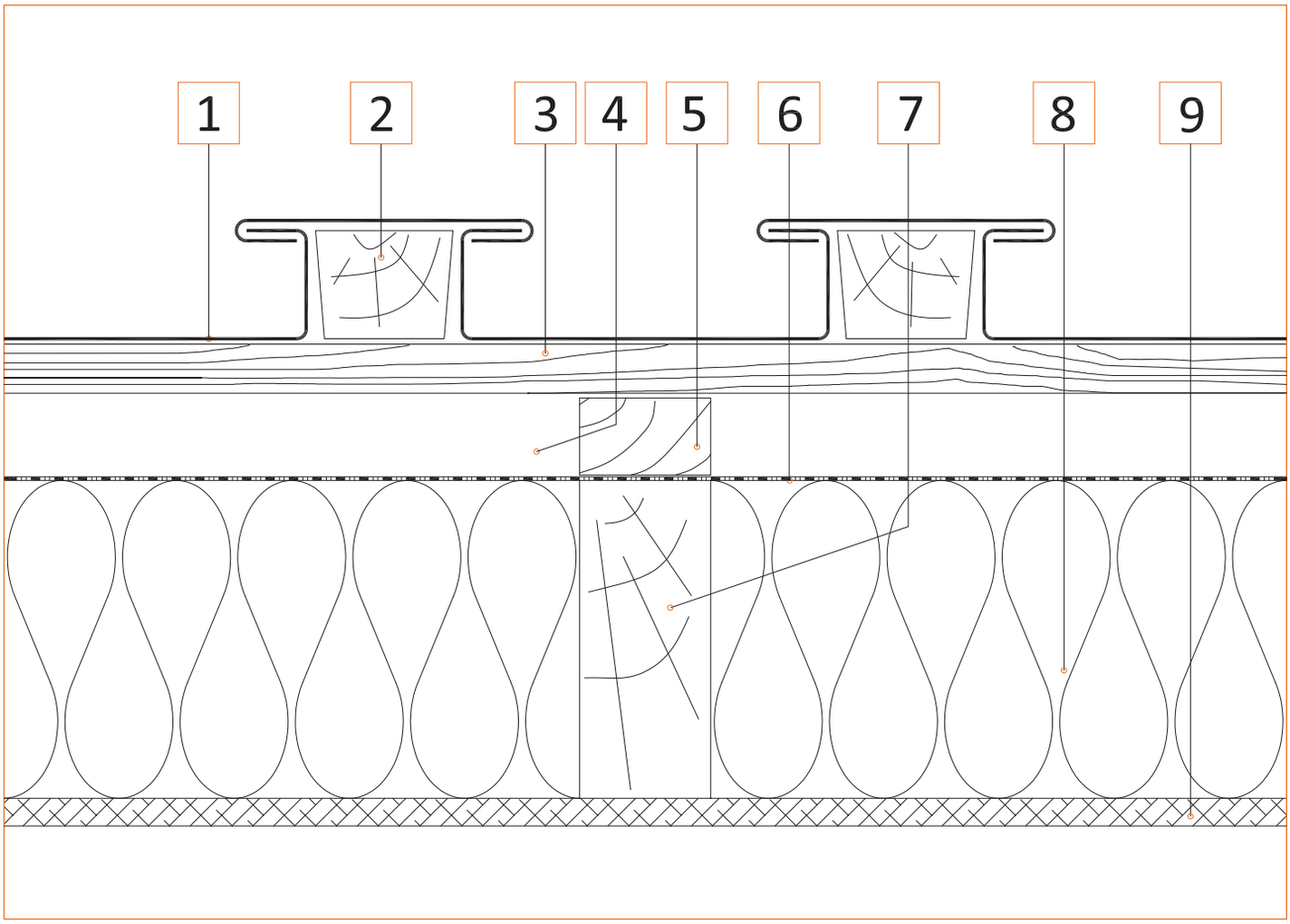
Technical chart: angled standing seam



1 – zinc-titanium; 2 – substructure; 3 – ventilation space; 4 – counter batten;
5 – vapour permeable foil; 6 – rafter; 7 – thermal insulation; 8 – inner cladding

Application	roof coverings
Dimensions: height, mm effective width, mm thickness, mm load, kg/m^2	 ~ 25 ~ 400; 500; 600 (there is a possibility of getting another width of cover of the range from 250 to 700 mm) 0,65; 0,70; 0,80 ~ 5,6 (for thickness 0,70 mm)
Roof inclination:	advised over 25°, areas of heavy snow over 35° (advised to use tangled mats with drainage and sealing tape inside seam)
Shape of roof:	flat, convex, concave and other non-standard
Kind of under-construction:	– ventilated – non-ventilated
Finishing of surface:	bright-rolled or pre-aged
Substructure:	– planks (in case of fire protecting impregnation use tangled mats) – big-size boards e.g. OSB, plywood (use tangled mats) – concrete (use tangled mats)
Fastening:	depending on the length of panels use fixed or sliding clips fastened to the bed depending on its kind with nails, screws or stretcher pins (galvanized or stainless steel)
Documents of reference:	material: EN 988 panel for covering: EN 506:2002

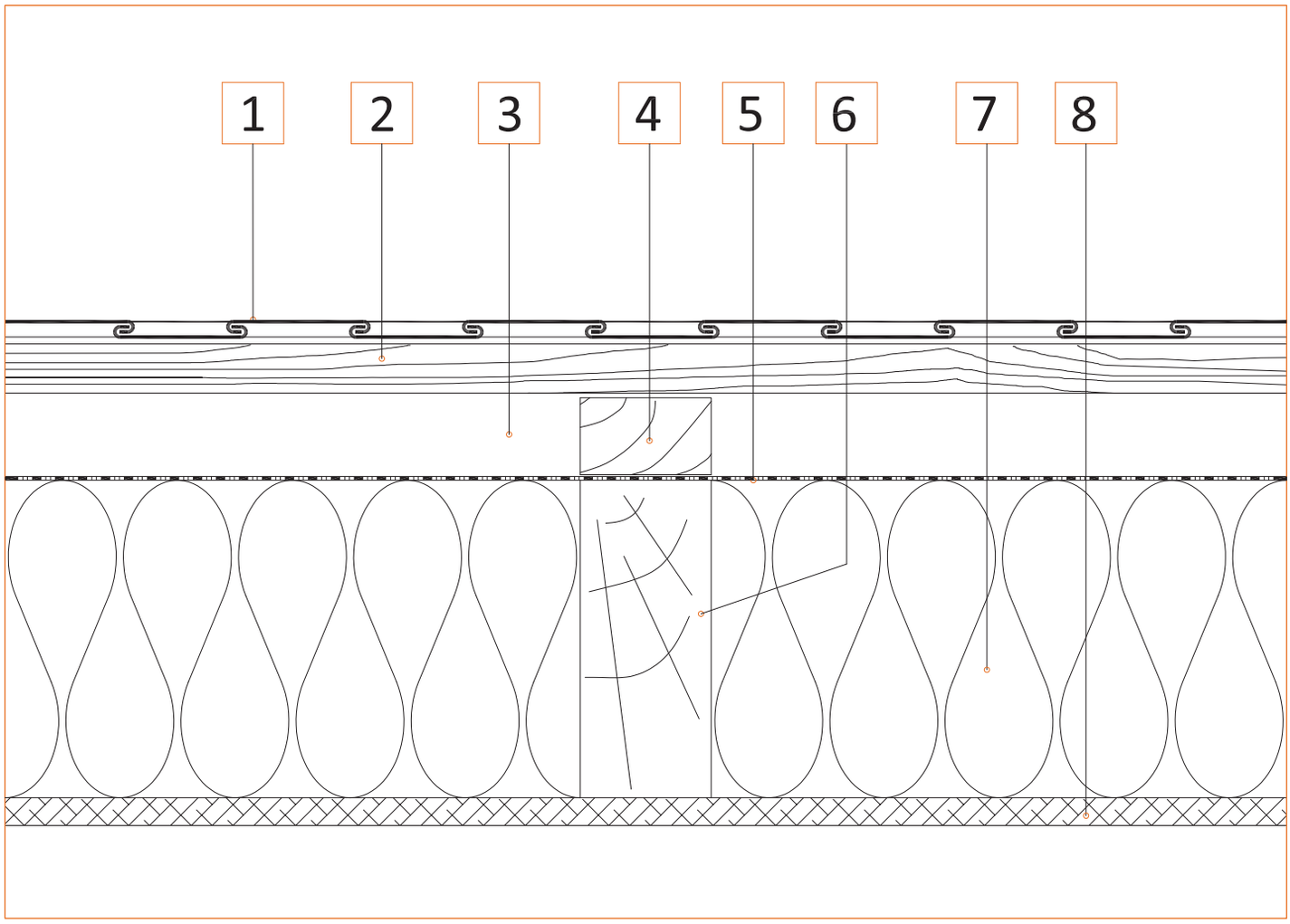
Technical chart: slat system



1 – zinc-titanium; 2 – wooden slat; 3 – substructure; 4 – ventilation space; 5 – counter batten;
6 – vapour permeable foil; 7 – rafter; 8 – thermal insulation; 9 – inner cladding

Application	roof coverings
Dimensions: height, mm effective width, mm thickness, mm load, kg/m^2	 ~ 40 ~ 400; 500; 600 (there is a possibility of getting another width of cover of the range from 250 to 700 mm) 0,65; 0,70; 0,80 ~ 6,30 (for thickness 0,70 mm)
Roof inclination:	– advised over 7° – acceptable from 3° – from 3° to 7° requires for tangled mat with drainage and sealing tape inside seam – from 7° to 15° requires for tangled mat with drainage – over 15° tangled mat usage depends on the kind of installation bed
Shape of roof:	flat, convex
Kind of under-construction:	– ventilated – non-ventilated
Finishing of surface:	bright-rolled or pre-aged
Substructure:	– planks (in case of fire protecting impregnation use tangled mats) – big-size boards e.g. OSB, plywood (use tangled mats) – concrete (use tangled mats)
Fastening:	with flat hooks fastened to the bed depending on its kind with nails, screws or stretcher pins (galvanized or stainless steel)
Documents of reference:	material: EN 988

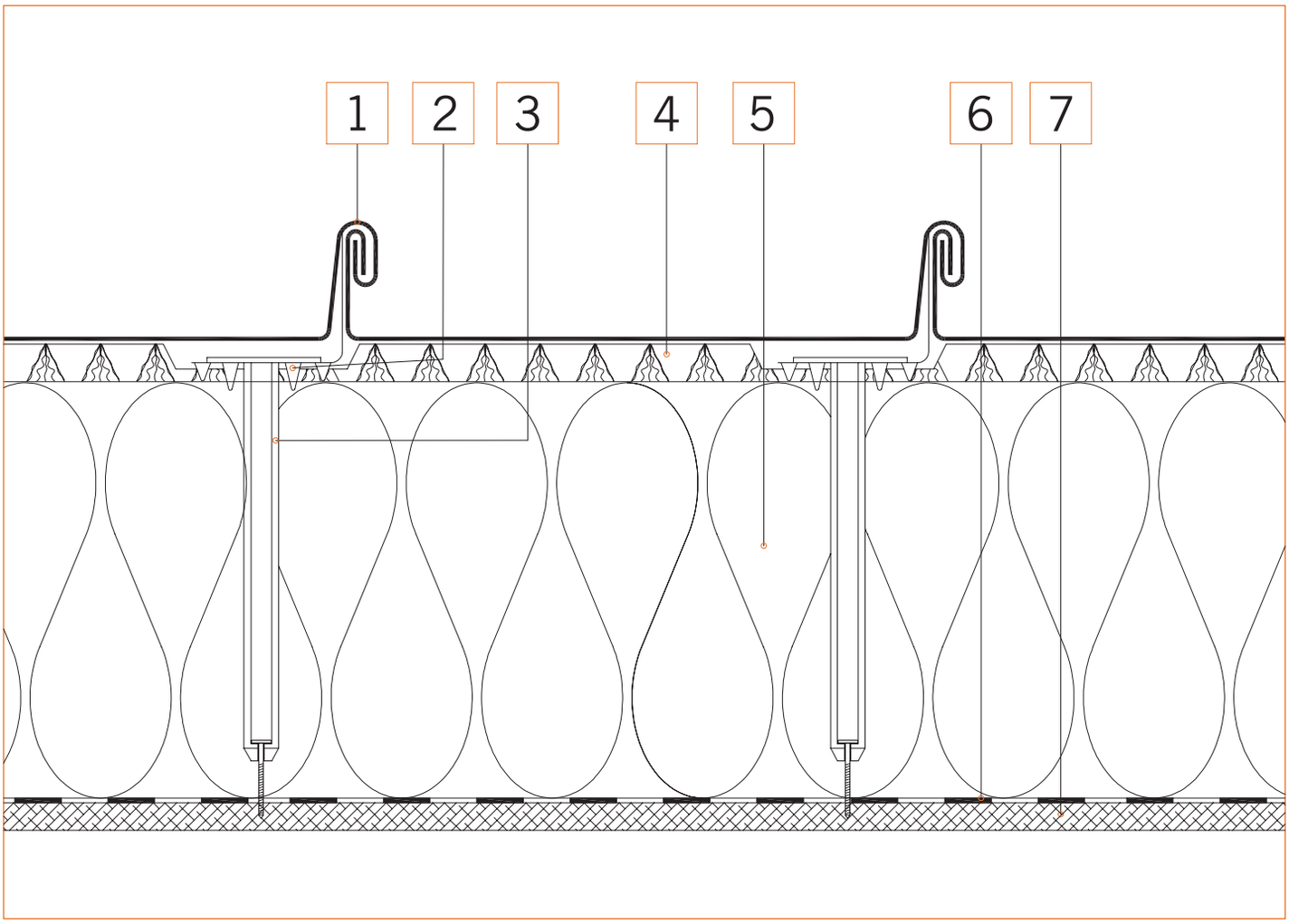
Technical chart: tile system



1 – zinc-titanium; 2 – substructure; 3 – ventilation space; 4 – counter batten;
5 – vapour permeable foil; 6 – rafter; 7 – thermal insulation; 8 – inner cladding

Application	roof coverings
Dimensions: height, mm effective width, mm thickness, mm load, kg/m^2	 ~ 10 ~ 300; 400; (there is a possibility of getting another width of cover of the range from 200 to 500 mm) 0,65; 0,70; 0,80 ~ 6,00 (for thickness 0,70 mm)
Roof inclination:	not less than 25°
Shape of roof:	flat, convex (with big radius)
Kind of under-construction:	– ventilated – non-ventilated
Finishing of surface:	bright-rolled or pre-aged
Substructure:	– planks (in case of fire protecting impregnation use tangled mats) – big-size boards e.g. OSB, plywood (use tangled mats) – concrete (use tangled mats)
Fastening:	with flat clips fastened to the bed depending on its kind with nails, screws or stretcher pins (galvanized or stainless steel)
Documents of reference:	material: EN 988

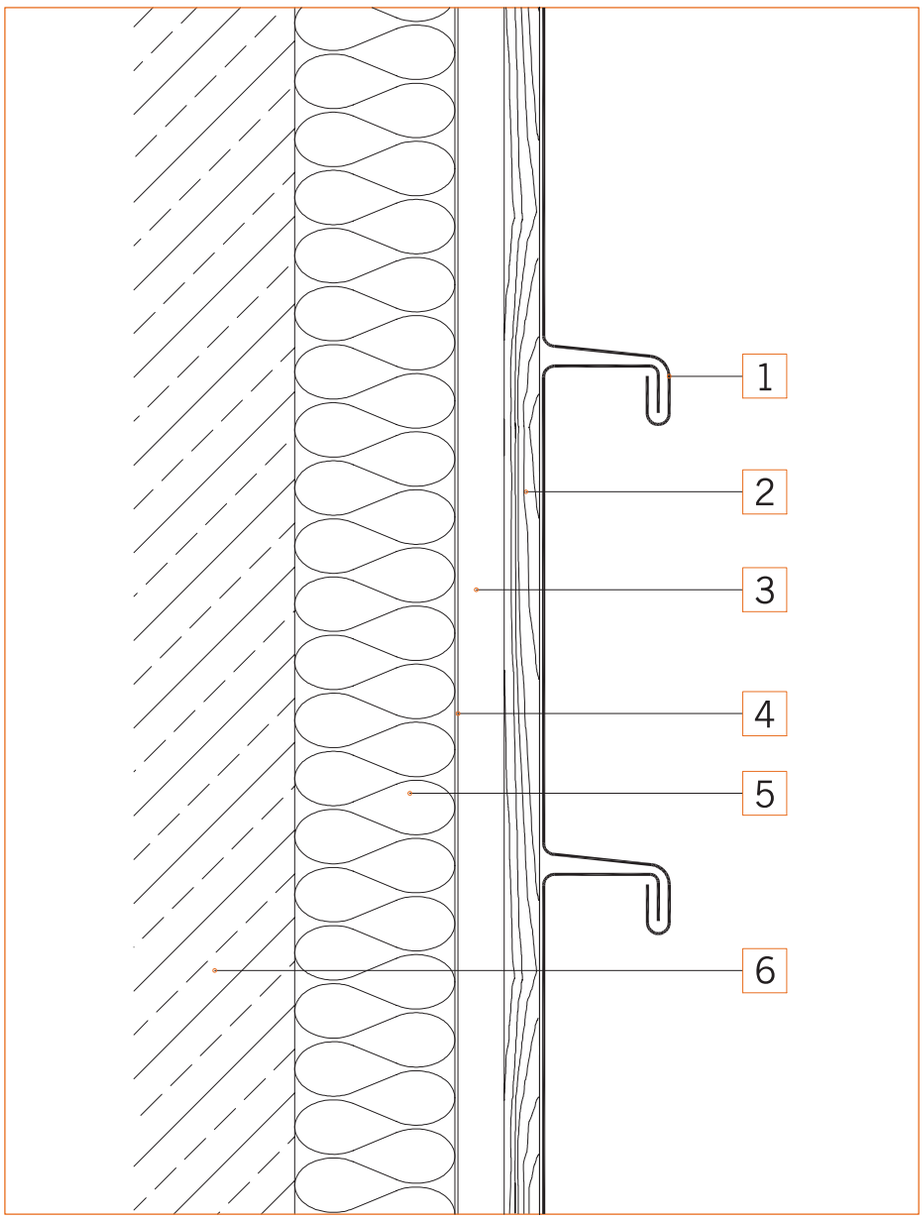
Technical chart: telescopic coupler



1 – zinc-titanium; 2 – hook clip; 3 – telescopic coupler; 4 – structural mat with drainage;
5 – thermal insulation; 6 – steam-isolating foil; 7 – inner cladding

Application	roof coverings
Dimensions: height, mm effective width, mm thickness, mm load, kg/m^2	 ~ 25 ~ 400; 500; 600 (there is a possibility of getting another width of cover of the range from 250 to 700 mm) 0,65; 0,70; 0,80 ~ 5,60 (for thickness 0,70 mm)
Roof inclination:	– advised over 7° – acceptable from 3° – from 3° to 7° requires for sealing tape inside seam – regardless of inclination requires for tangled mat with drainage
Shape of roof:	flat and semicircular
Kind of under-construction:	non-ventilated
Finishing of surface:	bright-rolled or pre-aged
Substructure:	hard mineral wool resistant to walking; there is a possibility of wide range regulation of the thermal isolation thickness
Fastening:	clips with wide feet fastened to the installation bed with telescopic coupler
Documents of reference:	materiał: EN 988

Technical chart: angled standing seam



1 – zinc-titanium
2 – substructure
3 – counter batten / ventilation space
4 – vapour permeable foil
5 – thermal insulation
6 – wall

Application	façade coverings
Dimensions: height, mm effective width, mm thickness, mm load, kg/m^2	 ~ 25 ~ 400; 500; (there is a possibility of getting another width in the range from 250 to 600 mm) 0,70; 0,80 ~ 6,70 (for thickness 0,80 mm)
Façade inclination:	– 90°, – soffits, ceilings – max. advised width 450 mm
Shape:	flat and semicircular
Kind of under-construction:	– ventilated – non-ventilated
Finishing of surface:	pre-aged
Substructure:	– planks (in case of fire protecting impregnation use tangled mats) – big-size boards e.g. OSB, plywood (use tangled mats) – concrete (use tangled mats)
Fastening:	depending on the length of panels use fixed or sliding clips fastened to the bed depending on its kind with nails, screws or stretcher pins (galvanized or stainless steel)
Documents of reference:	material: EN 988 panel for covering: EN 506:2002

List of reference 7.

Relating to roof coverings:

EN 988:1997	Zinc and zinc alloys. Specification for rolled flat products for building
EN 501:1994	Roofing products from metal sheet. Specifications for fully supported roofing products of zinc sheet
EN 506:2008	Roofing products of metal sheet. Specification for self-supporting products of copper or zinc sheet
EN 14783:2006	Fully supported metal sheet and strip for roofing, external cladding and internal lining. Product specification and requirements.

Relating to drainage:

EN 612:2005	Eaves gutters with bead stiffened fronts and rainwater pipes with seamed joints made of metal sheet
EN 1462:1997	Brackets for eaves gutters. Requirements and testing
EN 12056-3:2000	Gravity drainage systems inside buildings – Part 3: Roof drainage layout and calculation.

Other:

EN 1179 :2003	Zinc and zinc alloys. Primary zinc
EN 14290:2004	Zinc and zinc alloys Secondary raw material
EN 516:1995	Prefabricated accessories for roofing. Installations for roof access. Walkways, treads and steps
EN 517:1995	Prefabricated accessories for roofing. Roof safety hooks
EN 1991-1-3:2003	Actions on structures. General actions. Snow loads
EN 1991-1-4:2005	Actions on structures. General actions. Wind actions
EN 1991-1-5:2003	Actions on structures. General actions. Thermal actions
EN 12500:2000	Protection of metallic materials against corrosion. Corrosion likelihood in atmospheric environment. Classification, determination and estimation of corrosivity of atmospheric environments
EN 62305-1:2006	Protection against lightning. General principles.

8. Completed projects – examples

Fot. 10
Hot Springs
– Japan

Fot. 11
Palace
Poznańskich
– Łódź
Poland

Fot. 12
Theatre
– Chorzów
Poland

Fot. 13
Cheongup Miracle Library – Cheongup, Korea South

Fot. 14
President Palace – Wisła Poland

Fot. 15
Central United Methodist Church of Cheonan – Cheonan, Korea South

Fot. 16
Castle Museum – Pszczyna Poland

Fot. 17
Vivaldi Adel
A.P.T.
– Yongin,
Korea South

Fot. 18
Gym – Rudniki
near Wieluń
Poland

Fot. 19
Swimmingpool
– Kraków
Poland

Fot. 20
Office block
– Katowice
Poland

Fot. 21
Daeju Ipia
– Seul,
Korea South

Notes

8. Notes

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