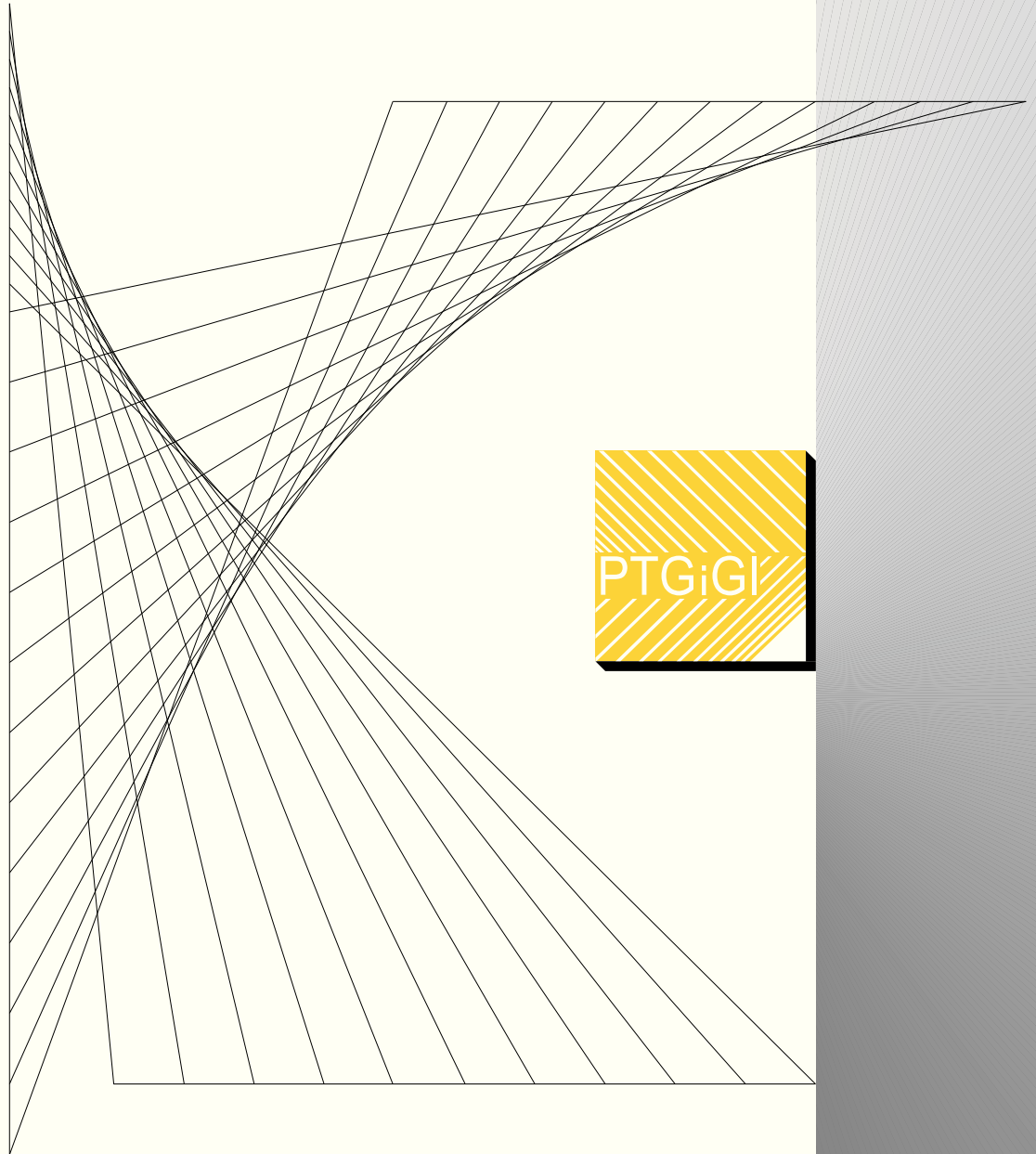


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## CLASSIFICATION OF SHAPES OF ROOFS WITH FLAT SURFACES

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**Abstract.** In many on traditional engineering we can find a lot of different, incomplete and inconsequent naming connected with roofs and their shapes. In this article there is presented an idea of classification of roofs connected with what the author of this article finds to be their basic features, that is number of surface slopes and their complexity.

**Keywords:** geometry, roofs, multi-surface roofs, draining of the water from the roof

### Introduction

A well known polish architect and lecturer Karol Podczaszyński (1790-1860) wrote in 1846 [3/ss: 7-8]: „*The naming of modern architecture cannot be as regular and organized as in chemistry for example; because (...) it needed a new language and was given a language as organized as chemistry itself, which it serves, but the language of architecture is more like ancient alchemy today*”.

Best example, that today we still have problems with the naming of traditional architectural constructions elements are names of roofs. Main reason for troubles with classification of shapes is huge diversity of implied solutions. Another reason are names coming from different sources, for example from carpenter’s tradition with its regional varieties and names coming from foreign languages<sup>1</sup>. All that makes it difficult for the designers to communicate with executors and investors, causes troubles in the preparation of scientific articles and translation of texts into foreign languages. What is however most important for the author of this article as a lecturer, that these problems overlap with many other problems connected with roof designing (see [5]). This article presents an idea of division of the roof shapes, basing on:

- number of surface slopes, that means number of directions of draining the water from the roof;
- complexity of multi-slope roofs (refers to roofs above objects, which projections are concave polygons) [2].

### General comments on roof divisions

Let’s start our study with the problem of classification of most common roofs used in engineering for many centuries (table 1). Let’s assume that:

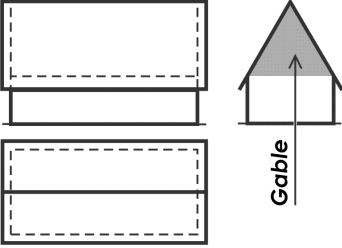
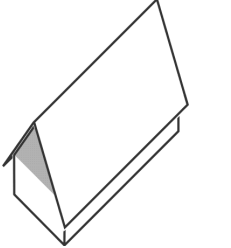
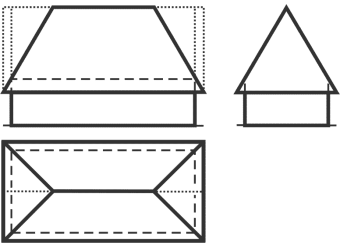
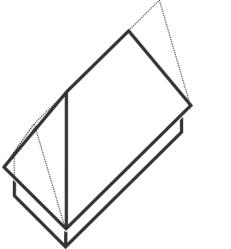
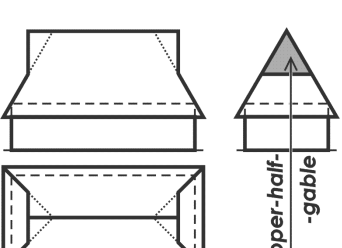
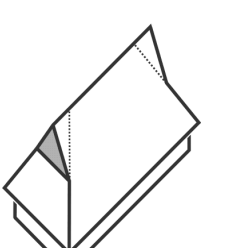
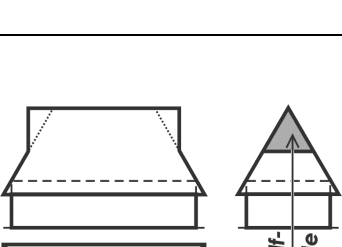
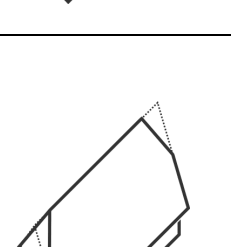
- the roofs have the same slope angles;
- the roofs are tops of buildings, which projections are rectangles;
- the roofs are symmetric, what means that on both sides of the ridge same solutions were used;
- the surfaces, which are crossing at the ridge are called ridge-surfaces.

---

<sup>1</sup> A hip roof can be called a walm-roof (from german Walmdach).

The most popular roof shape is a gable roof (table 1; item 1), called also the saddle roof. The characteristic feature of this roof is the fact that it is resting on walls of which two are rectangles and the other two are pentagons. Such pentagon can be divided into a rectangle in the lower part and a triangle situated just below the roof, which is called the gable. This is where the roof's name comes from. This most common solution can be adjusted through „cutting” the gables and part of surfaces with another two slopes (table 1; item 2).

Table 1: Illustration to discussion on roofs and their names, by the author of the article

Item	Projection and view	Axonometry	Name and <i>comments</i>
1.			Gable roof – two-slope roof
2.			Hip or hipped roof – four-slope roof <i>Gables were cut with surfaces crossing their ridge and the Edge points of eave lines of the gable roof.</i>
3.			Gablet or Dutch gable – four-slope roof with <b>upper-half-gables</b> , that is with trapezoid surfaces below half-gable; the roof is the result of extending the ridge-surfaces with presented triangles, which were cut with surfaces parallel to planes of the gables.
4.			Half-hipped – four-slope roof with <b>lower-half-gables</b> , that is with triangular surfaces above the half-gable; the result of cutting top corners of a gable roof and its gables with surface crossing points on the ridge and eaves of „naczólki” – the “half-hips”. The “half-hip” eaves are situated above the line of eaves of ridge-surfaces.

The dotted line shows the edges of the base-roof, that is the roof that has been adjusted.

Such a roof is called a hip or hipped roof<sup>2</sup>. However, if we assume that this roof shapes comes from above mentioned gable roof, than we could call this roof a “gableless”

<sup>2</sup> When the ridge length equals 0, then there roof is called tented or pavillon roof.

roof. If in such a roof we will extend the top parts of ridge-surfaces (see - table 1; item 3) and add surfaces parallel to the planes of the wall we will create a roof called a gablet or Dutch gable roof. To be accurate it is a roof with a small upper-half-gable (the gablet) and characteristic trapezoid surface below<sup>3</sup>. If we decide to cut the corners of ridge-surfaces and part of the gable of the gable roof (table 1; item 1) we will get another kind of roof, which we can call a roof with lower-half-gable, with characteristic triangular surface above the half-gable (see table 1; item 4). In Poland this roof is called a *naczółkowy*<sup>4</sup> roof, that means a roof with a surface „on the forehead” from polish *na*-on and *czoło*-forehead (what in case of roofs means high on the gable end wall). In english this roof is called a half-hipped roof.

Also middle-half-gables can be found (see fig. 1 a), when we combine the solutions with triangular and trapezoid surface. This solution should not be confused with a situation, when we have a roof with lower-half-gable with another small roof attached (pol. „przydaszek”), which is hidden under reaching outside the gable end wall parts of ridge-surfaces of the roof.

### Characteristics and number of surface slopes

Because of their complexion we can divide roof into two different groups:

- elementary, where the projection of the eave line is a convex polygon;
- complex, where the projection of eave line is a concave polygon (see [2]).

Table 2 presents a basic division of elementary roofs, which is based on shape of roof surfaces, what means roofs with straight and polygonal surfaces. It also shows the division basing on number of surface slopes<sup>5</sup>. The idea of such division was already presented in the literature by M. Dolnicki [1], and later by K. Tauszyński [4]. They had however skipped the three-slope roof (table 2, item 3), possibly because this kind of roof occurs not as often as other, flat, gable or hipped roofs. They also did not mention any roofs with polygonal surfaces, but the mansard roof (table 2, item 8), they also did not analyze the number of slope surfaces occurring. The author's of this article idea is to introduce defining the number of surface slopes also in case of polygonal roofs. It can help in more precise description of roofs, especially in case of monuments.

Table 3 presents a division of two-slope roofs, after adding common supplemental elements, affecting its name, such as false rafters and half-gables. Implying such method in describing existing architectural objects was presented on picture 1. There can be more adjusting elements for example dormers (see Fig. 2).

### On division of simple roofs

In case of elementary roofs we can find solutions alike to those proposed by the author of this article. However, there are no such studies conducted on complex roofs. Roofs covering buildings with projections with shape of a concave polygon are often called multi-slope roofs. It gives very little information on the actual roof shape. In connection with that fact, the author of this article proposes to divide the above mentioned roofs by the form of their foundation (table 4). The characteristic feature of the complex roof constructions is different way of connecting the elementary roofs.

---

<sup>3</sup> The expression „half” cannot be taken literally. It means, that there is no regular, full shape of the gable present. The division of roofs into ones with upper- and lower- half-gable was already presented in the thirties by Marjan Dolnicki [1] and Krzysztof Tauszyński [4].

<sup>4</sup> Polish word „naczółek” has more in common with a name of an element of bridle, the headstall. The history of this name requires further research. It cannot be found with popular dictionaries from second half of 19<sup>th</sup> century, for example [3] and [6].

<sup>5</sup> The polygons of eave line can have more edges than four.



Sketch	Roof	
	a/	b/
Views		
Projection		

Figure 1: Example of modified two-slope roofs: a/ simple with middle-half-gables (with upper-half-gables and lower-half-gables), b/ curb (so called *polish*) with small upper-half-gable and false rafters on both levels of the slopes, Zakliczyn, woj. Lesser Poland Voivodship (2016), photo by author



Sketch	Front	
	Projection	

Figure 2: A mansard roof, four-slope with lower-half-gable, a false rafters on both levels of the slopes and a tiny dormer topped with two-slope roof, Owiesno, Lower Silesian Voivodship (2013), photo by the author



Table 2: Division of roofs uniform due to the number and type of slopes, study by author





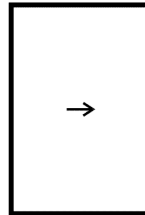
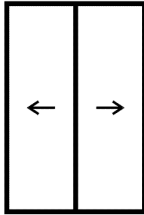
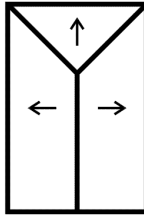
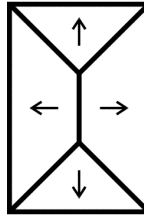
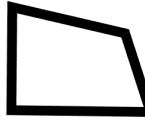


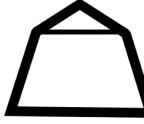
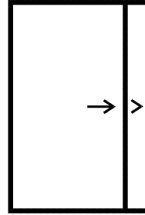
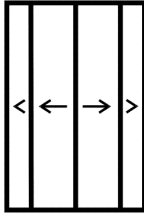
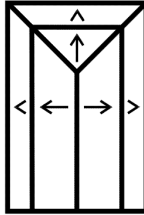
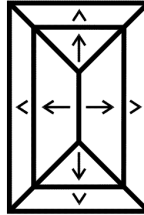
division of slopes	description of information	by number of slopes			
		shed	multi-sloped		
			gable	three-hipped roof	hip
simple	c.s.				
	f.a.				
	nr	1	2	3	4
	u.n.	shed	Gable	three-hipped	hipped or hip
		lean to skillion	Saddle -	- -	tent
p.n.	one-slope	two-slope	three-slope	four-slope	
curb**	c.s.				
	f.a.				
	nr	5	6	7	8
	u.n.	curb or mansard	curb or mansard	curb or mansard	curb or mansard
	p.n.	mansard*** one-slope	mansard*** two-slope	mansard*** three-slope	mansard*** four-slope
<p>Comments</p> <p>Abbreviations: nr – number of the roof; u.n. – used names; c.s. – cross-section; p.n. – proposed names; f.a. – (view) from above.</p> <p>The bases of the roofs (eaves) can be any kinds of convex polygons.</p> <p>The angles of inclination of the slopes to the horizontal plane can be different.</p> <p>The planes of cross-sections of the roofs were directed through the arrows marking the inclination direction.</p> <p>The reason for the division is in the features of the cross-sections of main slopes.</p> <p>** - also gambrel; *** - here a mansard roof, because of the characteristic way the surface „breaks”.</p>					

Table 3: Division of uniform, gable roofs with usual correcting elements added, study by the author





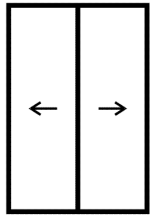
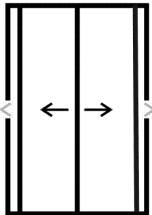
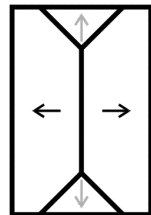
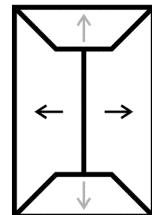




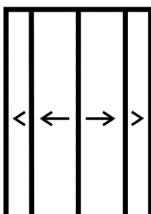
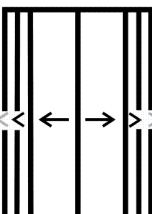
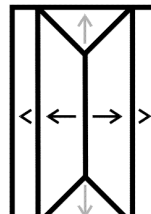
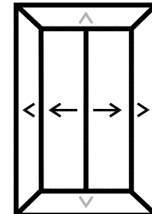
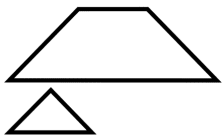
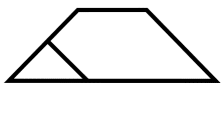
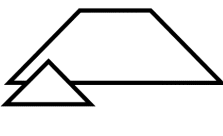
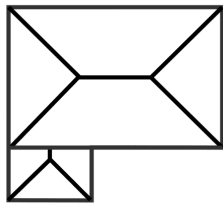
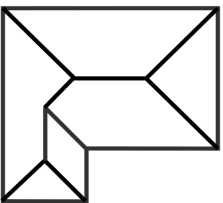
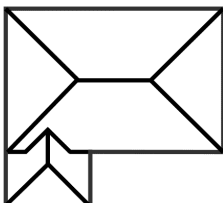
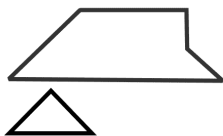
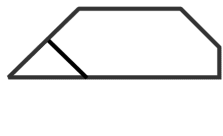
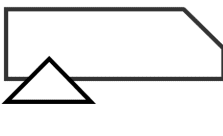
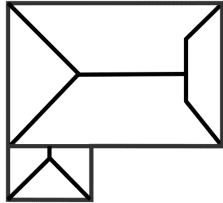
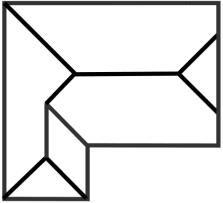
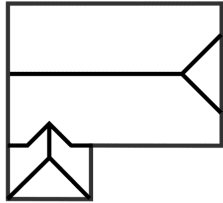
features of the slope*	description of information	roof type	correcting elements added to uniform roof		
		gable	false rafter (one or two)	upper-half-hip (one or two)	lower-half-hip (one or two)
simple	c.s				
	f.a				
	nr	7	8	9	10
	u.n.	gable or saddle	gable	half-hip	gabled or Dutch Gable
	p.n.	two-slope	two-slope with false rafters	four-slope with upper-half-gable	four-slope with lower-half-gable
curb**	c.s				
	f.a				
	nr	11	12	13	14
	u.n.	curb or mansard	curb or mansard	curb or mansard	curb or mansard
	p.n.	mansard*** two-slope	mansard*** two-slope with false rafters on lower slopes	mansard*** four-slope with upper-half-gable	mansard*** four-slope with lower-half-gable
<p>Comments</p> <p>Abbreviations: nr – number of the roof; u.n. – used names; c.s. – cross-section; p. n. – proposed names; f.a. – (view) from above.</p> <p>Possible combinations of elements added: a+b; a+c; b+c; a+b+c.</p> <p>Possibilities of adding further elements, for example dormer roofs.</p> <p>The planes of cross-sections of the roofs were directed through the arrows marking the inclination direction;</p> <p>*- the reason for the division is in the features of the cross-sections of main slopes; **- also gambrel; ***- here a mansard roof, because of the characteristic way the surface „breaks”.</p>					

Table 4: Roofs of projections in shape of concave polygons, study by the author

roofs being part of the solution	description of information	Complex		
		separately	equally	subordinately
uniform	f.f.			
	f.a.			
	nr	15	16	17
	p.n.	a roof composed separately of two roofs: a four-slope and a three-slope roof	a roof composed equally of two roofs: a four-slope and a three-slope roof	a roof composed subordinately of two roofs: a four-slope and a three-slope roof
mixed - examples	f.f.			
	f.a.			
	nr	18	19	20
	p.n.	a roof composed separately of two roofs: a four-slope with one upper-half-gable and a three-slope roof	a roof composed equally of two roofs: a four-slope with one upper-half-gable and a three-slope roof	a roof composed equally of two roofs: a four-slope with one upper-half-gable and a three-slope roof
<p>Comments</p> <p>Abbreviations: nr – number of the roof; u.n. – used names; f.f. – (view) from (the) front; p.n. – proposed names; f.a. – (view) from above.</p>				

As the base of the division there was taken the position of the eave lines of the elementary roofs being part of the applied solution.

Table 4 presents the proposed division of the complex forms being composed:

- separately, when roofs have no common parts;
- equally, when they have a common eave line;

- subordinately, when they have common parts, but do not have a common eave line.

Another problem is defining elements being parts of a complex roof. In case of roof no. 15 (table 4) we have no problem in naming the elementary roofs. Here we have two roofs – one bigger hipped roof and one smaller three-slope roof, but there are six directions of draining the water, because two surfaces of different roofs are oriented in the same direction. In case of roofs combined separately, nevertheless the directions are the same, the water from the gutters of these surfaces has to be gathered separately, on different levels. Another situation is when we are dealing with a roof that is equally combined (table 4, item 16). As we can see, the roof is a six-slope-roof. In the description of elements the complex roof has to be divided into the elementary roofs: a hipped and three-slope one.

Another problem is the lack of symmetry of elementary roofs, which examples were presented in table 4, items 18 - 20. In these cases roofs will be called mixed roofs, unlike the symmetric solutions, which will be called simple.

Proposed divisions and examples of solutions are only the beginning of the study of roof shape naming. The author looks to interest of the readers and a discussion.

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