

Sloping roof system and insulating board for sloping roof systems

This invention relates to an insulation panel for a sloping roof system, comprising an insulation body having a base and a top surface and lateral surfaces connecting the base to the top surface. The base is oriented anti-parallel with respect to the top surface, so that the top surface is at least inclined relative to the base. The insulation body is designed in a sandwich fashion and includes at least one first layer which has the heat and/or sound insulation properties and which is made from mineral wool, preferably rock wool. The invention further relates to a sloping roof system for a flat roof or a flat inclined roof, consisting of an insulation layer arranged on a support, especially on sub-roof constructed from trapezoid metal sheets, with a foil covering, particularly an air barrier, interposed. The insulation layer is composed of panel-shaped insulation elements and covered with an outer roof skin, wherein at least a part of the panel-shaped insulation elements includes an insulation body designed in a sandwich fashion and including at least one first layer with heat and/or sound insulating properties and made particularly from mineral wool, preferably from rock wool.

Insulation elements and roof constructions are known in prior art in a great variety of designs. A flat or flat inclined roof of the above-mentioned type normally consists of an insulation layer arranged on a support, with a foil

covering interposed. The insulation layer is additionally covered with an outer roof skin. The support may include a supporting structure.

The supporting structure of a flat or a flat inclined roof is comprised of trusses mounted on pillars at regular distances from each other or supported on the enclosing walls. To provide column-free hall areas, one tries to achieve large spans. The trusses consist for instance of steel profiles, steel-framework-constructions, concrete beams, plywood beams or wood box-girders. Purlins or rafters are fixed in the cross direction to the trusses on the upper chords thereof. At least in wood supporting structures, these supporting elements are also referred to as chord purlins. Though the following description refers to purlin roof designs, it may equally apply to chord roof designs.

As a support for the roof system, in-situ concrete ceilings, concrete components, formwork from solid wood or wood materials and trapezoid metal sheets are used. Formwork from wood materials is limited to panel sizes of 2.5 m x 2.5 m. The dimensions of trapezoid metal sheets are limited for reasons of transportation. Metal coverings in any desired length are profiled off coil at site. This is normally possible also for trapezoid metal sheets of the roof substructure. By appropriately shaping the blanks, the section modulus of the trapezoid metal sheets can be varied within vast limits or the thickness of the metal sheet can be adjusted to the cross sectional shapes. The usual spans of trapezoid metal sheets in their function as multiple span girders are 6 m.

A difference is made between flat roofs and inclined roofs and between non-utilized roofs and utilized roofs.

Due to the loads on the supports and formwork, but specifically with regard to the roof sealing, stagnant water is considered to be harmful. Originally gaseous parts of the atmosphere can become dissolved in the precipitations and can lead to a massive decrease in pH because of their boiling temperature during

drying being higher than that of water. Humidity binds dust, dirt and seeds and promotes algal formation and plant growth accompanied by the formation of humus and organic acids. Organic and inorganic acids can attack the roof sealing. Alone the formation of crusts can lead to harmful attacks in the region of the connecting seams between the individual sealing systems of a roof, which are mostly considered to be the weak point.

To avoid the accumulation of precipitations, already the bases or supporting structures of the roof systems should be planned with a slope of 2% (1.15°). Roofs which are even less sloped are special constructions and require special measures to avoid or reduce the risks caused by stagnant water. The Flat Roof Guidelines explicitly mention that stagnant water is unavoidable on roofs with a slope of up to 3° (~ 5%).

Precipitation water shall be discharged the short way. In roofs having an inclination of up to 5°, an interior drainage takes place through roof drains which should be provided at the lowest points of the areas to be drained and which should be spaced at least 50 cm from the superstructure of the roof or other penetrations of the roof sealing system. Channels leading to the roof drains should be sufficiently sloped. The roof drains themselves should not constitute any thermal bridges. They must be inspected and maintained at regular intervals and must be freely accessible for this reason.

Non-utilized roof areas are not intended for people to stay on the roof repeatedly and for a longer time and they are not intended for being utilized for traffic or greenery. These roofs are accessed merely for the purpose of maintenance and general servicing. Concerning greenery, a difference must be made between intensive and extensive greenery, the latter corresponding to the coverings with gravel that were usual in the past.

The roof superstructures must normally include a thermal insulation layer to meet the requirements for saving heat energy.

A roof superstructure of the above-mentioned type normally comprises a base consisting of trapezoid metal sheets for example, an air barrier having a water vapor diffusion inhibiting effect, an insulation layer formed by a mineral wool insulation material, preferably by rock wool insulation panels, and a roof sealing formed by webs of plastic material or rubber (elastomer) which are anchored in the trapezoid metal sheets by means of screws passing through the insulation layer.

For forming the air barrier, polyethylene foils as thin as approximately 100 μm are frequently used. These foils are loosely spread on the upper chords of the trapezoid metal sheets and are altogether not able to take a load. On the other hand, webs of elastomer material which are coated with metal foils and which are glued to the upper chords of the trapezoid metal sheets exhibit a certain load carrying capacity.

The various roof sealing materials will not be further differentiated in the following. Instead these materials are generally referred to as roof sealing webs, even if ready-made blankets, for example from elastomer, are employed.

Mineral wool insulation materials consist of artificially made, glassily solidified fibers partially bound with small amounts of mostly organic binding agents like thermosetting phenolic or formaldehyde urea resins. For hydrophobing the insulation materials throughout, the same are additionally impregnated with additives like oils or resins.

In commerce a difference is made between glass wool and rock wool insulation materials. Both kinds have different chemical compositions of the fibers and are consequently produced by different processes in different devices. Rock wool

insulation materials contain up to approximately 35% of non-fibrous particles, whereas glass wool insulation materials are largely free from those particles. However, there are offered also special rock wool insulation materials containing no or only a few non-fibrous particles. Moreover, recycling fibers are added to the rock wool insulation panels at an amount of up to 2 to 25% by weight and are usually only loosely embedded in the flakes of the primary fibers and thus do practically not contribute to the increase of the mechanical properties of the insulation materials.

For this reason rock wool insulation materials are differentiated from glass wool insulation materials and other mineral wool insulation materials by their thermal resistance. Rockwool insulation materials comprise all those mineral wool insulation materials having a melting point $\leq 1000^{\circ}\text{C}$ according to DIN 4102 part 17.

For producing a thermal insulation layer, factory-made mineral wool insulation materials according to DIN EN 13162 are used. The compressive strength of these mineral wool insulation materials is ≤ 40 kPa at 10% compression. To achieve this compressive strength using as little material as possible and thus also saving weight, the endless fiber webs which are mixed with unfixed binders and impregnated with additives are compressed in the vertical and horizontal directions during the manufacturing process. In this process, individual fibers or primary fiber agglomerations are folded upon each other and in themselves in the conveying direction. Transversely to them, mostly horizontally arranged layers are formed resulting in that the flexural strength in this direction is considerably higher than in the conveying direction. Increasing the proportions of binders is not an option because of the risk of losing the non-flammability of the insulation material and also for reasons of cost.

To utilize the anisotropy of the mechanical properties of the roofs concerned, the roof insulation panels are designed as multiple span girders, i.e. with

dimensions transversely to the profile of the trapezoid metal sheets which are as large as possible. Such trapezoid metal sheets have inner widths of more than 150 mm between the upper chords. To bridge these widths, the Flat Roof Guidelines require minimum thicknesses of the mineral wool insulation panels of 120 mm. According to a previous formula, half of the inner width between the upper chords of the trapezoid steel profiles was calculated as the minimum thickness, although this formula was based upon insulation panels in which the fibers lie flat with respect to both large surfaces.

Rock wool insulation panels have total densities in the range of approx 130 to approx 170 kg/m³, non-fibrous parts and recycling fibers included. After a deduction of the non-fibrous particles, the resulting net densities are less than 90 kg/m³ or more than 70 kg/m³ of primary fibers, binding agents included. Large format roof insulation panels are used with dimensions of 2 m length x 1.2 m width for example.

The surfaces of the rock wool insulation panels react sensitively to loads when they are walked on or when hand carts, sack trucks or lift trucks are moved over these surfaces. Both the profiles of the shoe soles and the profiles of the wheels of the transport means, such as the sharp edges of the wheels of the lift trucks, not only cause pressure loads on the surfaces concerned, but also shearing stresses. When the regions above the lower chords of the trapezoid metal sheets are walked on or travelled on in the longitudinal direction, the harmful effects of these loads are clearly increased.

Due to its hydrolyzing effect, rain water coming down onto the unprotected surfaces of the insulation panels weakens the frequently used thermosetting resins and the structure of the insulation material. Moreover, due to relaxation effects, quasi natural moisture losses generally occur within the rock wool insulation material.

By an increase of the gross density to approximately 180 to 220 kg/m³ within a 10 to 25 mm thick layer underneath the upper large surface, the resistance of the roof insulation panels is increased and the specific stress of the structure of the insulation material is reduced due to the more favorable introduction of forces.

An appropriate organization of the laying work and the use of suitable transport means help to avoid the transport of heavy stacks of parts of the insulation layer produced from insulation panels and their damaging. For carrying out subsequent work that may be required, for example completing the connections to attics, fire walls, penetrations and/or other building parts, the installation of dome lights and roof drains and so on, additional pressure-compensating panels have to be laid. But such precautions are regularly left out during planning, because one frequently shies away from organization work and costs for these measures.

Further, non-utilized roof areas must be regularly accessed for maintenance and cleaning. This maintenance comprises among others checking the water drains and the removal of debris. Non-utilized roofs must also be accessed for example for the maintenance and cleaning of air condition systems, antennas, lightening protection systems, billboards, smoke outlets and/or dome lights. This causes walkways being formed which are marked by damaged roof insulation panels. To avoid such damages, scrap rubber mats or panels are laid and concrete slabs or light grids are placed on the scrap rubber mats or panels, or light grids are additionally floor-mounted on the concrete slabs.

A further problem of flat or flat inclined roofs is constituted by the drainage of precipitations, melt water included. In most cases stagnant water on the roof sealing can be avoided only by an inclination of the base of the roof superstructure of $\geq$ approx 3°. Disadvantageously, even in new buildings supporting structures are planned and built without sufficient inclination, or their

admissible deflection is neglected. The admissible deflection of the trapezoid metal sheets is $1/500$ which at least makes 12 mm at the usual spans of 6000 mm. For purlins and trusses, deflections in a similar magnitude must be considered.

The deepest points of the partial areas which are predetermined by the purlins and trusses become apparent only after the completion of the entire superstructure of the roof, including the superimposed loads. The positions of these deepest points can even change through influences of weather, for example through deposits of snow. Hence a plurality of usually additional roof drains is fixed only after locating the deepest points. This additional work and these additional installations are costly. To avoid costs, roof drains are preferably arranged in the vicinity of purlins or on the trusses and hence quasi on the uppermost height lines of the entire roof construction.

To generally construct a water drain towards a small number of roof drains, sloping roof systems are provided which are additionally constructed on the insulation layer and which form a channel if arranged in pairs. To avoid stagnant water in this channel and to direct the precipitations towards the roof drains, sloped valley roof systems are additionally provided which are always constructed in pairs, so that a rising central ridge is formed while two downwardly sloping lateral surfaces together with the surfaces of the sloping roof system respectively form valleys. Between two roof drains arranged adjacent to each other, preferably two sloped valley roof systems are arranged, one with respect to the other one in such a way that the precipitations are directed in opposite directions, i.e. towards the respective roof drains.

At the calculation of the thermal resistance of the roof superstructure the insulation elements of sloping roof insulation systems are a factor that is considered. But in order to avoid thermal bridges and especially to achieve sufficient positional stability of the sloping roof system on the trapezoid metal

sheets and thus the required load bearing capacity, a thermal insulation layer constructed from large-format rock wool roof insulation panels is usually required. Sloping roof systems can also be installed on top of existing, i.e. old roof superstructures.

For limiting the height of the sloping roof insulation systems, the same are arranged against each other on larger roof areas and constitute saddle-shaped elevations, each with a ridge line and with the channels extending there between. Sloping roof insulation systems can extend up to the bordering building parts like attics, fire walls, superstructures and other penetrations. But in most cases the commercially available sloped roof panels are installed there, which form a plane sloping away from the bordering construction. In commerce, this plane is still referred to as a counter slope, even if the rest of the roof superstructure is planar, i.e. a counter slope is missing.

Commercially available sloping roof systems consist of a number of molded rock wool bodies, the outer large surfaces of which are inclined at least with respect to the mostly horizontal supporting surfaces. The angles of inclination mostly do not exceed 1.15° ($\sim 2\%$ decline), which is due to a higher amount of insulation material needed for larger angles of inclinations and to the costs which are thus increased. The molded rock wool bodies are matched to each other in their heights and widths. After reaching a certain height, additional molded rock wool bodies are arranged on a planar roof insulation panel, so that larger heights can be obtained with a small number of molded bodies.

Sloping roof insulation panels having smaller thicknesses can be cut from rectangular parallelepiped-shaped rock wool roof insulation panels and thus generally have the same structure as the rock wool roof insulation panels. Sloping roof insulation panels having larger thicknesses are composed of individual panel sections which are aligned at right angles to the roof surface, and a lateral surface of which is cut in a sloped fashion corresponding to the

desired angle of inclination. By this overwhelmingly right-angled orientation of the mineral fibers in the panel sections an increased compressive strength is achieved or it is possible to reduce the density of the panel sections while the level of the compressive strength is still the same.

For use in the above-described roofs, the insulation layers (sound and/or heat) must be sufficiently resistant to deformation and temperature and, as a base for the roof sealing, they must be sufficiently hardwearing and dimensionally stable. For reasons of costs and to avoid thermal bridges as far as possible, the rock wool roof insulation panels provided for this purpose are used as inherently planar prismatic insulation panels, i.e. parallelepiped-shaped insulation panels. Such insulation panels can be produced at low cost. They can be stacked, transported and quickly laid without expert knowledge. For reasons of costs and because of their higher load bearing capacity, large-format panels having dimensions of e.g. 2 m length x 1.2 m width are preferred. Small-format insulation panels having dimensions like 1.25 m or 1.0 m length x 0.6 or 0.625 m width are used only for secondary areas or on solid bases.

The surfaces of rock wool insulation panels are relatively sensitive to repeated mechanical loads occurring for example when the panels are stepped on or travelled on by wheel barrows, handcarts, lift trucks and so on. The effects of these general pressure loads are even intensified to the negative by the shearing stresses caused by profiled shoe soles or tire profiles. While two layers of bitumen still have a certain pressure-compensating effect and clearly reduce the above-mentioned shearing stresses of the surfaces, this is not the case when thin plastic or rubber webs are used.

To improve the surface properties and particularly the accessibility or carrying capacity of the rock wool roof insulation panels, a cover layer which is highly compacted up to 220 kg/m^3 and which is approx 2 cm thick is intended. But the long-term effect of the same is dependant on the rigidity of the remaining

insulation body. If the latter is repeatedly subject to loads, even this cover layer will crush like a floe.

A difference must be made between roof insulation panels and sloping roof insulation panels, the latter having an inclined surface in at least one direction. With sloping roof insulation panels, which are installed for instance in the valleys of inclined roofs, the inclined surface can be sloped toward the one side or towards the other side, thus ultimately forming a double slope.

On the other hand, sloping roof systems are known consisting of individual sloping roof insulation panels which have a length of 900 mm and a width of 600 mm on the basis, in the direction of the decline, whereby a 2% decline can be produced in the roof area. The thicknesses of the individual sloping roof insulation panels within this sloping roof system are between 40 mm and 184 mm. Because of possible damages already at the time of manufacture it is generally avoided to have the sloping roof insulation panels or other unprotected molded bodies terminate with a thickness close to zero.

If it is intended to increase the base length of this sloping roof system, a layer consisting of planar roof insulation panels is inserted, so that it is normally possible to continue with a first one of corresponding sloping roof insulation panels.

To limit the thickness and the volume of the sloping roof insulation panels required for constructing an inclined roof surface, saddle-shaped elevations are formed, whereby channels are produced in which roof drains are situated.

In view of the above-discussed prior art it is a p r o b l e m of the present invention to provide an insulation panel for a sloping roof system with improved mechanical properties, so that the insulation panel can resist high pressure loads and shearing stresses on the one side and is suitable for the construction

of a sloping roof system and for compiling a corresponding construction kit on the other side. The invention is also based on the p r o b l e m of providing a sloping roof system for a flat or flat inclined roof which can be constructed in an easy way and preferably with only a small number of construction parts and which additionally has the required mechanical properties, especially mechanical strengths.

The s o l u t i o n of this problem provides in an insulation panel of the kind described above, that the first layer is connected to a second layer having mechanical properties, especially a compressive strength and/or bending strength, different from those of the first layer and consisting of a material which is different from the material of the first layer and at least has a higher bending stiffness.

Concerning the sloping roof system according to the invention, the s o l u t i o n of the problem provides that the second layer has mechanical properties, especially a compressive strength and/or bending strength, different from those of the first layer and consists of a material which is different from the material of the first layer and at least has a higher bending stiffness.

Further features of the insulation panel according to the invention and of the sloping roof system according to the invention will become apparent from the respective subclaims and from the following description of further improvements and embodiments of the insulation panel and the sloping roof system.

In an insulation panel according to the invention, a right-angled construction of the base has proved to be advantageous, so that the lateral surfaces are oriented at right angles to each other. Such insulation panels can be easily laid on the usual roof areas and can also be readily cut with the usual cutting tools.

A further feature of the invention provides that the second layer of the insulation panel is constructed from a molded body consisting of a material which is pressure-resistant and/or exhibits a high bending strength, in particular magnesia binder, for instance from Sorel cement, or from mixtures of binding agents with magnesia binder. An advantage of this construction is that a corresponding second layer is sufficiently pressure-resistant, so that the insulation panel can be walked on and/or travelled on. This embodiment of the second layer, which consists of a magnesia binder, additionally has the advantage that the fire performance of a correspondingly constructed insulation panel is not negatively influenced.

A further development of this embodiment provides that the at least first layer is in the form of a rectangular parallelepiped and is arranged on a molded body which forms the at least second layer. An alternative may provide that the at least second layer is in the form of a rectangular parallelepiped and is connected to a molded body forming the at least first layer. Thus the invention either provides that the first layer having heat and/or sound insulation properties is constructed particularly from mineral wool, preferably rock wool, in the form of a rectangular parallelepiped-shaped element, namely a customary insulation panel, and that the second layer having mechanical properties different from those of the first layer includes a planar large surface which is arranged on the entire area of the large surface of the first layer, the second large surface of the second layer extending anti-parallel to the large surface of the first layer. Further the possibility exists for the insulation panel being constructed from a first layer having two large surfaces extending anti-parallel to each other, so that the second layer with mechanical properties different from the first layer is applied to one surface of the first layer, the second layer being in the form of a rectangular parallelepiped. In this latter embodiment one may benefit from the fact that the first layer having the heat and/or sound insulation properties can be easily adapted in its shape by cutting a corresponding layer as a molded body for example from a block of mineral wool, for example rock wool.

A further development of the insulation panel according to the invention provides that the insulation body includes at least one lateral surface extending parallel to the inclination and oriented to the base at angle deviating from the right angle. A still further development of the invention provides that the lateral surfaces have a height of at least 5 mm, so that the insulation panel over the entire surface thereof is constituted by a region, namely a layer, with heat and/or sound insulation properties, and a region, namely a layer, having a high compressive strength and/or bending strength. Thus the heat and/or sound insulation properties of such an insulation panel are maintained over its entire surface, for instance its surface supported on a sloping roof.

The first layer from mineral wool preferably has a fiber orientation towards its large surface. This construction has the advantage that the compressive strength of this first layer is increased.

A further feature of the invention provides that the second layer consisting of a pressure-resistant material includes a two-dimensional reinforcement made from wovens, non-wovens, rovings from glass, plastic and/or natural fibers. Also this measure serves to improve the mechanical properties, especially the compressive strength and/or bending strength of the second layer, so that this second layer exhibits at least a high bending stiffness, even if the thickness of the layer is relatively small.

According to a further feature of the invention the second layer which consists of a pressure-resistant material can additionally include amounts of water glass, organically modified silicates (ormosiles), silica glass and/or plastic dispersions or emulsions.

A further feature of the invention provides that, for improving its mechanical properties, the second layer, which consists of a pressure-resistant material, at

least includes an internal reinforcement made of textile, glass and/or mineral wool fibers. Here it turned out to be advantageous to construct the second layer, which consists of a pressure-resistant material, for up to 40% and preferably up to 25% from textile, glass and/or mineral wool fibers.

The layers of mineral fibers and for instance Sorel cement, which must be connected to each other, are preferably glued together or laminated one on top of the other during a manufacturing step.

A further feature of the invention provides that the second layer, which consists of a pressure-resistant material, particularly magnesia binder, includes fine-grained additives from brucite, aluminum hydroxide and/or titanium oxide, particularly in an amount of up to 25% by weight.

Preferably, these two layers are arranged one on top of the other and flush with each other, to provide a body having a planar lateral surface area, so that an insulation constructed from these insulation panels includes panels with the lateral surfaces thereof bearing against one another over the entire surface.

According to a further feature of the invention it can be provided that the second layer comprising the top surface projects at least compared to a lateral surface of the first layer comprising the base. In this case the projecting second layer can be supported on an adjacent insulation panel and thus cover the joint region of two adjacent insulation panels. The projecting second layer thus serves as a sealing of the transition zone between two adjacent insulation panels of a roof system.

A further feature of the invention provides that the second layer comprising the top surface has a material thickness of approx 2 mm to 25 mm, preferably of approx 3 mm to 10 mm. A second layer constructed in this way thus has a material thickness which is sufficient for forming together with the above-

mentioned features a sufficiently pressure-resistant and/or rigid layer. The material thickness is further selected in such a way that the total weight of the insulation panel is within a range allowing a person to handle the insulation panel. Such material thicknesses moreover allow large-format insulation panels which do not require machines to assist laying the panels within a roof system.

An advantageous embodiment of the invention further provides that a cover, in particular a cover in the form of a random web produced from artificial fibers is arranged on the surface of the insulation body, particularly on the second layer. This embodiment has the advantage that the connection between the two layers is improved through this cover, wherein a random web made of artificial fibers may have the effect of reinforcement.

A further development of the insulation panel according to the invention provides that the pressure-resistant and/or rigid layer is constructed differently thick, depending on the mechanical loads occurring during utilization. The second layer for instance can be formed with a greater thickness in the region of walkways and/or driveways. These regions can also be made visually recognizable by a special color, grain size or the like.

Concerning the above-mentioned cover, it may be provided that the same overlaps at least one, preferably two adjacent lateral surfaces of the insulation body, preferably of the second layer comprising the top surface. In this case the cover can again overlap an adjacent insulation panel at least partly, so that this cover has a sealing function in this respect. Incidentally, the cover can be formed so as to be self-adhering at least in the overlapping region, so that it can be readily and easily stuck together with the cover of an adjacent insulation panel or with an adjacent insulation panel.

A further feature of the invention provides that at least one lateral surface of the first layer comprising the base is at least partially provided with a pressure-

resistant and/or rigid coating, said coating preferably being of the same material as the pressure-resistant and/or rigid second layer. Such an insulation panel is especially suited for rim areas of a roof covering, wherein the layer protects both the top surface of the insulation material and a lateral surface against damage.

For further developing the insulation panel according to the invention a further embodiment of the invention provides that the first layer comprising the base is constructed in a multipart fashion from segments. Preferably, the segments of the first layer are glued to each other and/or are connected to each other through the pressure-resistant and/or rigid second layer. Additionally, it can be provided that the segments are arranged on a supporting layer and are preferably connected and especially glued to this supporting layer. This embodiment can be developed further for instance by constructing the supporting layer from a material suitable for heat and/or sound insulation, especially from mineral fibers.

A further feature of the invention provides that the insulation body includes a first layer with heat and/or sound insulation properties, particularly from mineral fibers, a second layer from a pressure-resistant and/or rigid material, particularly from a magnesia binder, arranged on the first layer, a third layer with heat and/or sound insulation properties, particularly from mineral fibers, arranged on the second layer, and finally a fourth layer from a pressure-resistant and/or rigid material, particularly from a magnesia binder. This insulation panel is thus designed in the fashion of a sandwich element and exhibits good mechanical strength and excellent heat and/or sound insulation properties.

The above-described insulation panel is further improved by constructing the first layer so as to be compressible. By this compressibility of the first layer this insulation panel can be readily adjusted to irregularities of the support of the roof seating the insulation panel.

Constructing the second layer and the fourth layer from identical materials has proved to be advantageous in such insulation panels, because this simplifies the manufacturing process.

In the following, particularly preferred embodiments of the sloping roof system according to the invention are illustrated.

Preferably, the sloping roof system according to the invention is developed further by a plate-shaped insulation element arranged on the support. The plate-shaped insulation element includes at least one lateral surface which is oriented to an upper large surface in the insulation layer and to a lower large surface in the insulation layer of the insulation element at an angle deviating from the right angle, and the lower large surface is formed greater in area than the upper large surface of the insulation element.

For the controlled discharge of rain water drainage systems are known. According to the invention, insulation elements having an inclined surface serve for this purpose. With such insulation elements having an inclined surface sloping roof systems are constructed serving for instance to discharge rain water into a drainage system of the sloping roof system.

A further development of the sloping roof system according to the invention provides that the angle of the superposed insulation elements or molded parts is smaller towards the support. If several insulation elements or molded parts are arranged one above the other, the surfaces which obliquely extend at an angle with respect to the horizontal exhibit a progression in the form of a circle of an arc or in the form of a segment of a circle of an arc.

The molded parts are preferably connected, particularly by gluing, to the lateral surface of the insulation element joining these molded parts and/or to the layer

of the insulation element arranged beneath, to guarantee a compound structure of the individual construction parts of the sloping roof system.

It is further provided that the insulation element in the region of its upper large surface in the insulation layer is arched and/or preferably bent into segments. This construction considerably improves the function of an insulation element for discharging precipitations, especially rain water, into the roof's own drainage system and particularly avoids the accumulation of water on the surface of the roof.

Additionally it can be provided that the lateral surface of the plate-shaped insulation element which is oriented to an upper large surface in the insulation layer and to a lower large surface in the insulation layer at an angle deviating from the right angle, is also arched, particularly concavely curved, in order to achieve the above-mentioned advantages also in this type of insulation element of a sloping roof system.

A further development of the sloping roof system according to the invention provides that at least one surface of the molded part adjacent to the lateral surface and/or of the adjacent insulation element includes a pressure-resistant and/or rigid layer at least in parts thereof. This layer protects the molded part or the insulation element from damage caused by being stepped on or also caused by influences of weather, for instance precipitations and/or solar radiation. A further development of this embodiment provides that the pressure-resistant and/or rigid layer extends over a part of the lateral surface to protect also this lateral surface from damage and influences of weather.

Further it turned out to be advantageous to extend the pressure-resistant and/or rigid layer over the lateral surface and up to the support and to arrange it preferably on a part of the support. Also this embodiment serves to protect the construction elements of the sloping roof system against mechanical stresses,

for instance pressure, bending and shearing stresses, and also against influences of weather, especially precipitations and/or high solar radiation.

A further feature provides that the insulation element includes two large surfaces, each comprising a layer constructed from a material different from the material of the first layer with the heat and/or sound insulation properties and at least exhibiting a higher bending stiffness. Insulation elements which are constructed in this way can be used also in regions of the sloping roof system intended to be walked and/or travelled on.

A further feature of the invention provides that one large surface of the insulation body is formed as a planar base which is arranged anti-parallel and at least inclined with respect to a second large surface of the insulation body, wherein the insulation body has lateral surfaces which connect the base to the second large surface. Accordingly, insulation elements like those described above in the form of an insulation panel can always be used in a sloping roof system according to the invention. Consequently, the above-described features and constructions of the insulation panel according to the invention can be implemented also in insulation bodies which are used in such a sloping roof system. Accordingly, concerning the advantages of such insulation bodies or insulation elements, reference is made to the above-described insulation panels.

Further features and advantages of the insulation panel according to the invention or of the sloping roof system according to the invention will become apparent from the following description of the attached drawing showing preferred embodiments of the insulation panel or the sloping roof system. In the drawing it is shown by:

Figure 1 a part of the sloping roof system in a perspective view;

- Figure 2 an insulation panel for a sloping roof system in a perspective view;
- Figure 3 the insulation panel according to figure 2 in a lateral view;
- Figure 4 an insulation panel for a sloping roof system in a perspective view;
- Figure 5 an insulation panel for a sloping roof system in a perspective view;
- Figure 6 an insulation panel for a sloping roof system in a lateral view;
- Figure 7 an insulation panel for a sloping roof system in a lateral view;
- Figure 8 an insulation element for a sloping roof system in a perspective view;
- Figure 9 an insulation element for a sloping roof system in a perspective view;
- Figure 10 an insulation element for a sloping roof system in a perspective view;
- Figure 11 the insulation element according to figure 10 in a lateral view;
- Figure 12 a part of a sloping roof system in a perspective view;
- Figure 13 a part of a sloping roof system in a lateral view;
- Figure 14 an insulation panel for a sloping roof system in a lateral view;
- Figure 15 a part of a sloping roof system in a lateral view;

- Figure 16 a part of a sloping roof system in a lateral view;
- Figure 17 a part of a sloping roof system in a lateral view;
- Figure 18 a part of a sloping roof system in a lateral view;
- Figure 19 a part of a sloping roof system in a lateral view;
- Figure 20 a part of a sloping roof system in a lateral view;
- Figure 21 a part of a sloping roof system in a perspective view;
- Figure 22 a part of a sloping roof system in a lateral view;
- Figure 23 a part of a sloping roof system in a perspective view;
- Figure 24 a part of a sloping roof system in a perspective view;
- Figure 25 a part of a sloping roof system in a perspective view;
- Figure 26 a part of a sloping roof system in a lateral view;
- Figure 27 a part of a sloping roof system in a perspective view;
- Figure 28 a part of a sloping roof system in a lateral view;
- Figure 29 a part of a sloping roof system in a lateral view;
- Figure 30 a part of a sloping roof system in a perspective view;
- Figure 31 a part of a sloping roof system in a perspective view;

Figure 32 a part of an insulation panel for a sloping roof system in a lateral view;

Figure 33 a part of an insulation panel for a sloping roof system in a lateral view;

Figure 34 a part of an insulation panel for a sloping roof system in a lateral view;

Figure 35 an insulation panel for a sloping roof system in a lateral view;

Figure 36 an insulation panel for a sloping roof system in a lateral view and

Figure 37 an insulation panel for a sloping roof system in a lateral view.

Figure 1 shows a part of a sloping roof system for a flat roof 1 consisting of a roof covering and a roof closure 2 which comprises an upper surface 3 with a film sealing 4, particularly an air barrier, arranged on it. On the film sealing 4 an insulation layer 5 constructed from a plurality of plate-shaped insulation elements 6 is arranged. The insulation elements 6 are aligned in several juxtaposed rows. Figure 1 also shows a central part 7 of the insulation layer 5. In this central part 7 additional drain openings 8 are arranged. The central part 7 of the insulation layer 5 is composed of sloping insulation panels 9 which are additionally placed onto the insulation elements 6. The construction of these sloping insulation panels 9 will be described in the following. Figure 1 shows that the insulation elements 6, which have a plate-shaped design, include a surface 10 which is arranged anti-parallel with respect to a second, oppositely arranged surface 10 that is supported on the film sealing 4. The surfaces 10 of the insulation elements 6 in a row have the same orientation and are joined by and flush with the surfaces 10 of the insulation elements 6 of an adjacent row.

The insulation elements 6 with their surfaces 10 altogether constitute a surface on one side of the central part 7 which is inclined towards the central part 7, so that precipitation water showering onto the surfaces 10 will be discharged towards the central part 7.

It can be seen in figure 1 that two drain openings 8 are spaced from each other in the central part 7. On both sides of the drain openings 8 sloping insulation panels 9 are arranged. The sloping insulation panels 9 between the two drain openings 8 constitute a sloping valley roof system which is designed in such a way, that the precipitations are directed in opposite directions, i.e. towards the drain openings 8. The sloping insulation panels 9 are attached to insulation elements 6 which form a component part of the insulation layer 5.

In the figures 2 and 3 an insulation element 6 is shown in a perspective and in a lateral view. The insulation element 6 is comprised of an insulation body from mineral fibers bound with a binding agent. The insulation body constitutes a first layer 11 of the insulation elements 6 and comprises a large surface 12. The insulation body has applied to it a second layer 13. The second layer 13 is substantially rectangular parallelepiped-shaped and comprises the large surface 10 of the insulation element 6. The large surfaces 10 and 12 extend anti-parallel to each other. Thus the large surface 10 is inclined with respect to the large surface 12.

The two layers 11 and 12 exhibit different mechanical properties, namely compressive strength and bending strength. The compressive strength of the first layer 11, namely the insulation body, is lower than that of the second layer 13.

In addition to the surfaces 10 and 12 the insulation element 6 comprises lateral surfaces 14 which are oriented at right angles so that two lateral surfaces 14

respectively extend parallel to each other thus constituting a right-angled base for the insulation element 6. This base corresponds to the large surface 12.

The second layer 13 and the first layer 11, namely the insulation body, are glued to each other, so that the insulation element 6 is integrally formed from the insulation body and the second layer 13. The figures 2 and 3 show that the insulation body in the region of its lateral surfaces 14 is at least 5 mm high, so that the entire second layer 13 is engaged by the insulation body from below. To improve the compressive strength of the insulation body or of the second layer 13, the first layer 11 has a fiber orientation towards the surface 12. In addition, the second layer 13 includes a two-dimensional reinforcement from glass fibers which are embedded in the second layer 13.

Finally, the figures 2 and 3 show that the lateral surfaces 14 of the insulation body and the lateral surfaces 14 of the second layer 13 merge flush with each, so that the respective lateral surfaces 14 of the insulation body 11 and of the second layer 13 are planar.

A further development of the insulation element 6 illustrated in the figures 2 and 3 can be seen in figure 4. In addition to the construction elements of the insulation element 6 according to the figures 2 and 3, the insulation element 6 according to figure 4 includes on the surface 10 of the second layer 13 a cover 15 in the form of a random plastic fiber web. The cover 15 can be glued to the surface 10 so as to be flush with this surface. Alternatively, that cover can project over the lateral surfaces 14, so it can be supported on an adjacent insulation element 6 of juxtaposed insulation elements 6.

The figures 2 to 4 show embodiments of the insulation element 6 with a surface 10 inclined in a direction relative to the surface 12. Differently from the figures 2 to 4, figure 5 shows an embodiment of the insulation element 6 which has a construction corresponding to the figures 2 and 3 but includes two inclinations

of the surface 10 relative to the surface 12 extending at right angles to each other as indicated by arrows 16.

Figure 6 illustrates a further embodiment of an insulation element 6 having a triangular cross section, wherein the surface 10 which is arranged oppositely to a right angle is constructed with the second layer 13. Such an insulation element can be used for instance in the rim area of a roof, particularly in the region of an attic 32.

Figure 7 shows a further embodiment of an insulation element 6 in combination with an insulation panel 17 which is in the form of a rectangular parallelepiped and consists of mineral fibers bound with binding agents. The insulation element 6 has a trapezoid cross section and includes a second layer constructed from rigid material and extending over a surface running parallel to the large surface 12 of the insulation body and over a lateral surface 14 which is erected so as to extend towards the surface 12 at an angle deviating from the right angle. The insulation element 6 has a height corresponding to the height of the insulation panel 17. This embodiment allows the insulation element 6 being constructed with a second layer 13 which extends over the large surface of the insulation body arranged oppositely to the large surface 12 or over the first layer 11 and is thus supported on a large surface 18 of the adjacent insulation panel 17. The second layer 13 can be additionally connected to the large surface 18 of the insulation panel 17 by means of an adhesive.

In the figures 8 to 11, which will be described in the following, various sloping insulation panels 9 are illustrated.

Figure 8 shows a first embodiment of a sloping insulation panel 9 which is designed as a magnesita molded body and has two lateral surfaces 19 running towards each other at an angle, and bases 20, only one base 20 being shown in figure 8. The sloping insulation panel 9 is wedge-shaped, with the lateral

surfaces 19 abutting each other along a line 21 and being oriented so as decline from this line 21 towards the bases 20, so that the lateral surfaces 19 have a downward slope from the line 21 with respect to a planar supporting surface.

In figure 9 an alternative embodiment of a sloping insulation panel 9 is shown, in which a bed-plate 22 is arranged between the bases 20 which includes a planar supporting surface 23 serving to take support on a surface 3 according to figure 1 or on planar insulation elements 6. Between the bed-plate 22 and the bases 20 setbacks are formed in a fashion so that they normally correspond to an inclination of insulation elements 6 in the region of their surfaces, so that these insulation elements 6 can be arranged flush in the space between the bed-plate 23 and the base 20. An alternative embodiment of the sloping insulation panel 9 according to figure 8 is illustrated in the figures 10 and 11. This embodiment of the sloping insulation panel 9 provides an insulation body having arranged on each of its lateral surfaces 19 a layer 13 constructed from pressure-resistant and rigid magnesia and glued to the insulation body 11. The insulation body 11 consists of mineral fibers bound with binding agents and thus exhibits excellent heat and sound insulation properties. Preferably, the insulation body 11 is produced as an integral press-molded part, with the second layers 13 being pressed together with the insulation body 11.

Between the two layers 13 a valley 24 is formed which corresponding to the lateral surfaces 19 has an inclination towards a tip 25 of the sloping insulation panel 9.

Figure 12 shows a further embodiment of a roof 1 consisting of a roof substructure including several trapezoid metal sheets 26 and a foil covering arranged on these metal sheets. On this foil covering 4 insulation panels 27 in the form of a rectangular parallelepiped are arranged. The insulation panels 27 abut each other by their lateral surfaces, and insulation elements 6, which

constitute a further embodiment of the invention, are arranged between two rows of insulation panels 27.

The insulation elements 6 are designed in a sandwich fashion and include a first layer 11 in the form of an insulation body, a second layer 13 and a third layer 28. These insulation elements 6 have a material thickness of approx 30 mm.

The first layer 11, which is formed as an insulation body, and the third layer 28 are made from mineral fibers bound with binding agents. It turned out to be advantageous to arrange the mineral fibers at least within the first layer 11, which is formed as an insulation body, so that the fibers have an orientation at right angles to the large surface. The second layer 13, which is the central layer in the sandwich element, consists of a non-flexible, rigid and thus pressure distributing magnesia panel. The thickness of this second layer 13 is so dimensioned that the third layer 28 slightly overlaps with its surface 10 the surface which is formed by the insulation panels 27. When subject to a load in the direction of the surface normal of the surface 10, this insulation element 6 is so compressed that the surface 10 will sink maximally to the level of the surfaces which are formed by the insulation panels 27. Accordingly, a much higher compressibility is not provided. It turned out to be advantageous to design the third layer 28 with a material thickness of approx 10 to approx 15 mm in order to guarantee its function as a springy spacer or as a separating layer. Differently from the above description, the third layer 28 can of course be constructed from rigid foam panels or random plastic fiber webs. This third layer 28 additionally serves as a protective layer for the magnesia panel which is thus protected against damage by sharp-edged items and against influences of weather.

Figure 13 shows the arrangement of an insulation element 6 according to the figures 2 and 3 in a sloping roof system, which insulation element is composed of a lower layer of insulation panels 27 and superposed sloping insulation

panels 8. Between two sloping insulation panels 8 an insulation element 6 is so arranged that the inclined surfaces of the insulation element 6 and of the sloping insulation panels 8 form one plane.

In this embodiment, the region of the insulation element 6 is designed as a region intended to be walked on. This can be visually marked by a clearly different second layer 13 for instance.

In figure 14 a further example of an insulation element 6 is shown. This insulation element 6 comprises an insulation body with two large surfaces 12 extending parallel to each other. On each of these two large surfaces 12 a second layer 13 is arranged fully covering the surface. The second layer 13 consists of a magnesia panel which is glued to the insulation body. Within the layers 13 reinforcing elements such as glass, plastic and/or natural fibers are arranged. These reinforcing elements are laminated with magnesia binders. The laminated layers are approx 0.5 mm to approx 30 mm thick. Material thicknesses between approx 1 mm and 10 mm have proved particularly appropriate. The two layers 13 may of course have different material thicknesses or may be reinforced differently from each other. The layers 13 can be applied by lamination in a working step during manufacture of the insulation body or they can be additionally adhered to the insulation body after the curing of the binder.

In the following various sloping roof systems will be described which are illustrated in the figures 15 to 31 and in which insulation elements 6 according to the figures 1 to 14 can be used.

Figure 15 shows a roof 1 with a roof closure 2 which has a surface 3. On the surface 3 a sealing film (not further illustrated) is arranged, for example a sealing film 4 such as shown in figure 1.

In the right half of figure 15 two superposed layers of insulation panels 17 in the form of a rectangular parallelepiped are arranged on the surface 3. The insulation panels 17 of the two superposed layers are arranged offset to each other regarding their lateral surfaces 19, thus producing a step-like design. In the steps 29 thus formed, insulation elements 6 are arranged which have a triangular cross section and comprise a surface arranged oppositely to a right angle, the surfaces of the insulation elements 6 which are arranged in adjacent steps being aligned in one plane.

On the uppermost layer of the insulation panels 17 a system of sloping insulation panels 9 is arranged, which accordingly are constructed with inclined surfaces deviating from the horizontal. As sloping insulation panels 9 those panels 9 can be used which are shown for example in the figures 8 to 11.

Differently from the right half of figure 15, the left half of figure 15 shows an alternative embodiment which is different from the embodiment shown in the right half of figure 15 in that the insulation panels 17 are formed integrally with the insulation elements 6. Accordingly, these insulation panels 17 differ from the block-shaped design in that one lateral surface 19 is oriented relative to the large surfaces 18 at an angle which deviates from the right angle. This can of course apply to more than one lateral surface 19. Two further embodiments are illustrated in figure 16 showing in its right half an insulation element 6 juxtaposed to two superposed insulation panels 17 and having a triangular cross section and including a step 30 on its lateral surface facing the insulation panels 17. The step 30 serves to seat the upper one of the two insulation panels 17, so that this upper one of the two insulation panels 17 is cantilevered towards the insulation element 6, compared to the lower one of the two insulation panels 17.

In the left half of figure 16 a further alternative embodiment is shown which provides an insulation element 6 extending in its height over two layers of

insulation panels 17 and having an inclined surface 31 arranged oppositely to the lateral surface 14 joining the lateral surfaces 19 of the insulation panels 17 so as to be flush with the lateral surfaces 19.

Apart from the above-described embodiment it is also possible for the insulation layer 5 consisting of more than two layers of insulation panels 17. The arrangement of sloping insulation panels 8 on the uppermost layer of insulation panels 17 is of course also possible and is provided in the embodiment according to figure 16.

Figure 17 further shows that the insulation element 6 joining an attic 32 for example, has a steeper slope compared to the insulation element 6 arranged on the opposite side of the drain opening 8. Both slopes serve to quickly and directly lead possible precipitation water to the drain opening 8 which extends with a tube section 33 thereof through the roof closure 2.

Further it can be seen that the layer 13 terminates flush with the large surface of the insulation panel 17 arranged next to the insulation element 6, so that a planar surface of the insulation layer 5 is produced which is free from projections that may constitute trip hazards.

Figure 17 further shows that the layer 13 of the insulation element 6 arranged in the region of the attic 32 is extended over the large surface of the insulation element 6 and almost up to the tube section 33, so that the layer 13 is supported with a part thereof directly on the surface 3 or on a sealing film arranged on the surface 3. This construction particularly provides for an additional protection of the delicate edge region of a mineral fiber insulation element 6 against damage.

Figure 18 illustrates a further embodiment of a roof 1 with a roof closure 2 that consists of several trapezoid metal sheets 26 and a foil covering 4 arranged

thereon. In addition to the usual insulation panels 17, which are made from mineral fibers bound with binding agents, figure 18 shows an insulation element 6 which is comprised of a first layer 11 constructed as an insulation body and a second layer 13 from Sorel cement which is arranged on the first layer. The second layer 13 has compressive strength and bending strength which are higher compared to the first layer and hence compared to the insulation body. The insulation element 6 has a slope and connects with its highest lateral surface 14 to the and flush with the adjacent insulation panel 17, thus producing a seamless transition between the large surface of the insulation panel 17 and the second layer 13 of the insulation element.

Figure 18 further shows the combination of an insulation panel 17, which is made as usual from mineral fibers bound with binding agents, and an insulation element 6 arranged next to it and constructed in a sandwich fashion and having a central insulation body 11 including on each of its two large surfaces a second layer 13 from Sorel cement.

From these insulation elements 6 having the two layers 13 from Sorel cement a walkway and/or driveway can be constructed easily and in an effective way on a roof 1. Of course, this is also possible with inclined insulation elements 6, as far as the inclination of the insulation elements 6 has a dimension which allows walking and travelling on this area without danger.

A further embodiment is illustrated in figure 19. Figure 19 again shows the combination of insulation elements 6 with insulation panels 17, wherein the insulation panels 17 are designed in accordance with the above description, especially with reference to figure 17. Moreover, the roof 1 illustrated in figure 19 is designed corresponding to the roof 1 according to figure 18.

The left half of figure 19 shows a first embodiment of an insulation element 6 consisting of a rectangular parallelepiped-shaped layer 11 in the form of an

insulation body made from mineral fibers bound with binding agents. The insulation body comprises on its large surface facing the film sealing 4 a second layer 13 from Sorel cement. This second layer 13 is also rectangular parallelepiped-shaped and has a small thickness. Finally, on the opposite surface of the insulation body a further layer 13 from Sorel cement is arranged which has a substantially triangular cross section in one part thereof and hence an inclination in the region of its large surface, and a rectangular cross section in another part thereof.

The insulation element 6 constructed in this way forms a sloping insulation panel 9.

The right half of figure 19 shows an alternative embodiment of such an insulation element 6, wherein a further layer 28 from mineral fibers bound with binding agents is additionally provided under the lower second layer 13. A further difference over the embodiment shown in the left half of figure 19 is that in the embodiment of the insulation element 6 according to the right half of figure 19 the insulation body 11 comprising a first layer 11 is constructed as a molded body and includes a slope in a part of its large surface that is directed away from the roof closure 2. The second layer 13 arranged thereon is constructed as a thin layer 13 from Sorel cement. The embodiments according to figure 19 can be arranged in combination on a roof closure 2, so that the central region of the juxtaposed insulation elements 6 forms a planar walkway and/or driveway, whereas the rim zones of the juxtaposed insulation elements 6 are constructed with a slope, so that the two slopes point to each other and thus discharge precipitation water to the central region of the two juxtaposed insulation elements 6.

A further embodiment of a roof 1 with sloping insulation panels 9 is illustrated in figure 20.

On the roof closure 2, which is designed corresponding to the roof closure 2 shown in the figures 18 and 19, a first layer of insulation panels 17 is arranged. Between two insulation panels 17 an insulation element 6 is arranged including a first layer 11 constructed as an insulation body and a superposed second layer 13 from Sorel cement. The second layer 13 from Sorel cement is oriented so as to face away from the roof closure.

On parts of the first layer of insulation panels 17 a second layer of insulation panels 17 is arranged, only one being illustrated in the right half of figure 20. This insulation panel 17 is joined by a sloping insulation panel 9 including in the region of its inclined large surface a second layer 13 from Sorel cement that extends up and into the region of the large surface of the adjoining insulation panel 17, so that the large surface of the insulation panel 17 is partly covered by the second layer 13. The second layer 13 of this sloping insulation panel 9 overlaps the entire large surface and extends up and into the region of the second layer 13 of the insulation element 6 arranged underneath.

Figure 20 further shows a system of sloping insulation panels 9 which are constructed with two layers and each of which including a surface having an inclination. This surface is overlapped by a second layer 13 from Sorel cement. The sloping insulation panels 9 are so designed that they constitute a uniform and even slope. Here the sloping insulation panel 8 which directly joins the second layer 13 of the insulation element 6 arranged in the first layer of insulation panels 17 is arranged so as to be spaced from the opposite sloping insulation panel 9, so that a channel 34 for discharging precipitation water into a drain opening not further shown is formed between these two sloping insulation panels 9 which are supported with their second layers 13 on the second layer 13 of the insulation element 6 arranged in the first layer of insulation panels 17. Figure 21 shows a part of the roof 1 in a perspective view. On a continuous insulation layer 5 consisting of insulation panels 17 and insulation elements 6, sloping insulation panels 9 are arranged, wherein two superposed sloping

insulation panels 9, which are designed in a pyramid segment shape, constitute a sloping element 35.

The sloping elements 35 are arranged so as to be distributed with a distance to each other over the insulation layer 5, the sloping elements 35 with the lower sloping insulation panels 9 each adjoining an insulation element 6. The insulation elements 6, which are juxtaposed with their narrow sides, are arranged in a line, thus forming with their second layers 13 from Sorel cement a walkway and/or driveway.

An embodiment of a roof 1 comparable to figure 21 is illustrated in figure 22, showing that the second layers 13 are arranged flat on a lower layer of insulation panels 17. Of course, a connection can be provided between the second layers 13 and the insulation panels 17 also in this case, and this connection is made on-site, i.e. during the erection of the roof 1. Figure 22 also shows a further insulation element 6 including a large surface which is inclined relative to the large surface of the insulation panels 17 and which is covered with a second layer 13 from Sorel cement. The slope is directed towards the sloping elements 35, so that both the sloping elements 35 comprising the sloping insulation panels 9 and the insulation element 6 comprising the inclined large surface are oriented to a central region 7. The two slopes have, however, a different inclination.

In figure 23 a roof 1 with an insulation layer 5 constructed from insulation panels 17 is shown. On a partial area of the rectangular parallelepiped-shaped insulation panels 17 a system of sloping insulation panels 9 is arranged. The sloping insulation panels 9 altogether constitute a flat inclined surface. The central region of the system composed of sloping insulation panels 9 from Sorel cement or having a layer 13 from Sorel cement forms a walkway and/or driveway. It can be seen that the system of sloping insulation panels 9 comprises several rows of juxtaposed sloping insulation panels 9. These rows

alternately comprise one or two sloping insulation panels 9 comprising a second layer 13 from Sorel cement. The sloping insulation panels 9 of the adjacent rows are further arranged with staggered joints.

A further embodiment of a roof 1 can be seen in figure 24. An insulation layer 5 against consists of rectangular parallelepiped-shaped insulation panels 17. On the insulation panel 17 are again arranged sloping insulation panels 9 forming two systems draining towards the region of a channel 34 by being inclined towards the channel 34.

Within the channel 34 a third system of sloping insulation panels 9 is arranged, which are constructed as a sandwich element and thus comprise an insulation body having an inclined surface and constituting a first layer 11. On the inclined surface a second layer 13 from Sorel cement is disposed, and the two layers 11, 13 are connected to each other.

In figure 25 a further development of the embodiment according to figure 24 is illustrated, wherein figure 25 merely shows two slope systems 36, 37 which are arranged on large-format insulation panels 17. The inclinations of the slope systems 36, 37 are oriented at right angles to each other. A first slope system 36 joins with its base point the lateral surfaces 14 of the second slope system 37. The slope systems 36 and 37 can be constructed corresponding to the embodiment according to figure 24.

In the transition zone between the first slope system 36 and the second slope system 37 valley elements 38 are added, which consist of mineral fibers bound with binding agents and which prevent the accumulation of precipitation water in this transition zone by draining this precipitation water through this valley elements 38 corresponding to the inclination of the sloping insulation panels 9 of the slope system 37.

It should be noted that all the above-described insulation elements 6, sloping insulation panels 9, insulation panels 17 and insulation panels 27 as well as the sloping elements 35 and/or valley elements 38 are constructed with two or more layers, wherein at least a second layer 13 consists of Sorel cement or a similar pressure-resistant and/or rigid material, so that the above-mentioned elements are normally suited for being walked on and/or travelled on, without damaging or destroying the insulation body of these elements.

An embodiment of the slope system 37 comparable to the embodiment of figure 25 is illustrated in figure 27. Differently from the embodiment according to figure 25 the embodiment according to figure 27 provides for the valley elements 38 being a part of the sloping insulation panels 9. The sloping insulation panels 9 and the valley elements 38 are thus constructed as a molded body.

In the same way also the figures 30 and 31 illustrate a corresponding slope system 36 and 37, wherein the slope system 37 shown in figure 30 is one which is inclined in two opposite directions. Figure 31 shows a slope system 36 which is inclined in two directions in a part thereof, whereas another part thereof is inclined only in one direction. For this purpose, the slope system 36 comprises different sloping insulation panels 8 with valley elements 38 integrally molded to the panels 8.

A further advantageous embodiment of the roof 1 is illustrated in figure 26. In this figure an insulation layer 5 constructed from insulation panels 17 can be seen, with a second insulation layer 5 constructed from insulation panels 17 arranged on the first insulation layer. The second, upper insulation layer 5 is constructed from thinner insulation panels 17. Both insulation layers 5 are not equal in area. The upper insulation layer 5 is shorter than the lower insulation layer 5. In the front face region of the last insulation panel 17 of the upper insulation layer 5 a sloping insulation panel 9 having a substantially triangular cross section is disposed. This sloping insulation panel 9 includes a large

surface on which a second layer 13 from Sorel cement is arranged. The rest of the sloping insulation panel 9 consists of an insulation body which constitutes a first layer 11.

On the above-described insulation panel 17 of the upper insulation layer 5 an additional sloping insulation panel 9 is arranged, which substantially corresponds to the above-described sloping insulation panel 9 and thus again includes an insulation body as a first layer 11 and a second layer 13 from Sorel cement disposed on an inclined surface of the insulation body.

This sloping insulation panel 9 is joined by further sloping insulation panels 9, the latter being formed of individual insulation segments 39 having a fiber orientation at right angles to the large surfaces and being connected to each other through the second layer 13 from Sorel cement. The longitudinal axis direction of this insulation segments 39 thus essentially is at right angles to the large surfaces of the insulation body 11 formed by these segments. The individual insulation segments 39 can also be glued to each other, depending on the fire protection requirements.

All in all this construction allows a slope being formed over a considerable length of a roof 1, without requiring a great number of different sloping insulation panels 9, since a considerable part of the sloping insulation panels 9 is composed of insulation segments 39 which are identically constructed with regard to their material thickness. These insulation segments 39 can be cut at site. Sloping insulation panels 9 constructed in this way serve to reduce the cost of constructing a sloping roof system.

The figures 28 and 29 again illustrate slope systems 36 or 37, figure 28 showing two slope systems 36 on both sides of an insulation element 6 on an insulation body as a first layer 11, and a second layer 13 from Sorel cement. The slope

systems 36 are arranged on insulation panels 17 which constitute an insulation layer 5.

Figure 29 additionally illustrates angles of the slope systems 36 and 37. The angle α describes the slope of the slope system 37, whereas the angle β describes the slope of the slope system 36. The angle α is greater than the angle β .

Finally, in the figures 32 to 37 different embodiments of a second layer 13 or of insulation elements 6 comprising a second layer 13 are shown. The figures 32 to 37 serve to explain the layer that has been described above especially as the second layer 13 from Sorel cement. According to figure 32 the second layer 13 can consist for example of a magnesia laminated board comprising at least one layer of a two-dimensional reinforcement from textile, glass, plastic and/or natural fibers. The fibers can be interwoven, felted or connected to each other with the aid of binding agents. They have a loose structure which is easy for the binding agent to penetrate or to be forced into this structure. The two-dimensional reinforcement means can be used alternately from layer to layer.

Figure 33 shows a further development of an embodiment of the second layer 13 which compared to the embodiment according to figure 32 additionally includes an externally applied separating layer 41. Such a separating layer 41 can be designed as a layer allowing the penetration of water steam and can be constituted for example by a plastic film, glass fiber web, random glass or plastic fiber web or by several ones of such elements. The separating layer prevents an undesired chemical interaction between the contact surfaces of the second layer 13 and other structural elements of the roof 1. The separating layer 41 can further have elastic properties to weaken localized mechanical stresses. Due to their three-dimensional effect such separating layers 41 can serve to drain penetrating precipitations, particularly thaw water.

Figure 34 shows a sandwich element comprising a second layer 13 adhered with the aid of magnesia binders or other adhesives to a magnesia molded body 42 reinforced or filled with single fibers and/or grainy to fine-grained or floury additives, whereby a boundary layer 43 is formed. The second layer 13 is arranged on a first large surface of the molded body 42. Additionally, also the second large surface of the molded body 42 may have a second layer 13 arranged thereon, which identically corresponds to or differs from the second layer 13 arranged on the first large surface. Particularly this additional second layer 13 can be constructed according to the figures 32 and 33 and comprise a reinforcing layer 40. Of course, it is possible that several reinforcing layers 40 are embedded in the second layer 13 from magnesia.

The figures 35 to 37 again illustrate insulation elements 6 which are constructed according to figure 34 and additionally comprise second layers 13 according to the figures 32 or 33. In this respect figure 35 illustrates an insulation element 6 formed on both large surfaces comprising a second layer 13, whereas figure 36 illustrates an insulation element 6 in which a corresponding second layer 13 is only arranged on the inclined large surface. Figure 37 finally illustrates an insulation element 6 in which the second layer 13 forms an integral part of the insulation element 6, so that this layer 13 is worked in the insulation body already during manufacture. The insulation body can be formed from mineral fibers bound with binding agents and also from a different insulation material, for instance magnesia, in the form of a molded body as shown at pos. 43 in figure 34.

List of reference numbers

1	roof	29	step
2	roof closure	30	step
3	surface	31	inclined surface
4	film sealing	32	attic
5	insulation layer	33	tube section
6	insulation element	34	channel
7	central region	35	sloping element
8	drain opening	36	slope system
9	sloping insulation panel	37	slope system
10	surface	38	valley element
11	layer	39	insulation segment
12	surface	40	reinforcing layer
13	layer	41	separating layer
14	lateral surface	42	molded body
15	cover	43	boundary surface
16	arrow		
17	insulation panel		
18	surface		
19	lateral surface		
20	base		
21	line		
22	base element		
23	supporting surface		
24	valley		
25	tip		
26	trapezoid metal sheet		
27	insulation panel		
28	layer		

Claims

1. Insulation panel for a sloping roof system, comprising an insulation body having a planar base and a top surface as well as lateral surfaces connecting the base to the top surface, wherein the base is oriented anti-parallel with respect to the top surface, so that the top surface is inclined at least with respect to the base, wherein the insulation body is designed in a sandwich fashion and comprises at least a first layer with heat and/or sound insulation properties, particularly from mineral wool, preferably rock wool,
c h a r a c t e r i z e d i n
that the first layer (11) is connected to the second layer (13) with mechanical properties, particularly a compressive strength and/or bending strength, different from those of the first layer (11) and consists of a material which is different from the material of the first layer (11) and at least has a higher bending stiffness.
2. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that the base is rectangular, so that the lateral surfaces (14) are oriented at right angles to each other.
3. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that the second layer (13) is formed by a molded body from a pressure-resistant and/or rigid material, particularly from a magnesia binder, for example Sorel cement, or from mixtures of binding agents with magnesia binder.
4. Insulation panel according to claim 3,
c h a r a c t e r i z e d i n

that the at least first layer (11) is rectangular parallelepiped-shaped and arranged on a molded body constituting the at least second layer (13).

5. Insulation panel according to claim 3,
c h a r a c t e r i z e d i n
that the at least second layer (13) is rectangular parallelepiped-shaped and connected to a molded body constituting the at least first layer (11).
6. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that the insulation body includes at least one lateral surface (14) extending parallel to the inclination and oriented to the base at an angle deviating from the right angle.
7. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that the lateral surfaces (14) have a height of at least 5 mm.
8. Insulation panel according to claim 3,
c h a r a c t e r i z e d i n
that first layer (11) from mineral fibers has a fiber orientation towards the surface (12).
9. Insulation panel according to claim 3,
c h a r a c t e r i z e d i n
that the second layer (13) consisting of a pressure-resistant material at least includes a two-dimensional reinforcement (40) from wovens, non-wovens, rovings from glass, plastic and/or natural fibers.
10. Insulation panel according to claim 3,
c h a r a c t e r i z e d i n

that the second layer (13) consisting of a pressure-resistant material additionally includes amounts of water glass, organically modified silicates (ormosiles), silica glass and/or plastic dispersions or emulsions.

11. Insulation panel according to claim 3,
c h a r a c t e r i z e d i n
that the second layer (13) consisting of a pressure-resistant material at least comprises an interior reinforcement (40) from textile, glass and/or mineral wool fibers.
12. Insulation panel according to claim 11,
c h a r a c t e r i z e d i n
that the second layer (13) consisting of a pressure-resistant material includes up to 40% by weight, preferably 25% by weight, of textile, glass and/or mineral wool fibers.
13. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that the layers (11, 13) are connected, preferably glued to each other or laminated onto each other.
14. Insulation panel according to claim 3,
c h a r a c t e r i z e d i n
that the second layer (13) consisting of a pressure-resistant material, in particular of magnesia binder, includes fine-grained additives from brucite, aluminum hydroxide and/or titanium oxide, particularly in an amount of up to 25% by weight.
15. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n

that the layers (11, 13) are arranged one on top of the other so as to terminate flush with each other.

16. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that the second layer (13) comprising the surface (12) projects at least compared to a lateral surface (14) of the first layer (11) comprising the base.
17. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that the second layer (13) comprising the surface (10) has a material thickness of approx 2 mm to 25 mm, preferably approx 3 mm to 10 mm.
18. Insulation panel according to claim 3,
c h a r a c t e r i z e d i n
that the pressure-resistant and/or rigid second layer (13) is formed with a different thickness, depending on the mechanical loads occurring during utilization.
19. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that on the surface (12) of the insulation body, in particular on the second layer (13), a cover (15) arranged, particularly in the form of a random plastic fiber web.
20. Insulation panel according to claim 19,
c h a r a c t e r i z e d i n
that the cover (15) projects over at least one, preferably two adjacent lateral surfaces (14) of the insulation body, preferably of the second layer (13) comprising the surface (12).

21. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that at least one lateral surface (14) of the first layer (11) comprising the base is at least partly formed with a pressure-resistant and/or rigid coating, wherein the material of the coating is preferably identical with the material of the pressure-resistant and/or rigid second layer.
22. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n
that the first layer (11) comprising the base is formed in a multipart fashion from segments.
23. Insulation panel according to claim 22,
c h a r a c t e r i z e d i n
that the segments of the first layer (11) are glued to each other and/or connected to each other through the rigid and/or pressure-resistant second layer (13).
24. Insulation panel according to claim 22,
c h a r a c t e r i z e d i n
that the segments are arranged on and preferably connected to a supporting layer, particularly by gluing.
25. Insulation panel according to claim 24,
c h a r a c t e r i z e d i n
that the supporting layer is made from a material suitable for heat and/or sound insulation purposes, particularly from mineral fibers.
26. Insulation panel according to claim 1,
c h a r a c t e r i z e d i n

that the insulation body includes a first layer (11) with heat and/or sound insulation properties, particularly from mineral fibers, a second layer (13) from a pressure-resistant and/or rigid material, particularly from a magnesia binder, arranged on the first layer, a third layer (28) with heat and/or sound insulation properties, particularly from mineral fibers, arranged on the second layer and finally a fourth layer from a pressure-resistant and/or rigid material, especially from magnesia binder.

27. Insulation panel according to claim 26,
c h a r a c t e r i z e d i n
that the first layer (11) is formed to be compressible.
28. Insulation panel according to claim 26,
c h a r a c t e r i z e d i n
that the second layer (13) and the fourth layer are made from an identical material.
29. Sloping roof system for a flat or a flat inclined roof, consisting of an insulation layer which is arranged on a support, particularly on a sub-roof made of trapezoid metal sheets, with a foil sealing, particularly an air barrier, being interposed, wherein the insulation layer is composed of plate-shaped insulation elements and covered with an outer roof skin and wherein at least a part of the insulation elements comprises an insulation body which is designed in a sandwich fashion and comprises at least a first layer with heat and/or sound insulation properties, particularly from mineral wool, preferably rock wool,
c h a r a c t e r i z e d i n
that the second layer (13) has mechanical properties different from those of the first layer (11), particularly a different pressure strength and/or bending strength, and consists of a material different from the material of the first layer (11) and at least having a higher bending stiffness.

30. Sloping roof system according to claim 29,
characterized in
that on the support a plate-shaped insulation element (6) can be
arranged which at least comprises a lateral surface (14) which is oriented
to a large surface of the insulation element (6) which is the upper large
surface in the insulation layer (5) and to a large surface of the insulation
element (6) which is the lower large surface in the insulation layer (5), at
an angle deviating from the right angle, and that the lower large surface
is formed greater than the upper large surface of the insulation element
(6).
31. Sloping roof system according to claim 29,
characterized in
that on the support a plate-shaped insulation element (6) with a lateral
surface (14) is arranged which is joined by and particularly flush with the
surface of a molded part having a substantially triangular or trapezoid
cross section and comprising a surface inclined at an angle with respect
to the horizontal.
32. Sloping roof system according to the claims 29 and 30,
characterized in
that the insulation layer (5) comprises several, at least two layers of
superposed insulation elements, wherein the molded parts of adjacent
superposed insulation elements having a triangular or trapezoid cross
section are preferably oriented to be flush with their surfaces inclined with
respect to the horizontal.
33. Sloping roof system according to the claims 29 and 31,
characterized in

that the insulation layer (5) comprises several, at least two layers of superposed insulation elements, wherein the molded parts of adjacent superposed insulation elements formed with a substantially triangular or trapezoid cross section are preferably aligned with their surfaces extending inclined with respect to the horizontal.

34. Sloping roof system according to 31,
characterized in
that the molded parts consist of a material suitable for heat and/or sound insulation purposes and are particularly made from a material identical with the material of the insulation elements.
35. Sloping roof system according to claim 30 or 31,
characterized in
that the angle is $\leq 45^\circ$.
36. Sloping roof system according to claim 30 or 31,
characterized in
that the angles of the superposed insulation elements or molded parts are smaller towards the support.
37. Sloping roof system according to claim 29,
characterized in
that the molded parts can be connected, particularly by gluing, to the lateral surface of the adjoining insulation element and/or to the insulation element in the layer arranged underneath.
38. Sloping roof system according to claim 31,
characterized in

that in the region of its large surface which is the upper large surface in the insulation layer, the insulation element is arched and/or preferably bent into segments.

39. Sloping roof system according to claim 30 or 31,
c h a r a c t e r i z e d i n
that the lateral surface can is arched, in particular concavely curved.
40. Sloping roof system according to claim 30 or 31,
c h a r a c t e r i z e d i n
that at least one surface of the molded part and/or of the insulation element arranged adjacent to the lateral surface includes a pressure-resistant and/or rigid layer, at least in parts thereof.
41. Sloping roof system according to claim 40,
c h a r a c t e r i z e d i n
that the pressure-resistant and/or rigid layer (13) extends over a part of the lateral surface (14).
42. Sloping roof system according to claim 40,
c h a r a c t e r i z e d i n
that the pressure-resistant and/or rigid layer (13) extends over the lateral surface (14) up to the support and is preferably arranged on a part of the support.
43. Sloping roof system according to claim 29,
c h a r a c t e r i z e d i n
that the insulation element has two large surfaces, each comprising a layer (13) from a material which is different from the material of the layer (11) with the heat and/or sound insulation properties and which at least has a higher bending stiffness.

44. Sloping roof system according to claim 29,
c h a r a c t e r i z e d i n
that a large surface of the insulation body is formed as a planar base
arranged anti-parallel and at least at an inclination with respect to a
second large surface of the insulation body, wherein the insulation body
has lateral surfaces (14) connecting the base to the second large
surface.
45. Sloping roof system according to claim 44,
c h a r a c t e r i z e d i n
that the base is rectangular, so that the lateral surfaces (14) are oriented
at right angles to each other.
46. Sloping roof system according to claim 29,
c h a r a c t e r i z e d i n
that the second layer (13) can be formed by a molded body from a
pressure-resistant and/or rigid material, particularly from a magnesia
binder, for example Sorel cement, or from mixtures of binders with
magnesia binder.
47. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that the at least first layer (11) is rectangular parallelepiped-shaped and
arranged on a molded body constituting the at least second layer (13).
48. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that the at least second layer (13) is rectangular parallelepiped-shaped
and connected to a molded body constituting the at least first layer (11).

49. Sloping roof system according to claim 44,
characterized in
that the insulation body at least has a lateral surface (14) extending
parallel to the inclination and being oriented to the base at an angle
deviating from the right angle.
50. Sloping roof system according to claim 44,
characterized in
that the lateral surfaces (14) have a height of at least 5 mm.
51. Sloping roof system according to claim 29 or 44,
characterized in
that the first layer (11) from mineral wool has a fiber orientation towards
the surface.
52. Sloping roof system according to claim 29 or 44,
characterized in
that the second layer (13) consisting of a pressure-resistant material at
least has a two-dimensional reinforcement from wovens, non-wovens,
rovings from glass, plastic and/or natural fibers.
53. Sloping roof system according to claim 29 or 44,
characterized in
that the second layer (13) consisting of a pressure-resistant material
additionally includes amounts of water glass, organically modified
silicates (ormosiles), silica glass and/or plastic dispersions or emulsions.
54. Sloping roof system according to claim 29 or 44,
characterized in

that the second layer (13) consisting of a pressure-resistant material at least comprises an interior reinforcement from textile, glass and or mineral wool fibers.

55. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that the second layer (13) consisting of a pressure-resistant material comprises up to 40% by weight, preferably up to 25% by weight, of textile, glass and/or mineral fibers.
56. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that the layers (11, 13) are connected, preferably glued to each other or laminated onto each other.
57. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that the second layer (13) consisting of a pressure-resistant material, in particular of magnesia binder, comprises fine-grained additives from brucite, aluminum hydroxide and/or titanium oxide, particularly in an amount of up to 25% by weight.
58. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that the layers (11, 13) are arranged one upon the other so as to terminate flush with each other.
59. Sloping roof system according to claim 44,
c h a r a c t e r i z e d i n

that the second layer (13) comprising the surface projects at least compared to the lateral surface (14) of the first layer (11) comprising the base.

60. Sloping roof system according to claim 44,
c h a r a c t e r i z e d i n
that the second layer (13) comprising the surface has a material thickness of approx 2 mm to 25 mm, preferably approx 3 mm to 10 mm.
61. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that the pressure-resistant and/or rigid second layer (13) is formed differently thick, depending on the mechanical loads occurring during utilization.
62. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that on the surface of the insulation body, particularly on the second layer (13), a cover (15) is arranged, particularly in the form of a random plastic fiber web.
63. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that the cover (15) projects over at least one, preferably two adjacent lateral surfaces (14) of the insulation body, preferably of the second layer (13) comprising the surface.
64. Sloping roof system according to claim 29 or 44,
c h a r a c t e r i z e d i n
that at least one lateral surface (14) of the first layer (11) comprising the base is at least partly formed with a pressure-resistant and/or rigid

coating, said coating preferably consisting of a material which is identical with the material of the pressure-resisting and/or rigid second layer.

65. Sloping roof system according to claim 44,
c h a r a c t e r i z e d i n
that the first layer (11) comprising the base is constructed in a multipart fashion from segments.
66. Sloping roof system according to claim 65,
c h a r a c t e r i z e d i n
that the segments of the first layer (11) are glued to each other and/or connected to each other through the pressure-resistant and/or rigid second layer (13).
67. Sloping roof system according to claim 65,
c h a r a c t e r i z e d i n
that the segments are arranged on a supporting layer and are preferably connected, particularly glued to the same.
68. Sloping roof system according to claim 67,
c h a r a c t e r i z e d i n
that the supporting layer is constructed from a material suitable for heat and/or sound insulation purposes, in particular from mineral fibers.
69. Sloping roof system according to claim 29,
c h a r a c t e r i z e d i n
that the insulation body comprises a first layer (11) with heat and/or sound insulation properties, particularly from mineral fibers, a second layer (13) from a pressure-resistant and/or rigid material, particularly from a magnesia binder, arranged on the first layer, a third layer (28) with heat and/or sound insulation properties, particularly from mineral fibers,

arranged on the second layer and finally a fourth layer from a pressure-resistant and/or rigid material, particularly from a magnesia binder.

70. Sloping roof system according to claim 69,
c h a r a c t e r i z e d i n
that the first layer (11) is designed so as to be compressible.
71. Sloping roof system according to claim 69,
c h a r a c t e r i z e d i n
that the second layer (13) and the fourth layer are made from an identical material.
72. Sloping roof system according to claim 44,
c h a r a c t e r i z e d i n
that the second surface includes several planes having a different inclination.
73. Sloping roof system according to claim 29,
c h a r a c t e r i z e d i n
that the first layer (11) and the second layer (13) are connected to each other.
74. Sloping roof system according to claim 29,
c h a r a c t e r i z e d i n
that the second layer (13) is formed smaller in area than the first layer (11).