Ruukki is a metal expert you can rely on from start to finish, when you need materials, components, systems or total solutions. We continuously develop our operating model and product range to meet your needs.
1 Ruukki lightweight purlins

1.1 Advantages of lightweight purlins

Ruukki offers wide range of lightweight purlins with high quality, durability and versatility of shapes and applications. Production technology and top quality raw materials assure of high load bearing capacity and stiffness leading to increase of span lengths. Purlins are widely applied as secondary roof and wall structures for almost all kind of buildings. Ruukki lightweight purlins offer several considerable advantages over alternative structures:

• The purlins are lightweight in proportion to their load bearing capacity. Thus, roof structures built using lightweight purlins are very light.
• The use of material is very efficient. Owing to the high strength of the base material, the required load bearing capacity is achieved with a smaller cross-sectional thickness, which translates into savings in materials and costs.
• Lightweight purlins produce savings in transport costs.
• The purlins require little space in transport, purlins for quite a large roof can be transported as a single delivery.
• Local increase of the load bearing capacity of lightweight purlins is easy, e.g. by lapping purlins inside each other without having to make changes in the structural system of the whole roof or wall.
• Longer spans are possible with lightweight purlins than with alternative applicable solutions.
• Lightweight purlins are made of zinc-coated material with good corrosion resistance. This makes lightweight purlins applicable also in difficult conditions.
• Lightweight purlins are fully recyclable material. Waste steel can be reused in the roof as weather protection, and the reuse of the whole roof at the end of its service life requires only little energy.

1.2 Material of lightweight purlins

Lightweight purlins are made of cold rolled thin gauge steel sheet, which is delivered in coils. The material of the hot dip galvanised (20μm) thin gauge steel sheet is grade S350GD+Z275, in compliance with EN 10346. The yield strength of the steel sheet is minimum 350N/mm².

1.3 Manufacture of Ruukki lightweight purlins

Lightweight purlins can be roll formed or press braked from cold rolled thin gauge steel sheet. The purlins can also be pre-punched at factory.

1.4 Cross-sections of Ruukki lightweight purlins

Lightweight purlin Z

Lightweight purlin C

Lightweight purlin Sigma

Lightweight purlin Hat

2 Structural systems

2.1 Single span system

2.1.1 Single span system, purlin designation diagram

2.1.2 Single span system, purlins

2.1.3 Single span system, support cleats

2.2 Double span system

2.2.1 Double span system, purlin designation diagram

2.2.2 Double span system, purlins

2.2.3 Double span system, support cleats

2.3 Sleeved system – alternative in Ruukki’s PurCalc software

2.3.1 Sleeved system, purlin designation diagram

2.3.2 Sleeved system, purlins

2.3.3 Sleeved system, support cleats

2.4 Overlapped system – recommended by Ruukki

2.4.1 Overlapped system, purlin designation diagram

2.4.2 Overlapped system, purlins

2.4.3 Overlapped system, support cleats

2.5 Hole design principle for manufacture

2.6 Types of holes

2.7 Support cleats

3 Factors to be considered in the use of lightweight purlins

3.1 Torsional rigidity

3.2 Improving torsional rigidity

3.3 Local buckling

3.4 Distortion of section

3.5 Resistance to support reactions

3.6 Purlins that are supported at the flange

3.7 Transverse rigidity

3.8 Unsupported lower flange

3.9 Unsupported lower flange under compression

3.10 Cantilever purlin

4 PurCalc purlin design software

5 Handling, transport and storage of lightweight purlins

5.1 Handling

5.2 Transport

5.3 Storage

6 Installation of lightweight purlins
### 1.6 Geometries and characteristics of cross-sections

#### Purlin Z – Cross-section geometries

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#### Purlin Z – Cross-section characteristics

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Steel grade: S350GD+Z  
Yield strength: $f_y = 350$ MPa  
Tensile strength: $f_u = 420$ MPa
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</tbody>
</table>
Lightweight purlin Hat

Steel grade: S350GD+Z
Yield strength: $f_y = 350$ MPa
Tensile strength: $f_t = 420$ MPa
2 Structural systems

There are four alternative roof purlin systems for different applications, as well as various combinations of these systems. The properties of the systems and the selection criteria are discussed below.

2.1 Single span system

Used in walls and roofs, in moderate spans
- A simple system
- Same support reactions of primary rafters in centre bays
- Small number of joint components
- Whole roof consists of similar purlins
- Higher consumption of steel
- Higher deflections
- Can be implemented with Z, C, hat and sigma purlins.

2.1.1 Single span system, purlin designation diagram
2.1.2 Single span system, purlins

Note! On site the purlin is seen from the eaves

Note! Wide flange side in vertical design of pre-punching
Reversed design to be used in reversed purlins

Note! In manufacturing drawings the purlin is seen with the wide flange down and towards the reader

L=span

Pre-punched single span single purlin SS

Pre-punched single span purlin, left end bay SL

Pre-punched single span purlin, inner bay SI

Pre-punched single span purlin, right end bay

2.1.3 Single span system, support cleats

Unbroken flange up

On site WIDE flange UP PURLINS

Support cleat at end support

Support cleat at end support

<table>
<thead>
<tr>
<th>Hole</th>
<th>Ø</th>
<th>On site WIDE flange UP</th>
<th>Support cleat at end support</th>
<th>Support cleat at end support</th>
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<td>U-160<em>55</em>4</td>
<td>U-160<em>55</em>4</td>
</tr>
</tbody>
</table>

Note! WIDE flange UP, ALL PURLINS
Support cleat at end support

Support cleat at end support
2.2 Double span system

Used in walls in 4-6m spans, and in roofs in moderate spans
• Small deflections
• Small number of parts requiring installation
• Amount of installation work limited
• Different support reactions of principal rafters
• Long sections, more difficult to handle
• Can be implemented with Z, C, hat and sigma purlins

It is possible to use the same support cleat at intermediate support of each 2-span purlin as at purlin joint.

A top hat purlin always has to be equipped with a brace section. The material thickness of this brace section is recommended to be the same as the material thickness of the purlin itself. The dimensions of the brace section are shown together with the cross-sectional dimensions of the top hat purlin, see section 1.6.

Length of brace section \( L > \text{Max}(3s, 2H) \), where \( s \) is the support width and \( H \) is the height of the section.
2.2.2 Double span system, purlins

Note! On site, the purlin is seen from the eaves.

Note! Wide flange side in vertical design of pre-punching.
Reversed design to be used in reversed purlins.

Note! In manufacturing drawings the purlin is seen with the wide flange down and toward the reader.

L=span
L_L=Left span length
L_R=Right span length

Pre-punched single span single purlin DS

250 C_L  L_L  L_R  >250 C_R
Cantilever

Pre-punched single span purlin, left end bay DL

250 C_L  L_L  L_R-35  >250 C_R
Cantilever

Pre-punched single span purlin, inner bay DI

250 L_L-35  L_L  L_R-35  >250 L_R

Pre-punched single span purlin, right end bay DR

250 L_L-35  L_L  L_R  >250 C_R
Cantilever

2.2.3 Double span system, support cleats

Note! Narrow flange up
Note! Wide flange up

On site WIDE flange UP, ALL PURLINS
Support cleat at intermediate support
Support cleat at purlin joint

Z100

Hole Ø = 14

Z120

Hole Ø = 14

Z150

Hole Ø = 14

Z200

Hole Ø = 18

Z250

Hole Ø = 18

Z300

Hole Ø = 18

Z350

Hole Ø = 18
2.3 Sleeved system – alternative design with Ruukki’s PurCalc software

Used in roof and wall structures
System contains a special sleeve section, normally either similar gauge to basic purlin or max. 0.5 mm thicker.

- Optimal weight
- Small deflections
- Sections easy to handle
- A larger number of components
- More installation work
- For Z sections the sleeve section is identical to the basic purlin section
- Dimensions of sleeve section are shown together with the cross-sectional dimensions of the sigma purlin, see section 1.6.

2.3.1 Sleeved system, purlin designation diagram
2.3.2 Sleeved system, purlins

Note! On site, the purlin is seen from the eaves

Note! Wide flange side in vertical design of pre-punching
Reversed design to be used in reversed purlins

Note! In manufacturing drawings the purlin is seen with the
wide flange down and toward the reader

L=span
L_L=Left span length
L_R=Right span length
L_tot= 0.13(L_L+L_R)+70

Sleeved system, left end bay, VL

Sleeved system, inner bay, VI

Sleeved system, right end bay, VR

2.3.3 Sleeved system, support cleats

Note! Wide flange DOWN, SLEEVE SECTION VE

Note! On site WIDE flange DOWN,
SLEEVE SECTION VE

On the site WIDE flange UP, ALL PURLINS

Support cleat

Z100
\[ \varnothing = 14 \]

Z120
\[ \varnothing = 14 \]

Z150
\[ \varnothing = 14 \]

Z200
\[ \varnothing = 18 \]

Z250
\[ \varnothing = 18 \]

Z300
\[ \varnothing = 18 \]

Z350
\[ \varnothing = 18 \]
2.4 Overlapped system - recommended by Ruukki

Used in roof and wall purlins, in spans of 6-10m.
The purlins are overlapped inside one another.
A double purlin or a thicker section in end bay.

- Optimal weight
- Small deflections
- Long spans can be achieved
- A larger number of joints
- More installation work
- Can be implemented with Z sections

2.4.1 Overlapped system, purlin designation diagram

[Diagram showing the overlapped system with different sections and labels for seeing from eaves and upper flange towards ridge.]
2.4.2 Overlapped system, purlins

Note! On site, the purlin is seen from the eaves

Overlapped reinforcement purlin LF, if required, in end fields

Overlapped purlin LL, left end bay

Overlapped purlin LI, inner bay

Overlapped purlin LR, right end bay

Note! Wide flange side in vertical design of pre-punching
Reversed design to be used in reversed purlins

Note! In manufacturing drawings the purlin is seen with the wide flange down and toward the reader

L=span
L_L=Left bay length
L_R=Right bay length

2.4.3 Overlapped system, support cleats

N= Narrow flange up
W= Wide flange up

Support cleat

Z100
Ø = 14

Z120
Ø = 14

Z150
Ø = 14

Z200
Ø = 18

Z250
Ø = 18

Z300
Ø = 18

Z350
Ø = 18

Note! Narrow flange up
On the site WIDE flange DOWN
On the site WIDE flange UP
2.5 Hole design principle for manufacture

Standard pre-punching is used for each purlin system. The pre-punching dimensions are given with the lower flange toward the viewer and the wider flange of the section as the lower flange. The longitudinal location of the holes is given as a distance from the cutting point, from left to right. The dimensioning of holes for fixing screws is standardised.

Pre-punching is implemented using punches of different sizes and forms. The selection of punches varies depending on the production plant and the section manufacturing method. The standardised sizes and locations of holes for fixing screws are presented below. Additional information about the pre-punching possibilities can be obtained by contacting us.

2.6 Types of holes

Holes are made during production at continuous line – information:
- max. material thickness 3mm (for ø 60mm max. material thickness 2mm),
- holes can be made in a row,
- oval and rectangular holes can be rotated by 90°.

<table>
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<th>Type of hole</th>
<th>Diameter [mm]</th>
<th>Rotation</th>
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<td>[mm]</td>
<td>[°]</td>
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<td>5×25</td>
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</table>

No limitation in number of holes during production.
2.7 Support cleats

Purlin systems utilise support cleats attached to the primary beams of the building frame. The purlins are fixed to these support cleats from the web with screw joints. In Ruukki systems the support cleats are U sections made of at least steel grade S235. In the design of the support cleats, the tying of the section sheet on the roof ridge with a ridge moulding is taken into account. If a ridge moulding is not used, the dimensioning of the U section and its fixing to the primary rafter must be separately checked due to the stresses caused by the load component acting in the direction of the roof slope.

When screw joints are used, the support cleats are delivered with pre-drilled holes for hexagon screws, diameter either 14mm or 18mm depending on the size of the purlin. The sizes and the distances are shown in the purlin diagram. A sleeved system features two vertical rows of fixings, an overlapped system either one or two rows depending on selected support cleats. Single and double span systems have one or two rows, depending on the location of the support cleat and on the selection of support cleat. The program PurCalc for purlin dimensioning also determines the required number of fixings.

If self-drilling screws are to be used for some reason, the support cleat is not pre-drilled. However, it should be noted that screw joints must always be used if the material thickness of the purlin exceeds 1.5mm, due to joint ductility requirements.

Examples of support cleats:

C, Z and Sigma purlins are supported from their web to the primary rafter using the following U sections at low roof slopes, and when the section sheet is tied to the opposite slope sheet with a ridge moulding. Otherwise the fixing sections have to be dimensioned specifically for loads acting in the direction of the slope plane.

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<th>Hc</th>
<th>U-Section</th>
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<td>U-120<em>55</em>4</td>
</tr>
<tr>
<td>350</td>
<td>U-160<em>55</em>6</td>
</tr>
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3 Factors to be considered in the use of lightweight purlins

3.1 Torsional rigidity

Lightweight purlins exhibit an open cross-section and low torsional rigidity in proportion to their bending rigidity. Due to the low torsional rigidity the lateral buckling resistance of an unsupported purlin restricts the load bearing capacity significantly.

3.2 Improving torsional rigidity

Torsional rigidity can be improved by fixing the purlin to a form plate or corresponding that provides transverse support to the upper flange of the purlin. The bending rigidity of the form plate also increases the rotational rigidity of the purlin.

3.3 Local buckling

The resistance of a thin gauge sheet cross-section is restricted due to buckling of plate-like cross-sectional parts under compression, or by buckling under compression of plate-like stiffeners that resist buckling. A plane section does not lose its load bearing capacity completely; in fact, a plane section often retains a considerable part of its capacity in this state. This is modelled in calculations by removing a part under the most stress from the plane section, or by thinning the edge stiffener and the part of the plane section considered to be part of it.

3.4 Distortion of section

In cross-sections of certain shapes, distortion of the section also restricts the load bearing capacity.
3.5 Resistance to support reactions

Buckling of the plane section is also possible in the support cleat, whereby the web of the purlin as a result of the support reaction tends to deviate from its plane, which restricts the load bearing capacity of the purlin. For reinforcement, a support cleat is normally used, e.g. a U section that is fixed from its back to the web of the purlin so that the support cleat alone transmits the support reaction to the rafter.

3.6 Purlins that are supported at the flange

Top hat purlins are always provided with a brace piece (cf. cross-sectional dimensions of top hat purlins), which is fixed together with the basic purlin through its flanges directly to the primary rafter. The resistance to the support reactions is then produced by the top hat purlin and the brace section together.

3.7 Transverse rigidity

The rigidity of thin gauge sheet purlins in the direction of the minor axis is low. This causes bending at the roof slope plane, unless the slope has sheet rigidity. This could be the case, for example, if the sheet seams from the ridge toward the eaves are not fixed. However, it is recommended that the section sheets of the slopes are tied together with a ridge moulding. In practice, this will prevent the bending of the purlin in the direction of the roof slope, and at the same time essentially reduce the stresses acting on the support cleats.

3.8 Unsupported lower flange

In single span purlins the unsupported lower flange of the purlin may be under compression due to wind uplift, whereby it can buckle in the transverse direction. This applies particularly to wall purlins, in which the self-weight of the structure does not counteract the suction pressure, as is the case in roof structure.

If distortion of the end of a cantilever purlin is prevented using e.g. a U section of the same height as the purlin, fixed from its flanges to the flanges of the cantilever purlin, the following shall be valid for the end support:

\[ \frac{N_{eff}}{A_{eff}} + \frac{M_{x,SD}}{W_{eff,y}} \leq \frac{M_{L,RL,V}}{W_{eff,y}} \]

where

- \( N_{eff} \) is the design value of normal force
- \( A_{eff} \) is the effective area of the cross-section in axial compression
- \( M_{x,SD} \) is the design value of the moment with an end support
- \( W_{eff,y} \) is the effective bending resistance of the cross-section against bending about the y axis
- \( M_{L,RL,V} \) is the bending resistance, when account is taken of the influence of shear force
- \( N_{eff} \) is the design value of normal force
- \( A_{eff} \) is the effective area of the cross-section in axial compression
- \( M_{x,SD} \) is the design value of the moment with an end support
- \( W_{eff,y} \) is the effective bending resistance of the cross-section against bending about the y axis
- \( M_{L,RL,V} \) is the bending resistance, when account is taken of the influence of shear force

3.9 Unsupported lower flange under compression

In continuous purlins the unsupported lower flange of the purlin is under compression at the brace moment, whereby it tends to buckle. This restricts the load bearing capacity of the purlin.

3.10 Cantilever purlin

The load bearing capacity of cantilever purlins is low, but it can be increased to some extent by fixing the cantilever end rigidly to the face section.

Otherwise the following shall be valid

\[ \frac{N_{eff}}{A_{eff}} + \frac{M_{x,SD}}{W_{eff,y}} \leq \frac{2M_{L,RL,V}}{3W_{eff,y}} \]

Minimum dimensions of the section that joins the free flanges of a cantilever purlin (upper flanges of the cantilever purlin are provided with continuous support by a form plate)

<table>
<thead>
<tr>
<th>Purlin height</th>
<th>L-section</th>
</tr>
</thead>
<tbody>
<tr>
<td>max 150</td>
<td>45*45-1.5</td>
</tr>
<tr>
<td>max 200</td>
<td>70*70-1.5</td>
</tr>
<tr>
<td>max 300</td>
<td>70*70-2.0</td>
</tr>
<tr>
<td>max 350</td>
<td>70*70-2.5</td>
</tr>
</tbody>
</table>
4 PurCalc purlin design software

Design with PurCalc software enables the most economical solution for cold-formed purlin-based roof structure.

The software includes Ruukki’s offering of Z, Hat, Sigma and C purlins. The options included in the software enables following calculations methods:
- Calculation of purlin structure based on Eurocode, without purlin restrainment.
- Calculation of purlin structure based on test results, when purlins are restrained with Ruukki’s profile sheet.
- Calculation of purlin structure based on test results, when purlins are restrained by Ruukki’s roof sandwich panels.

Language options in the software are; Romanian, Hungarian, Slovak, Czech, Polish, English, Swedish and Finnish.

5 Handling, transport and storage of lightweight purlins

5.1 Handling

All necessary health and safety precautions have to be taken into account when handling the purlins. When handling the products, it is recommended to use protective clothing and cut resistance gloves. When cutting the products, please use also respirator as cutting may release dust and small particles.

Also special care shall always be exercised to prevent any damages to purlins itself. Even small dents and deflections may impair the load bearing capacity of the purlin significantly. Scratches on the zinc coating of the components be avoided.

The materials shall be sufficiently protected against moisture and damages at various stages of their handling. If components are handled manually, appropriate protective gloves shall be worn to prevent injuries.

5.2 Transport

The purlins and the fixing components are at the production plant packed in packages that are easy to handle. Purlins are bundled together and small components are packed in separate packages. The content is clearly marked on each package to ensure they are transported to the correct site. On the site the materials should be carefully checked to ensure the correct quantity and condition of the products. The supplier shall be informed in writing of any deficiencies and transport damages immediately. Damaged products are not allowed to install without Ruukki’s approval.

5.3 Storage

Materials should be stored as closed as possible to the final installation location indicated in the installation diagrams to avoid unnecessary liftings and transports.

Purlins shall be stored in a dry place protected against rain and snow, on a level base. The dry storing conditions will prevent white rust on galvanised surface. Products shall be supported at regular intervals to prevent deformation. It is recommended that products are supported in a slightly inclined position (1:20), to ensure that possible water leaking onto the purlins will be drained. The packages should be raised above ground to allow ventilation of the bottom side of the packages. Materials should not be piled on top each other, as this may damage the sections.

If purlins get wet in rain, they must be separated and dried to eliminate the possibility of white rust. If required, sufficient support shall be provided for the packages to prevent them from tipping or falling over.

6 Installation of lightweight purlins

All necessary health and safety precautions have to be taken into account when handling the purlins. When handling the products, it is recommended to use protective clothing and cut resistance gloves. When cutting the products, please use also respirator as cutting may release dust and small particles.

The installation specification should contain at least the following information:

- project data
- designer
- installation technician
- material list and layout diagram
- storage of components on site
- handling of transport packages on site
- installation equipment
- installation stages
- screw joints
- temporary bracing during installation
- installation tolerances
- qualification of structures and quality control

Structural parts must not be forced in place so that they are deformed or subjected to stresses. Thin gauge sheet structures are sensitive to local damage, and for this reason special attention shall be paid in installation to preventing the parts from being dented or otherwise damaged.

Roof purlins do not usually require temporary bracing during installation, but this shall be verified when longer spans or higher slopes are concerned. Z roof purlins shall always be installed with the upper flange toward the ridge, cf. the Figure. In addition, the lower flange of a Z purlin must be installed at a distance of ca. 10 mm from the upper chord of the truss or the beam.

The work specification, the drawings, the installation plan and the quality control plan shall be studied before installation is started. The acceptance inspection of the materials, accessories, installation parts and lightweight purlins shall include an inspection of waybills, dispatch notes, transport damages and handling damages. It is important to verify that the materials and accessories comply with standards or are delivered with certified product declarations.

It is recommended that during installation, attention is paid to the following factors:

- location of structures
- straightness of structures
- angles
- joints between components
- main dimensions
- other dimensions
- handling, lifting and storage of materials, accessories and parts
- scaffolding
- tightening and locking of screws and nuts

The installation sequence shall be determined before the purlins are installed. The bundles of purlins are lifted in the correct locations according to the installation diagram drawn up by the designer. Purlins with the wide flange down are installed first.