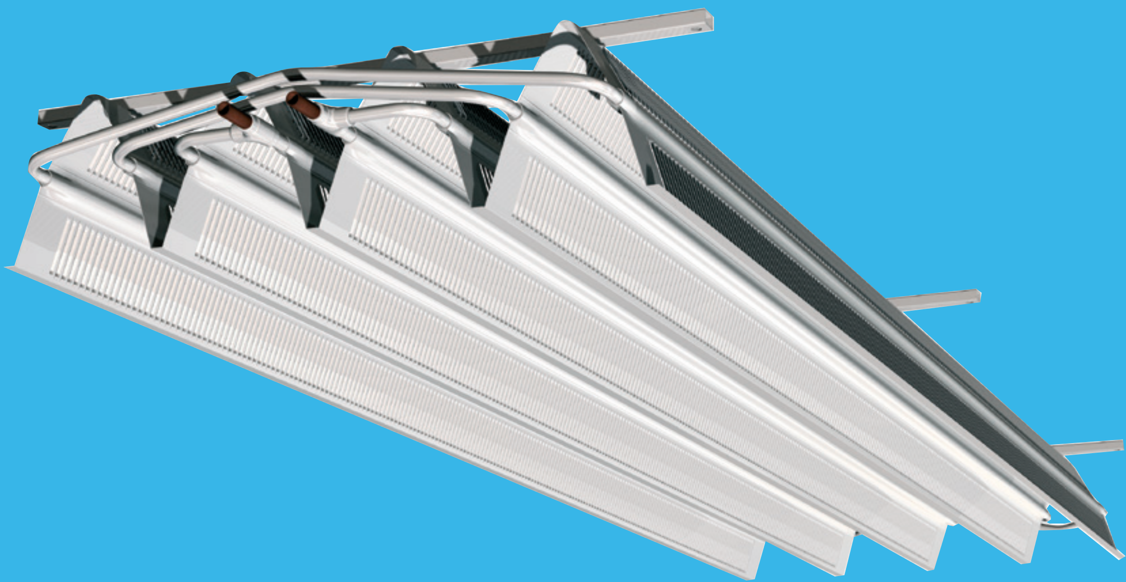
lindab | we simplify construction



Lindab Carat

Chilled beam

Chilled beam Carat

Use

Lindab's chilled beam Carat is placed above a perforated suspended ceiling and supplies cooling, with a low air velocity, to the room below.

Carat has a high radiation quotient of approx. 35% (compared to approx. 5% for traditional finned products). This gives great freedom in placing, when installing Carat, yet keeps air velocities low.

Carat can be used for cooling. It can be equipped with the Regula Connect condensation guard feature. It offers many possibilities and great flexibility. For example, it is possible to paint Carat any colour you want.

Installation

Carat is installed suspended or above a perforated suspended ceiling. Carat can be supplied with different connection options, depending on whether the passive beam is to be installed individually or in series.

Worth noting

The radiation quotient of Carat is as high as 35%, which results in low air velocities when the beam is placed above a perforated suspended ceiling. A low air velocity ensures a good indoor climate and eliminates the risk of draft problems.

Lindabs active chilled beams are Eurovent-certified and tested according to EN-14518.

Key figures

Length:	1200 - 6000 mm (steps of 100 mm)
Width:	310, 440, 580, 710, 840 mm
Height:	147 mm
Capacity:	1850 W

Calculation setup
Room temp: 25°C, Water temp: 14-17°C

Chilled beam

Carat

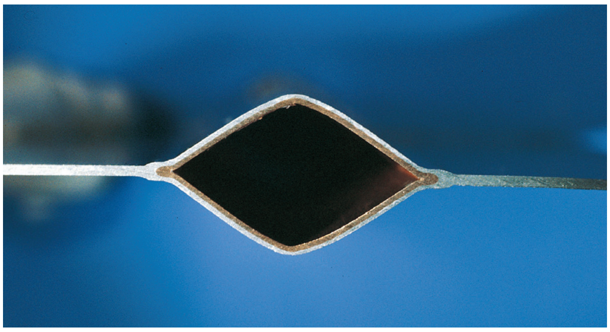
Radiation exchange in chilled beams creates no air movement

Function

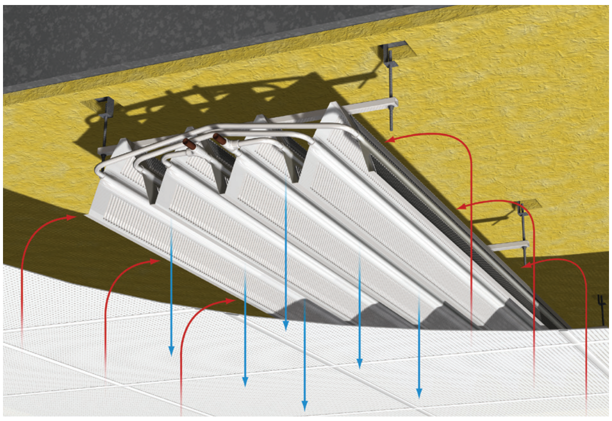
As cold water passes through the chilled beam, the warm air from the room is cooled on the cold surface of the beam. The cooled air (which has a higher density) then streams through the chilled beam and down into the room (see Picture 2). This leads to air circulation in the room, where warm air from the room is continually replaced by cooled air. The cold surfaces of the beam also absorb heat radiation from warmer surrounding surfaces.

The high radiation quotient leads to direct heat exchange between the cold surfaces of the beam and the warm surfaces in the room. The radiation quotient for Carat is approx. 35% of the total emitted cooling effect. This is a high quotient, compared to conventional finned battery beams, which have a radiation quotient of approx. 5%.

Direct heat exchange, through a high quotient of radiation to the room surfaces, and a high cooling effect, even at lower room temperatures, allows a large amount of cold to be stored efficiently in the building structure during low-load periods. The overall result is that Carat gives off more cooling energy during a 24-hour period than a finned battery beam. This means that a lower room temperature can be achieved.



Picture 1. Cross-section of Lindab's unique strips. The rhomboid shape provides an efficient heat-transfer surface.



Picture 2. How Carat works.

Optimal design

Construction

Carat is a chilled beam that absorbs heat by both radiation and convection. By optimising the beam's radiation quotient, output has been increased by 50% compared to finned battery beams, without increasing the risk for drafts.

Carat is based on a method that is unique in the world: in a cold-rolling process, the copper pipe is connected by metallurgical bonding to a gilled aluminium sheet. The energy transfer between the cooling surface and the water circuit is made more efficient, which results in a high cooling effect per surface unit. The technology for the metallurgical bonding of copper and aluminium renders galvanic corrosion impossible.

Carat is available in widths from 31 cm to 84 cm. The length can vary from 1.2 m to 6.0 m.

Carat provides a high cooling effect per surface unit, which leads to resource-efficiency and a low weight for the product. Carat is made of 100% recyclable materials.

The water pipes are made of copper. Nevertheless, the water should be oxygen-free to prevent corrosion.

Easy to clean

Hygiene

Carat's surface area is four times smaller than that of a corresponding finned battery beam with the same performance. All parts of the product are accessible for cleaning and inspection. These qualities, together with the relatively strong aluminium plate, make Carat easy to wipe and clean.

Chilled beam Carat

Data

Variants

Carat is a passive chilled beam that absorbs heat by both radiation and convection and is installed above a perforated suspended ceiling or exposed.

Installation: Carat is mounted horizontally.

Lengths: Carat is available in lengths from 1.2 m to 6.0 m, in steps of 0.1 m.

Width: Carat is available in five widths: 31, 44, 58, 71 and 84 cm (see Pictures 4 to 8, on page 5).

Height: All models are 147 mm high.

Water connection: Carat is available with a variety of connection dimensions, 10, 12, 15, 22 and 28 mm, depending on the product's width and connection options.

Surface treatment: Carat is powder-coated.

Colour

The product is available as standard, in signal white RAL 9003 or in pure white RAL 9010, gloss value 30. Other RAL colours on request.

Accessories

Delivered separately.

Control: Refer to the chapter Regula.

Hangers: For recommended installation principles (see: "Carat Installation Instruction").

All these different hangers are available at Lindab:

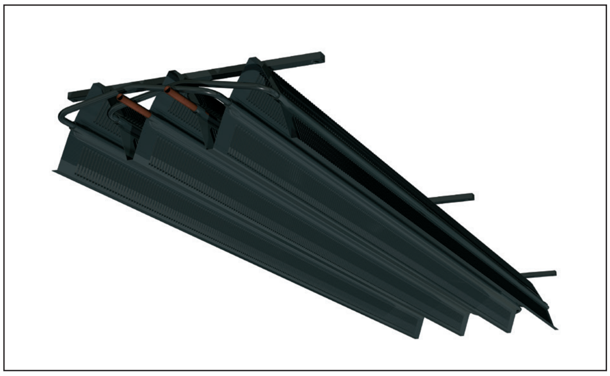
-pendulum hangers (in different sizes)
-threaded rods M8
-wiring hanger system

For additional accessories please refer to the "Accessories" document on www.lindqst.com.

Plus features

Factory preinstalled.

Edge protection: For visible installation.



Picture 3. Carat with black coating.

Chilled beam Carat

Versions

Picture 4. Carat -31

Picture 5. Carat -44

Picture 6. Carat -58

Picture 7. Carat -71

Picture 8. Carat -84

Chilled beam Carat

Dimensioning

Cooling capacity when installed above a perforated suspended ceiling

Example 1:
What is the output of a 3 m Carat-44 that is placed above a perforated dropped ceiling?

The temperature difference between the room temperature and the average water temperature is assumed to be 10 K.

The perforations in the ceiling consist of 4 mm holes, with a degree of perforation of 28%. The ceiling consists of perforated panels with a total area of 5.4 m². The total ceiling area is 12 m².

Find the intersection point for the lines at 28% and 4 mm in diagram 1. Follow the line to the left, from the intersection point, and read off the capacity on the left scale for Carat-44. The value is P_{Lt} = 16 W/(m² K).

This gives: P_W = 16 W/(m K) × 3 m × 10 K = 480 W.

The capacity applies for the nominal water flow per strip q_w = 0.025 l/s. To obtain a flow-adjusted capacity, refer to steps 3 to 8 on the next page.

You should check what the maximum output is for the suspended ceiling. Go straight to the right, from the intersection point for the lines at 28% and 4 mm, and read off the value on the scale. The value is P_{Lt} = 11.5 W/(m² K).

This gives: P_w = 11.5 W/(m² K) × 10 K × 5.4 m² = 621 W.

The maximum cooling output from the ceiling is higher than what the product gives.

Definitions:
Pa = Cooling capacity air [W]
P_w = Cooling capacity water [W]
P_{tot} = Cooling capacity total [W]
q_{ma} = Air mass flow rate [kg/s]
q_a = Primary air flow rate [l/s]
q_w = Water flow rate [l/s]
q_{wmin} = Minimal water flow rate [l/s]
q_{wnom} = Nominal water flow rate [l/s]
c_{pa} = Specific heat capacity air [1,004 kJ/kg K]
t_r = Room air temperature [°C]
t_{wi} = Water inlet temperature [°C]
t_{wo} = Water outlet temperature [°C]
Δt_{ra} = Temp. diff., room air and primary air temp. [K]
Δt_{rw} = Temp. diff., room air and mean water temp. [K]
Δt_w = Temp. diff. water circuit [K]
$\varepsilon_{\Delta tw}$ = Capacity correction for temperature
ε_{qw} = Capacity correction for water flow
P_{Lt} = Specific cooling capacity [W/(m K)]

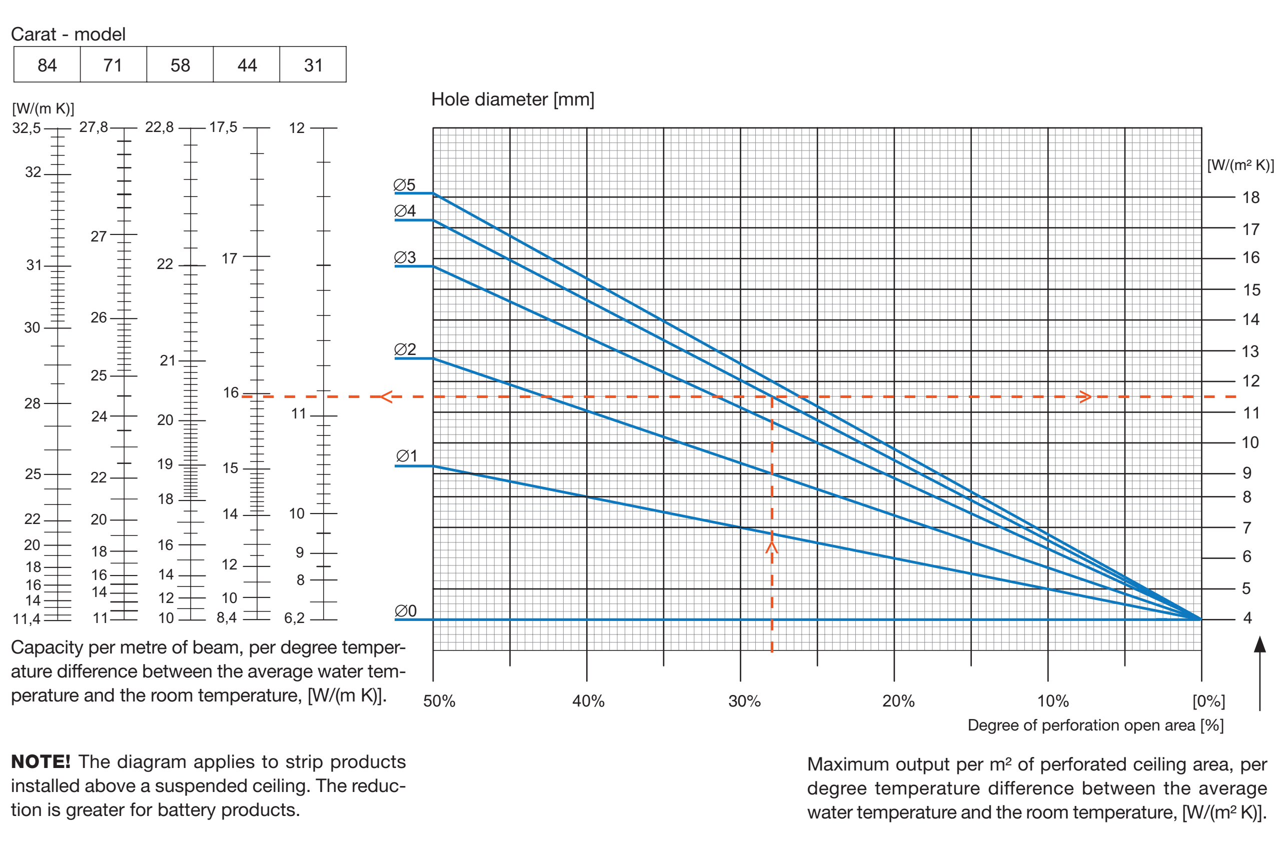


Diagram 1. Carat, cooling capacity when installed above a perforated suspended ceiling.

Chilled beam Carat

Dimensioning

Cooling capacity P_w for suspended installation

To calculate Carat's cooling capacity P_w, follow the steps below.

1. Calculate Δt_{rw}.
2. Read off the specific cooling capacity P_{Lt} per metre and K in table 1.
3. Calculate the water flow q_w.
4. Read off the number of parallel circuits in table 2.
5. Calculate the water flow q_w per strip.
6. Read off the capacity correction ε_{qw} in diagram 2.
7. Multiply the capacity P_w by the capacity correction ε_{qw}.
8. Repeat steps 5 to 7.

Example 2:
What is the cooling capacity of a 3.6 m Carat-58 with ø12 mm water connection?
The room summer temperature is assumed to be 24.5°C
The cooling water temperature in/out of Carat is 14/17°C

Temperature difference: $\Delta t_{rw} = t_r - (t_{wi} + t_{wo})/2$
$\Delta t_{rw} = 24.5 - (14+17) / 2 = 9$ K

Model	Specific cooling capacity P_{Lt} (W/(m K))
Carat-31	12
Carat-44	17.5
Carat-58	22.8
Carat-71	27.8
Carat-84	32.5

Table 1. Carat, specific cooling capacity P_{Lt} per metre and K.

Read off the specific cooling capacity P_{Lt} for Carat-58, in table 1: 22.8 W/(m K).
Cooling capacity: $P_w = 22.8$ W/(m K) × 9 K × 3.6 m = 739 W

Calculate the water flow using this capacity, with the following formula: $q_w = P_w / (c_{pw} \times \Delta t_w)$
$q_w = 739$ W / (4200 Ws/(kg K) × 3 K) = 0.059 l/s

Read off the number of parallel circuits for Carat-58 with Ø12 water connection in table 2. The value is 2. The water flow per strip will be 0.059 l/s / 2 = 0.029 l/s.

The capacity correction ε_{qw} , read off from diagram 2, will then be 1.015 and the new capacity:
$P_w = 739$ W x 1.015 = 750 W.

Calculate the new water flow using the new capacity
$q_w = 750$ W / (4200 Ws/(kg K) × 3 K) = 0.0595 l/s.

The water flow per strip will then be 0.0595 l/s / 2 = 0.029 l/s, and the capacity correction approx. 1.015.

The capacity correction ε_{qw} read off is 1.015, and the cooling capacity is then calculated to be 750 W.

Size	Model				
	31	44	58	71	84
ø10	1	1	1	1	1
ø12	2		2		2
ø15	4	3	4	5	3
ø22		6	8	10	6
ø28					12

Table 2. Number of parallel circuits for Carat, depending on model and connection alternative.

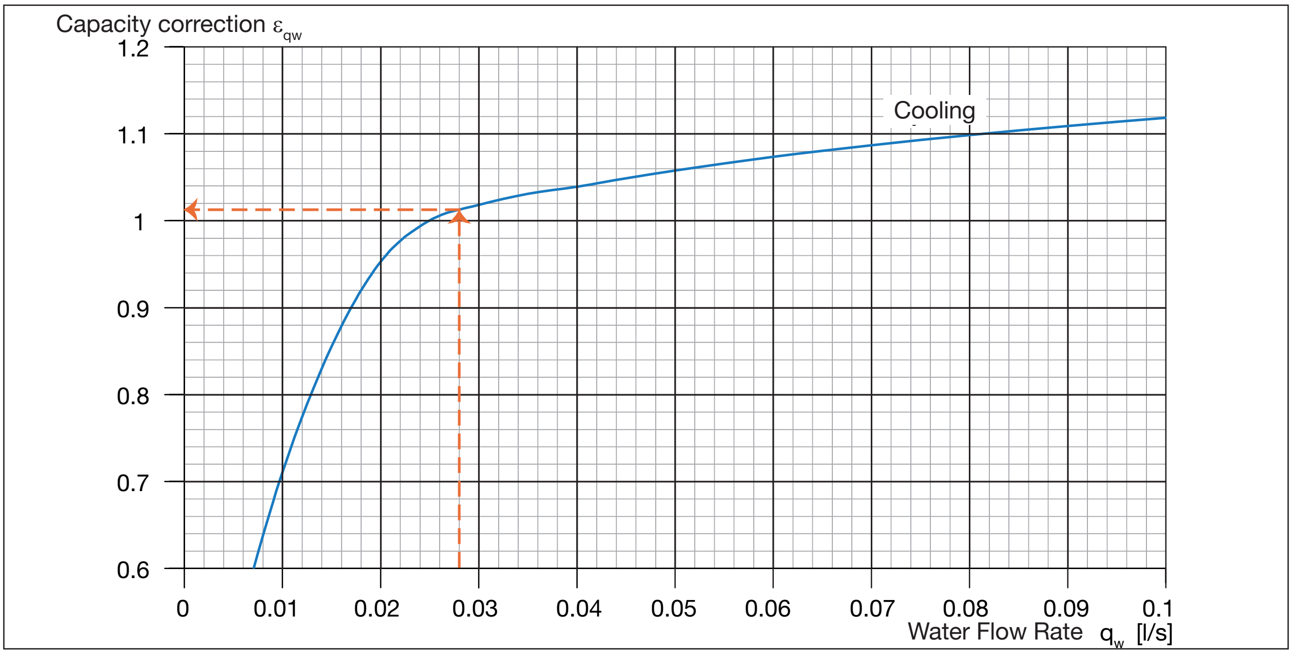


Diagram 2. Capacity correction ε_{qw} for water flow for cooling average water temperature = 15°C.

Chilled beam Carat

Air velocities in the living area, depending on the cooling capacity

Extensive measurements show that if Carat is placed above a metal perforated suspended ceiling, air velocities in the occupied zone are reduced, compared to a suspended product. The extent of the reduction depends on the suspended ceiling's degree of perforation. Diagram 3 shows the air velocities for Carat with different cooling capacitys for four different perforations, as well as for suspended installation of Carat and for finned battery beams. The output is also reduced compared to a suspended installation. For cooling capacity, refer to diagram 1.

Air velocities are reduced when Carat is placed above a metal perforated suspended ceiling, the reason for this is that the perforated sheet is cooled by the increased radiation exchange between Carat and the perforated metal. Moreover, the cold air spreads under the beam and increases the area of the cold surface. At the same time, the volume of air that passes through the perforated ceiling decreases; i.e. there is a change from convection to radiation. Radiation exchange in chilled beams does not create any air movement.

Minimum flow

Please note that flows below the recommended minimum water flow q_{wmin}, can result in unwanted air in the water pipes. Exceeding the nominal flows is not recommended as the capacity gains will only be minimal.

For minimal (q_{wmin}) and nominal water flows (q_{wnom}) please refer to page 11, table 3.

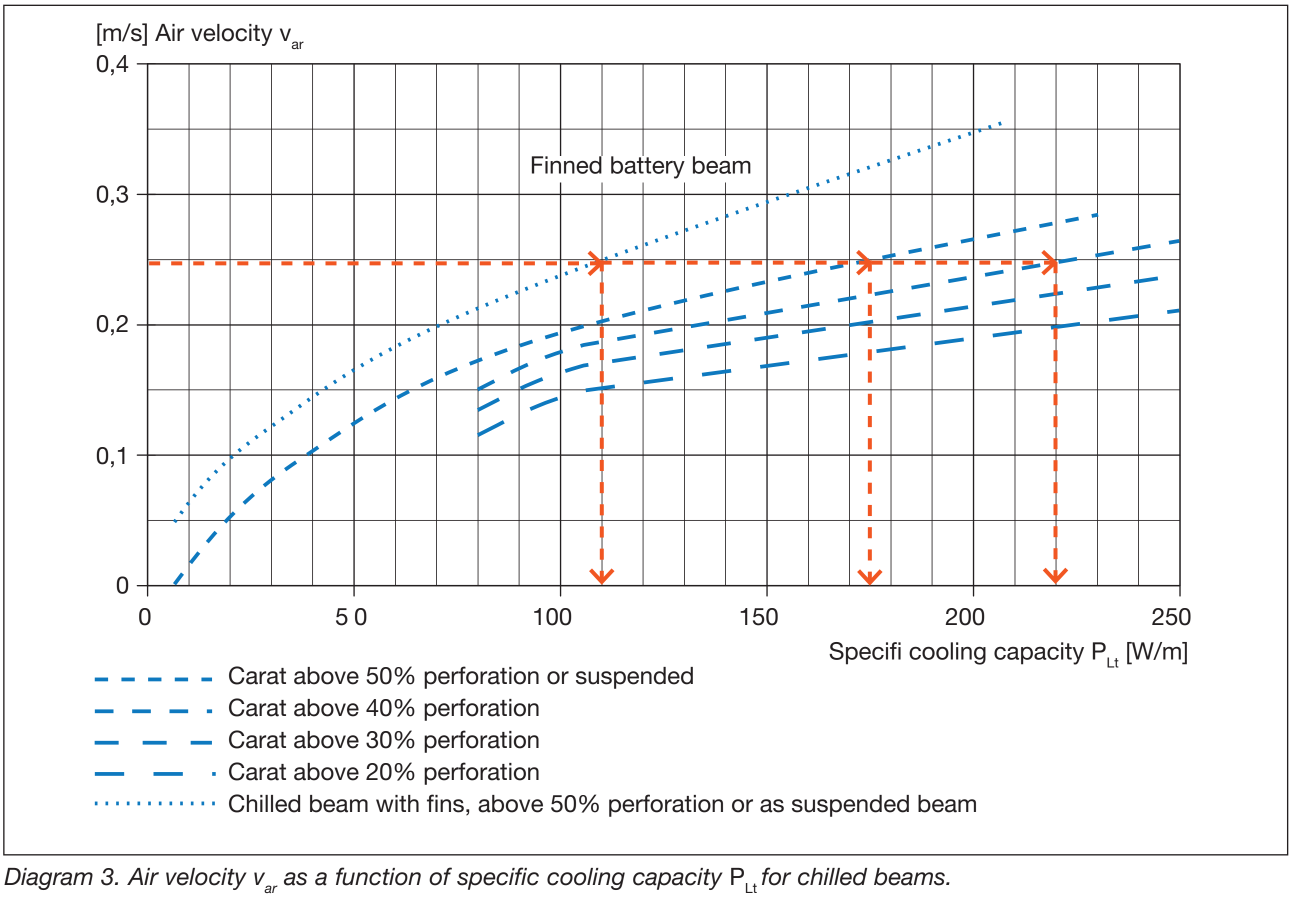


Diagram 3. Air velocity v_{ar} as a function of specific cooling capacity P_{Lt} for chilled beams.

Chilled beam Carat

Pressure drop in water circuit, cooling

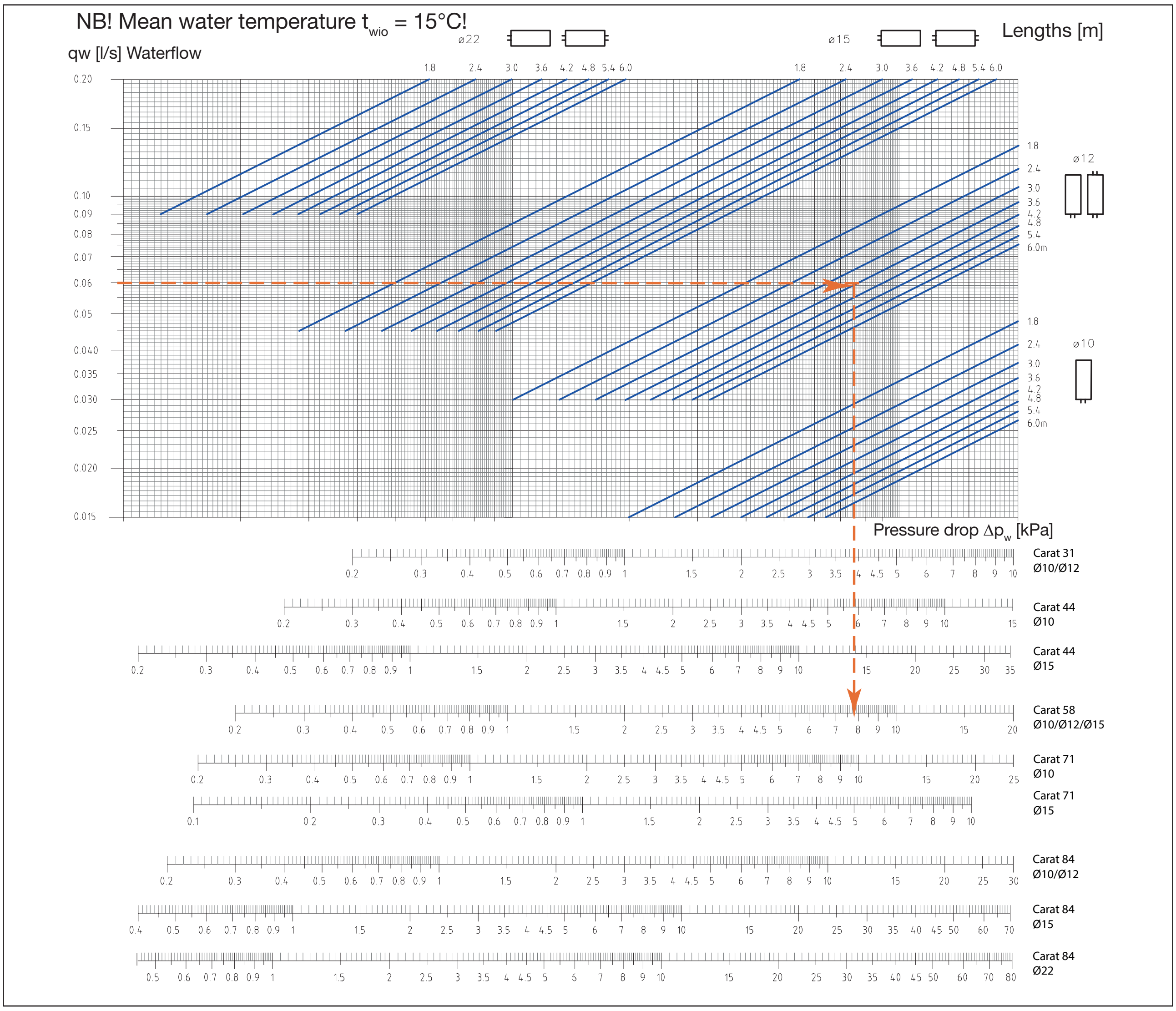


Diagram 4. Pressure drop Δp_w for Carat connection option "1" , "3" and "13".

Example:
3.6 m long Carat-58-12-1, which provides an output of 750 W.
$\Delta t_w = 3$ K
$q_w = P_w / (c_{pw} \times \Delta t_w)$
$q_w = 750$ W / (4200 Ws/(kg K) × 3 K) = 0.0595 l/s
The pressure drop in the water circuit in diagram 4 is read off as $\Delta p_w = 7.8$ kPa.

Definitions:
q_w = Water flow rate [l/s]
P_w = Cooling capacity water [W]
c_{pw} = Specific heat capacity water [4200 Ws/(kg K)]
Δt_w = Temperature difference water circuit [K]
t_{wio} = Mean water temperature [°C]
Δp_w = Pressure loss water circuit [kPa]

* Diagrams are for a certain mean water temperature t_{wio}. For other temperatures please do your calculations in our waterborne calculator in www.lindqst.com!

Pressure drop in water circuit, cooling

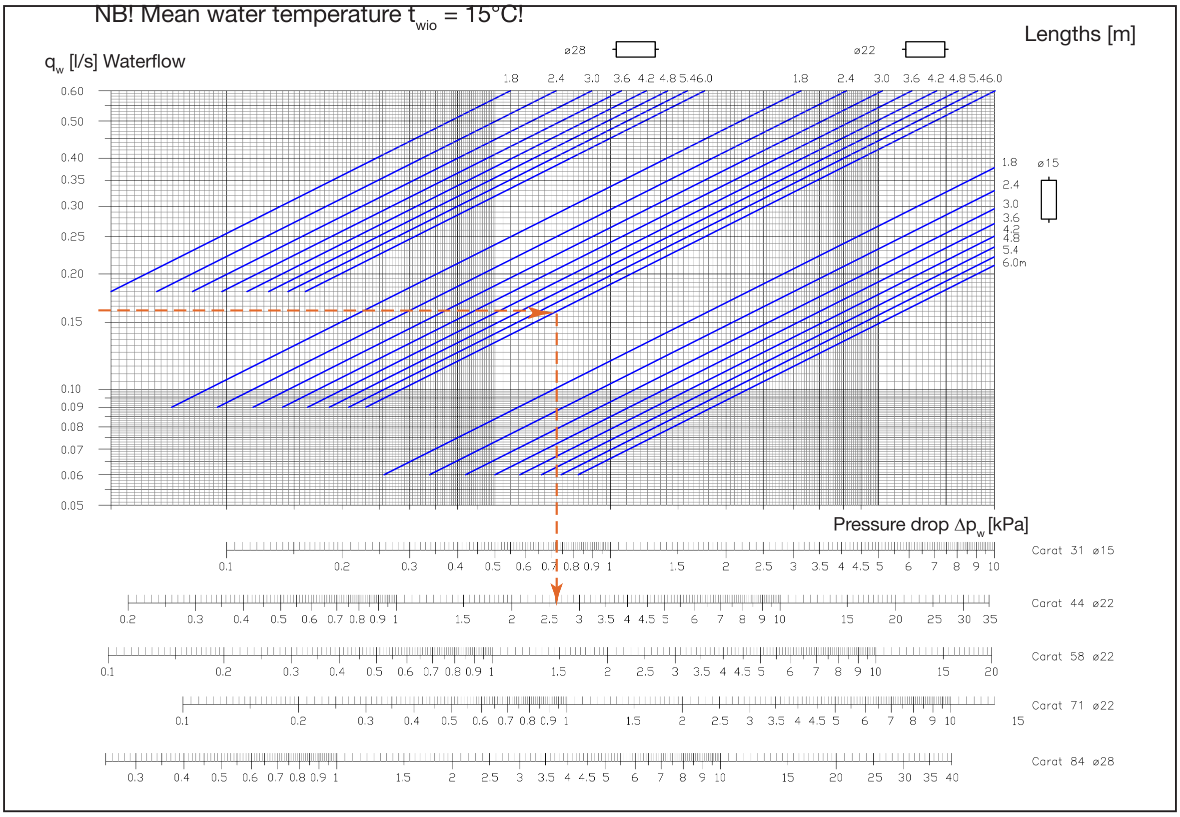


Diagram 5. Pressure drop Δp_w for Carat with connection option "13".

Products connected in series

1. Calculate the total water flow q_w in the circuit.
2. Read off the pressure drop Δp_w, for each individual product, with the total water flow q_w.
3. Add the pressure drop Δp_w, for each individual product.
4. Add the pressure drop Δp_w, for the other components.

Definitions:

q_w = Water flow rate [l/s]
P_w = Cooling capacity water [W]
c_{pw} = Specific heat capacity water [4200 Ws/(kg K)]
Δt_w = Temperature difference water circuit [K]
t_{wio} = Mean water temperature [°C]
Δp_w = Pressure loss water circuit [kPa]

* Diagrams are for a certain mean water temperature t_{wio}. For other temperatures please do your calculations in our waterborne calculator in www.lindqst.com!

Example:
A total water capacity P_w of 2 kW must be supplied to a room, with a temperature difference Δt_w of 3 K between the supply and return water.

2 pc. 6 m long Carat-44-22-13 are selected.

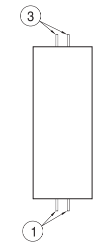
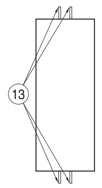
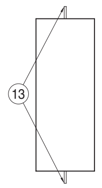
The water flow in the circuit will be:
q_w = 2000 W / (4200 Ws/(kg K) × 3 K) = 0.16 l/s

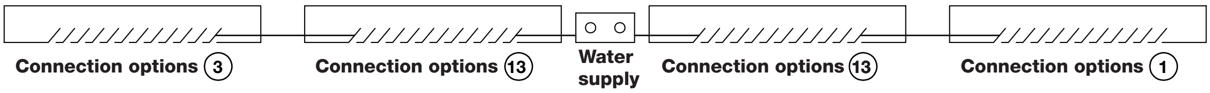
Read off the pressure drop: Δp_w = 2.6 kPa.

Add the pressure drop for each individual product:
Δp_w = 2.6 + 2.6 = 5.2 kPa

Chilled beam Carat

Couplings & connections

Model	Coupling options	Pipe diameter [mm]	q_{wmin} [l/s]	q_{wnom} [l/s]	No. Parallel flows
Carat-31		10 12	0.015 0.030	0.025 0.050	1 2
Carat-44		10 15	0.015 0,045	0.025 0.075	1 3
Carat-58		10 12 15	0.015 0.030 0.060	0.025 0.050 0.100	1 2 4
Carat-71		10 15	0.015 0.075	0.025 0.125	1 5
Carat-84		10 12 15 22	0.015 0.030 0.045 0.090	0.025 0.050 0.075 0.150	1 2 3 6
Carat-31		12	0.030	0.050	2
Carat-44		15	0.045	0.075	3
Carat-58		15	0.060	0.100	4
Carat-71		15	0.075	0.125	5
Carat-84		22	0.090	0.150	6
Carat-31		15	0.060	0.100	4
Carat-44		22	0.090	0.150	6
Carat-58		22	0.120	0.200	8
Carat-71		22	0.150	0.250	10
Carat-84		28	0.180	0.300	12



Due to of the beam's "gills", its surface structure looks different, depending on the direction from which it is viewed. If products connected in series are to have the same appearance, the connection point should be oriented in the same direction throughout the room. Note! Connection option 13 can be turned in both directions.

Table 3. Carat's couplings & connections.

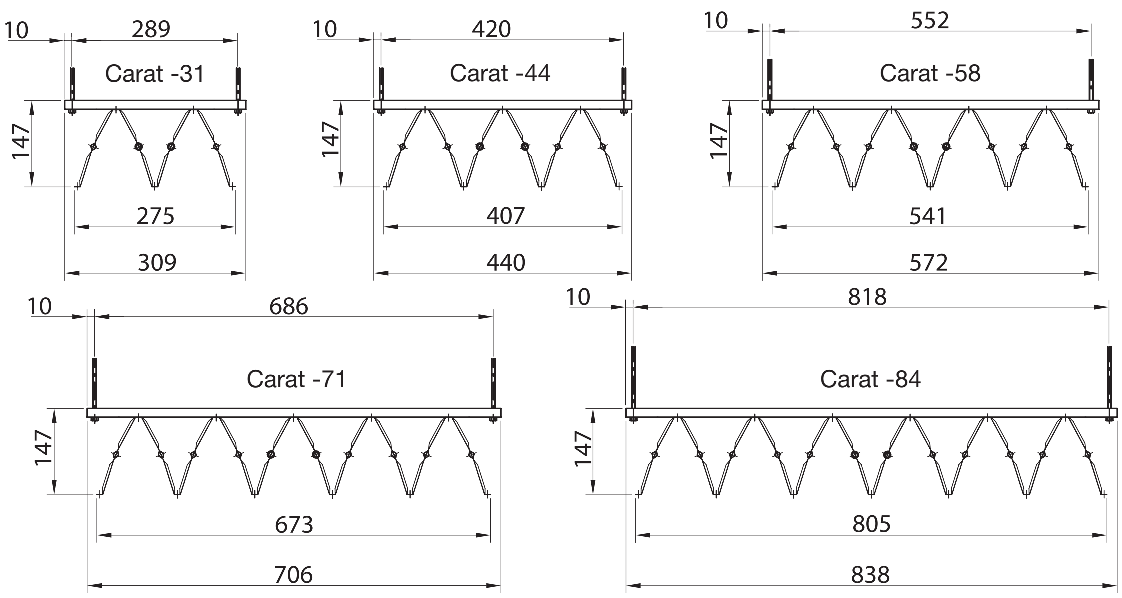
Weight & water content

	Carat-31	Carat-44	Carat-58	Carat-71	Carat-84
Dry weight, [kg/m]	1.7	2.5	3.3	4.2	5.0
Water content, [l/m]	0.4	0.5	0.7	0.9	1.06
Copper pipes, quality	EN12735-2 CU-DHP	EN12735-2 CU-DHP	EN12735-2 CU-DHP	EN12735-2 CU-DHP	EN12735-2 CU-DHP
Pressure class	PN10	PN10	PN10	PN10	PN10

Table 4. Carat's weight & water content.

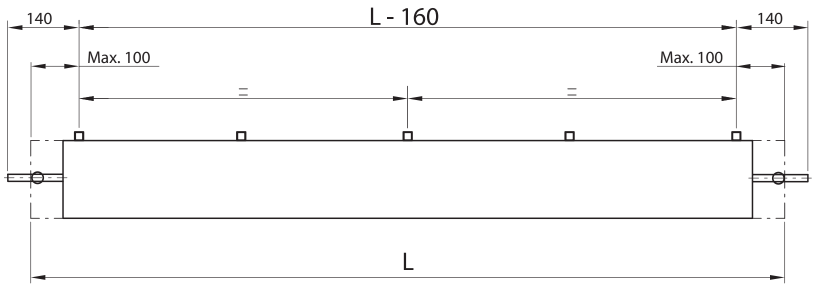
Chilled beam Carat

Width & height, mm



Length, mm

As standard, Carat is available in lengths from 1.8 m to 6.0 m, in steps of 0.1 m.



3 × 2 suspension points for lengths > 3 m.

Connection dimensions, mm

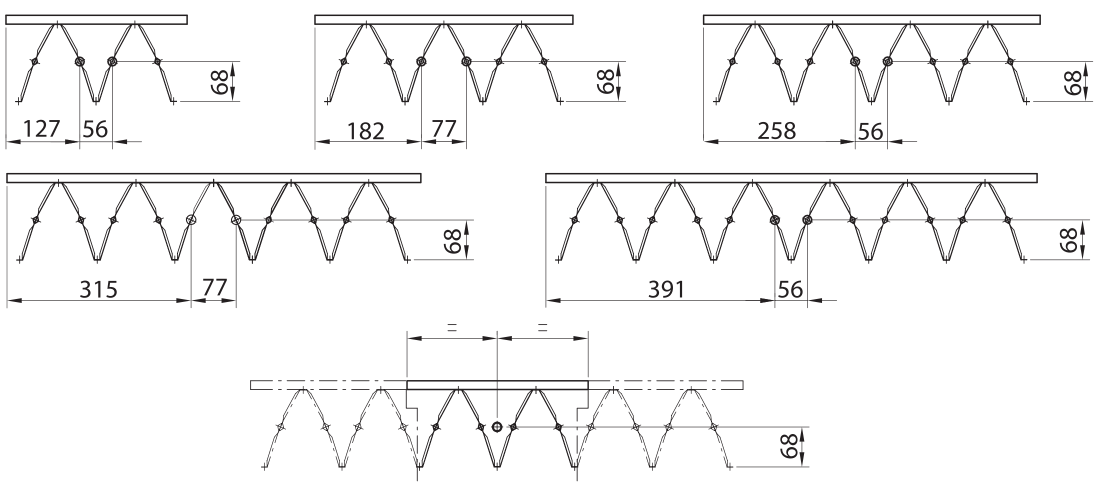


Figure 1. Carat, width, height, length and connection dimensions.

Chilled beam Carat

Installation examples

Carat has a wide range of applications and can be installed in offices, exhibition halls and industrial premises or warehouses. Carat is suitable for both visible and hidden installation. Hidden installation above a perforated suspended ceiling is the most common in office environments. During installation, it is important that the separation between the product and the ceiling be large enough. Otherwise, the output can be reduced because of insufficient air intake. The minimum acceptable distance varies depending on the width of the product. Table 5 and figures 2 to 4 list the minimum installation dimensions that are required for each model, so as to avoid a reduction in Carat's capacity. If the minimum installation dimensions are not met, the cooling capacity of Carat must be reduced in accordance with diagram 6.

Carat is light, and this makes the product easy to handle during installation. There are 3 suspension options for Carat: Pendulum, threaded rods (M8) or suspended wires (FH-system) are easy to adjust, so as to achieve the necessary measurement between the product and the ceiling.

Model	A (mm)	B (mm)	C (mm)
Carat -31	45	192	232
Carat -44	55	202	252
Carat -58	70	217	267
Carat -71	85	232	302
Carat -84	105	252	322

Table 5. Minimum installation dimensions, required by the respective models, to avoid a reduction in Carat's capacity.

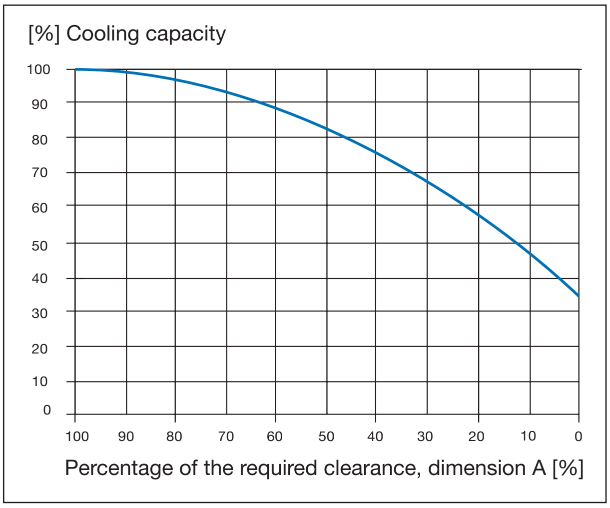
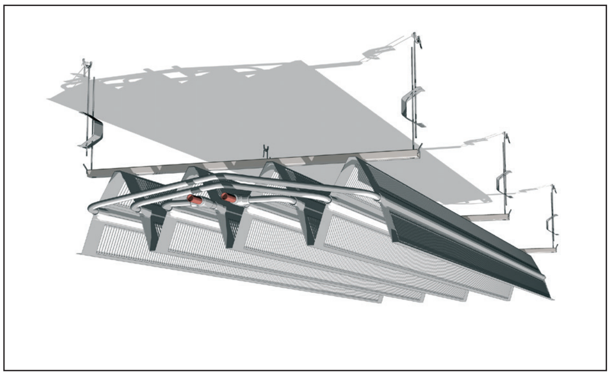
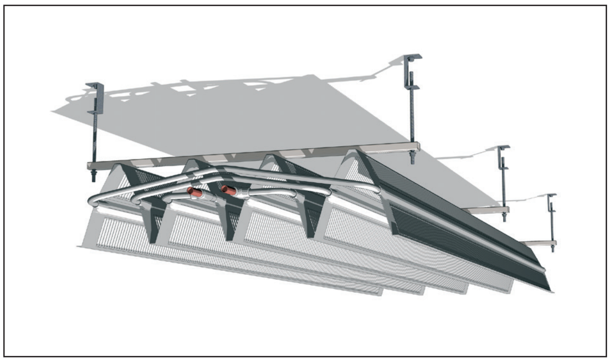


Diagram 6. Reduction of the cooling capacity when dimension A is reduced.



Picture 9. Installation of Carat with pendulum hangers suspended



Picture 10. Installation of Carat with threaded rods.

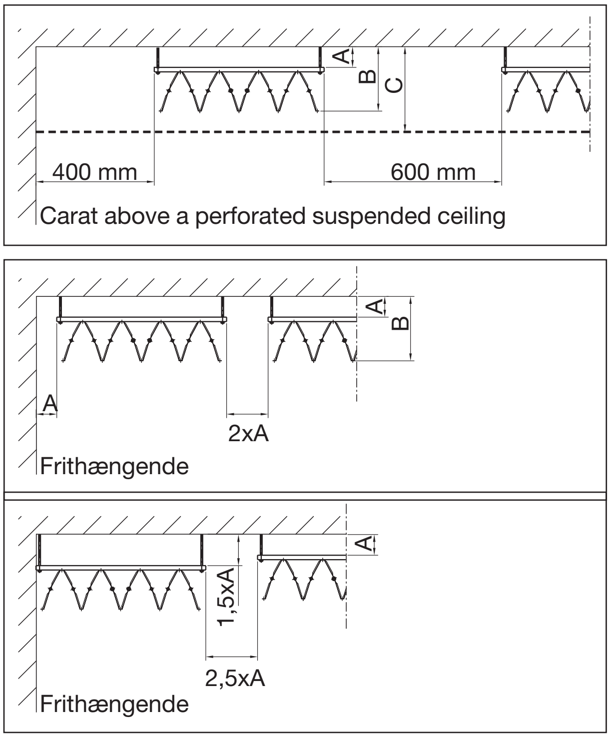


Figure 2-4. Installation dimensions for Carat.

NB! To achieve low air velocities as per diagram 3, the distance between the beams should be at least 600 mm.

LindQST - just a click away

The Lindab Quick Selection Tool, lindQST®, is a very fast, easy-to-use and flexible online tool for your daily work.

Calculate the Carat here

Picture 11. LindQST - Indoor Climate Designer

LindQST® helps you select the right waterborne products, e. g. active chilled beams, passive radiant chilled beams, radiant cooling- and heating panels and fasade units and quickly finds the corresponding documentation.

In *Waterborne Documentation* you can easily find all available product documentation. Always in the latest version.

In *Waterborne Calculator* you can do a professional calculation based on your specific input data to finetune your choice or calculate different variants of the product. Smart warnings piont out if a set-up will not work.

In *Waterborne Selector* you can compare the proposed products according to your specific regiurements and select the one which fits best to your needs .

Not enough? With *Indoor Climate Designer* you can insert your selected waterborne product into your room and simulate the actual air distribution, optimize the placing in the ceiling taking into account the calculated air velocities and sound levels.

You can at anytime display your selection and calculations graphically. In addition, you can print or save all results and related documents for your documentation (incl. data sheets, dxf-files and room books).

With lindQST® you will easily find the most suitable product for your project.

It provides an easy and quick access to the latest product information, technical specifications and assembly instructions on the Internet, making it the ideal tool installers, consultants and architects alike.
www.LindQST.com

- Fast product selection waterborne products in accance to Eurovent (chilled beams and facade units).
- Easy access to all current documentation.
- Fast design of waterborne products.
- Indoor Climate Designer: Graphical representation of the spatial situation in 2D / 3D and floor plans from AutoCAD®.
- Calculation of capacities, sound power levels, pressure losses and flow conditions.
- 3D particles or smoke show the air distribution in the room.
- Diagram showing the time course of the CO_2 concentration in the room.
- Room book generation and data sheet for individual rooms and outlets or entire projects.
- Project can be saved and exchanged in its own project area.

Chilled beam Carat

Control

Lindab offers control equipment that is very simple to use. To avoid the heating and cooling being activated at the same time, the system is controlled sequentially (Regula Combi). For the technical data, refer to the chapter Regula.

Designations

Product:	Carat
Width:	31, 44, 58, 71, 84 cm
Connection dimensions, water:	10, 12,15, 22, 28 mm
Coupling options:	1, 3, 13
Length:	Length in metres
Plus features:	See page 4

Programme text

Chilled beams from Lindab	**Qty**
Product:	
Carat -58-15-1, 3 m	10
Plus features:	
Colour, RAL 9005 (black)	
Accessories:	
No.	
Product:	
Carat -71-15-13, 2.4 m	25
Plus features:	
Edge protection	
Accessories:	
Regula Combi	25
Regula Secura	25
Cooling control valve	25
Cooling actuator	25
Product:	
Carat -71-15-1, 2.4 m	10
Plus features:	
Edge protection	
Accessories:	
Regula Combi	10
Regula Secura	10
Cooling control valve	10
Cooling actuator	10

Order code

Product **Carat** **71** **15** **1** **2.4**

Width:
31, 44, 58, 71, 84

Water connection:
10, 12, 15, 22, 28 mm

Connection type:
1, 3, 13

Product length:
1.2 m - 6.0 m (In steps of 0.1 m)

Good Thinking

At Lindab, good thinking is a philosophy that guides us in everything we do. We have made it our mission to create a healthy indoor climate – and to simplify the construction of sustainable buildings. We do that by designing innovative products and solutions that are easy to use, as well as offering efficient availability and logistics. We are also working on ways to reduce our impact on our environment and climate. We do that by developing methods to produce our solutions using a minimum of energy and natural resources, and by reducing negative effects on the environment. We use steel in our products. It's one of few materials that can be recycled an infinite number of times without losing any of its properties. That means less carbon emissions in nature and less energy wasted.

We simplify construction

Lindab®