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ROOF DRAIN

Scupper / Parapet Type

FD-4010	FD-4020	FD-4030	FD-4040	FD-4100
 24	 25	 26	 27	 28

Small Sump Type

FD-4050	FD-4060	FD-4060G	FD-4060GX	FD-4060OF
 29	 30	 31	 32	 33

Large Sump Type

FD-4080	FD-4080G	FD-4080GX	FD-4080EX	FD-4080GEX
 42	 43	 44	 45	 46

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System solutions for
Flat roofs, parking decks, balconies, facades and terraces

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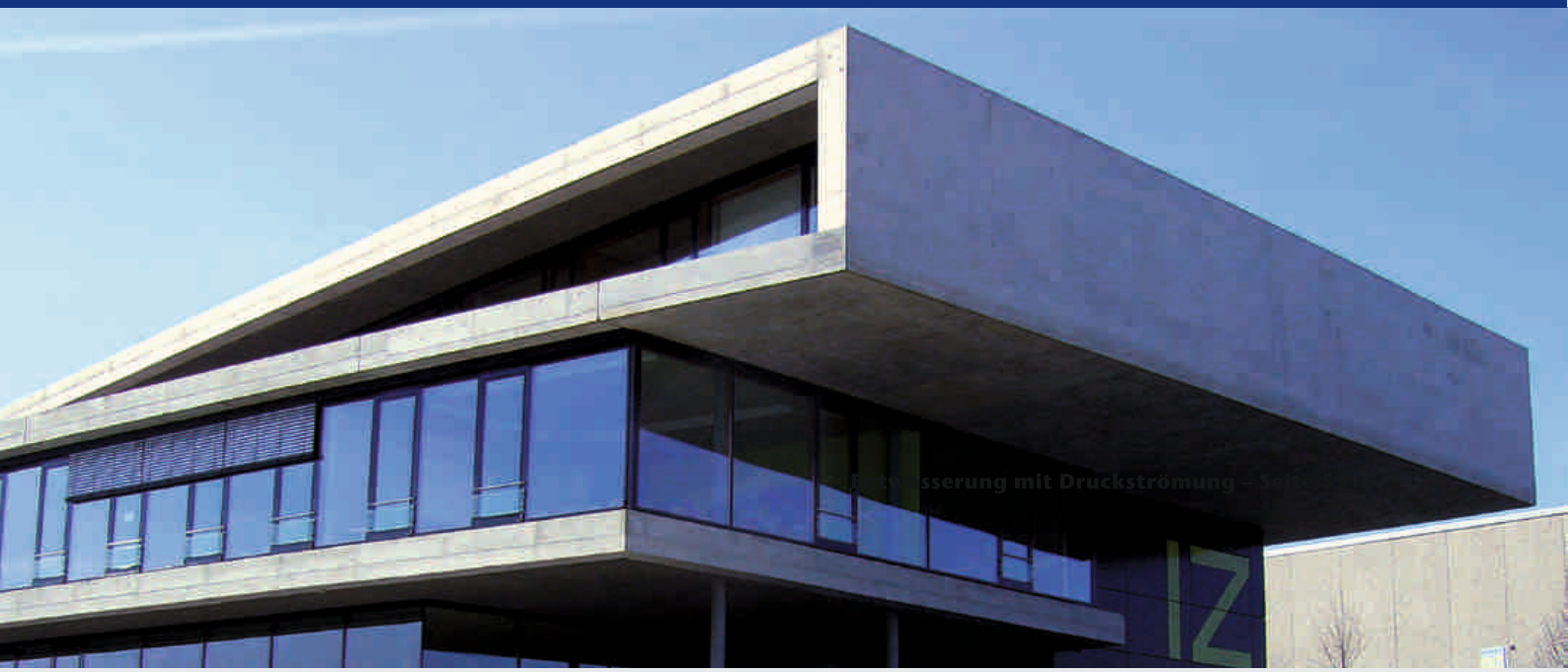
System solutions for flat roofs, parking decks, balconies, facades and terraces



Flat roofs, parking decks, balconies, facades and terraces are all architectural features with their own special problems. They all benefit in particular from professional planning of the drainage aspects. In the light of the general increase in the occurrence of heavy rainfall, we have adjusted to the changing conditions and developed a complete system which delivers the optimum drainage solution for every situation.

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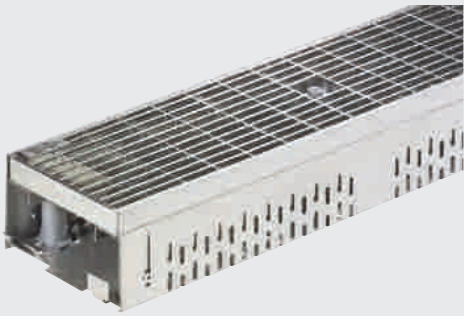
Roof Drain



Broad service spectrum for planners

Project assistance
ACO Applications Technology helps you with the drainage plan for each project – from housing complexes to distribution centres. The Applications Technology assistance provided by our back office and field staff includes a wide range of services:

- Technical layout/product selection
- Installation recommendations
- Article descriptions
- Customised on-site advice

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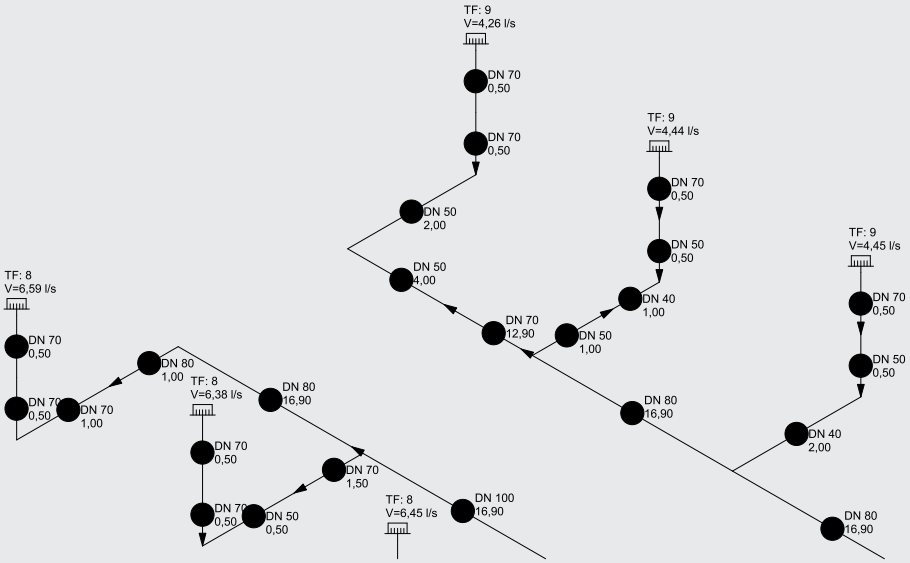
Online catalogue
Easy download of scale drawings and article descriptions with the new K12 online catalogue on our website. Product selection made easy with the relevant selection criteria.

- Selection assistant
- Easy keyword and article searches
- Article descriptions (TXT, Datanorm and GAEB)
- Scale drawings (DXF)
- Product visuals
- Installation and assembly instructions

www.aco-haustechnik.de/katalog

Syphonic drainage systems
The hydraulic calculation of syphonic drainpipe networks and the selection of the relevant drain systems must be carried out in compliance with the applicable regulations and standards. Applications Technology can help you with:

- Hydraulic capacity calculations
- Isometrics and lists of materials



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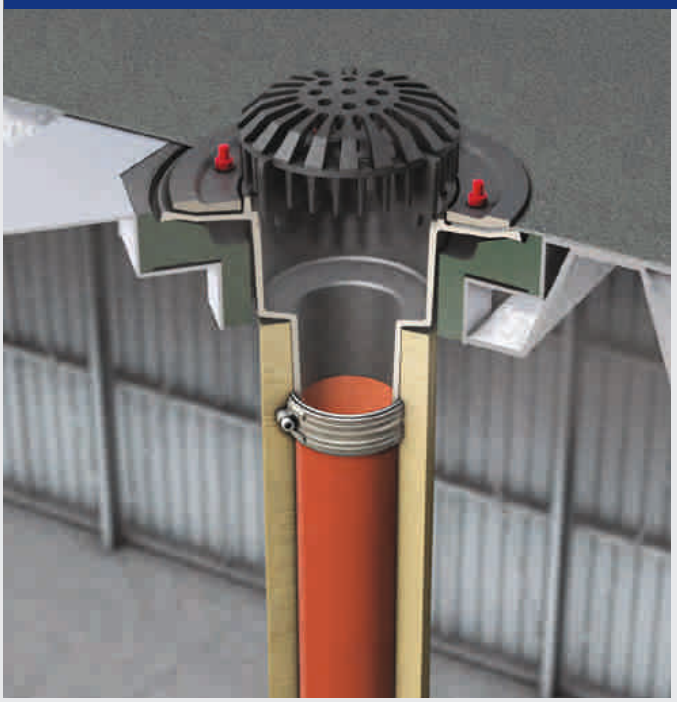
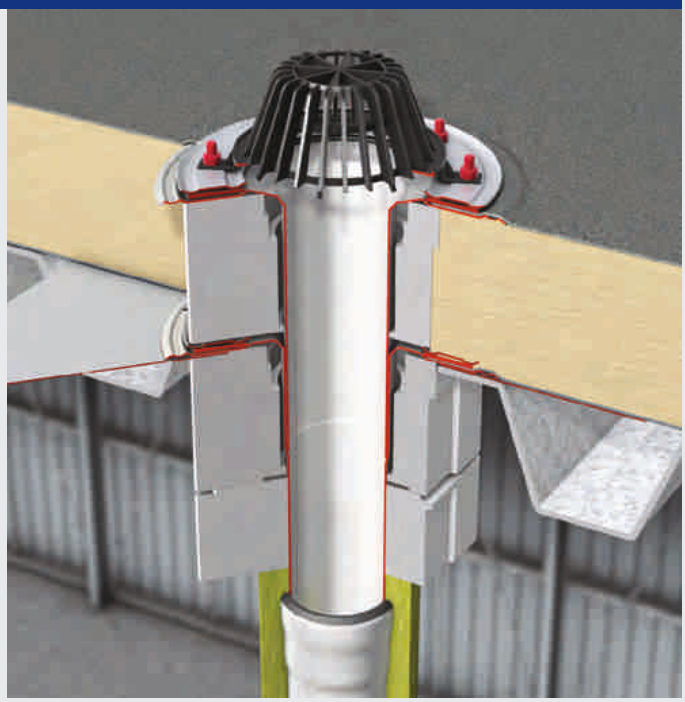
Roof Drain

Gravity drainage





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Gravity Drainage

ACO Spin flat roof drains for gravity drainage

The roof forms the upper boundary of a building. The roof seals are very important because of the severe stress the roof is exposed to from precipitation, strongly fluctuating climatic influences, and a whole range of traffic loads and stresses.

Roof structures can therefore be divided up into two groups depending on the seal:

- Flat roof structures with one seal
- Flat roof structures with two seals

A stainless steel flat roof drain for two sealing membranes.

The Spin flat roof drains can be used in all types of roofs thanks to their modular system. In roofs with two seals, the drain body is integrated with the vapour seal, whilst the riser is in incorporated in the roof sealing membrane. The drains are fitted with compression sealing flanges which allow them to be integrated within all standard sealing membranes.
The drain bodies are installed in special insulating bodies to prevent the formation of of condensation water around the drain body – this is particularly important for thermally-insulated flat roofs, green roofs and parking decks.

- Planning must comply with EN 12056-3, as well as the flat roof regulations and, where applicable, the green roof regulations.

Flat roof with a gravel protection layer

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Gravity Drainage

Roof drainage

General

Drainage can be implemented using roof drains or roof gutters hung in front of the roofs with appropriate eaves. Internal drainage is recommen ded for roofs with gentle slopes (up to 5°).

Roof surfaces with internal drainage systems must have at least two drains or one drain and a safety overflow independent of the size of the roof.

Roof drains

The drains of internal roof drainage systems must be arranged at the lowest points of the roof and capable of being connected to the roof seal with a permanent and watertight join.

Roof drains must generally be positi oned at least 30 cm away from other installations on the roof, joints or other ducts penetrating the roof sealing membrane. They must also be installed so that they create no thermal bridge in the construction of the roof.

Roof drains must be freely accessible for maintenance purposes.

Roof drains must be fastened within the substructure.

The flanges in roof drains should be incorporated within the substructure where possible. Two-piece roof drains should be used in thermally insulated roof structures with vapour seals.
Thermally insulated roof drains must be installed if heated spaces or used rooms are located directly below the ceiling.

Roof drains are integrated within the roof sealing membranes by fixed and loose flanges, adhesive flanges or integrated connecting membranes. The connecting membranes must be suitable for the specific roof sealing membrane used in each case.

Pre-fabricated roof drains must comply with EN 1253.

In the case of green roofs, there should be no planting in the area immediately around the roof drains.

Emergency drainage

Flat roof drainage systems must always be laid out in accordance with the reference rainfall figures. The reference rainfall can be exceeded during periods of heavy rainfall. This can cause water to pool on the surface of a flat roof.

An independent emergency drainage system for flat roof drains is therefore required in accordance with EN 12056-3. This emergency drainage system must enable rainwater to be drained safely onto empty surfaces. It is forbidden to connect the emergency drainage system to the regular drainage system.

Fire protection

Flat roof drains with fire protection are required on flat roofs in accordance with state building regulations if the separation between the roof drains and a rising wall in these areas is less than 5 metres (walls with openings or with no fire resistance capacity).

In this case, an appropriate fire protection roof drain without an odour seal must be installed. This prevents the spread of fire and smoke into neighbouring parts of the building.

Special attention should be given to the fire resistance class of the roof structure. The roof drain must have at least the same fire resistance class or a higher fire resistance class than the ceiling.

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Gravity Drainage

Calculating the number of flat roof drains and emergency roof drains required for gravity drainage systems

The following parameters are specified in DIN 1986-100 (version May 2008) Chapter 14.2.1, to calculate the number of drains required for a flat roof drainage system:

- The size of the effective roof in square metres (A)
- Type of roof – flow coefficient (C)
- Local reference rainfall in litres/second and hectare l/(s*ha) ($r_{(D,T)}$)

Effective roof area

In accordance with DIN 1986-100, Chapter 14.2.4.1, calculating the effective roof area must be based on the roof area projected onto the floor plan.

Flow coefficient

The flow coefficient (C) is determined by the type of roof to be drained. This is selected from Table 9 in DIN 1986-100. The following is a short extract:

Type of drained area	Flow coefficient (C)
Membrane roof	1.0
Concrete roof	1.0
Gravel roof	0.5
Extensive greening under 10 cm layered structure	0.5
Intensive greening	0.3

Reference rainfall

The variable reference rainfall $r_{(D,T)}$ consists of two parameters:

D = rainfall duration in minutes
T = annuality of the reference rainfall

The reference rainfall for flat roof drainage systems is based on a rainfall period of 5 minutes and an annuality of five years.
Calculations therefore refer to a reference rainfall of $r_{(5,5)}$.

The relevant reference rainfall for rainwater drainage in gravity drainage systems $r_{(5,5)}$ is taken from KOSTRA/DWD 2000/[1] in accordance with the specific location.

Abbreviations are explained as follows:

Reference rainfall	Duration of the rainfall event	Annuality of the rainfall event	Application
$r_{(5,5)}$	5 minutes	Every 5 years	Rainfall discharge for gravity drainage systems
$r_{(5,100)}$	5 minutes	Every 100 years	Rainwater discharge for emergency drainage systems

Calculating the rainwater drainpipes

- Downpipes

DIN 1986-100, Section 14.2.7.2 specifies that the nominal widths of the downpipes must not be smaller than the connected nominal width of the associated flat roof drain or the collective connecting line. The rainwater downpipes can be calculated with a level of fill up to f = 0.33. Downpipes with inclines ≥10° are ignored when calculating the drainage capacity.
In the case of inclined drainpipe sections with gradients of <10°, the dimensions of the rainwater downpipes must be calculated using the gradient of the inclined section and a level of fill of h/d1 = 0.7.

- Single and connective connecting lines

DIN 1986-100, Section 14.2.7.1 specifies that single connecting pipes must be dimensioned in the same way as collective connecting pipes. However, the nominal width of the pipes must not be smaller than the nominal width of the flat roof drain. In addition, collective connecting pipes must be dimensioned in the same way as connecting lines.

- Connecting lines and buried pipes

DIN 1986-100, Section 14.2.7.3 specifies that the minimum diameter of buried pipes must be DN 100. The dimensioning of buried pipes outside of buildings must take into account a minimum flow rate of v = 0.7 m/s and a maximum flow rate of v = 2.5 m/s. The minimum gradient must be 1:DN. The limit for the level of fill h/d1 is 0.7. Caution: collecting pipes and buried pipes within buildings must be dimensioned with a level of fill of h/d1 = 0.7 taking into consideration a minimum gradient of 0.5 cm/m.

[1] **KO**ordinierte **ST**arkniederschlags-**R**egionalsierungs-**A**uswertungen des Deutschen Wetterdienstes, Bezug: CD-Rom über ITWH, Hannover. Im Anhang A von DIN 1986-100 befindet sich ein Auszug mit Regenspenden für wichtige deutsche Städte.

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Gravity Drainage

Calculation example
Flat roof drain for gravity drainage system

A gravity rainwater drainage system for a flat roof is planned for a large warehouse in Rosenheim/Germany. The roof will have an effective area of 1300 m² and is designed as an air-insulated roof with a gravel cover. Six buried pipeline connections are available to drain the roof.

The dimensioning figures for the rainwater drainage are selected in accordance with the parameters.

These are:

- Effective roof area (A) = 1.300 m²
- Flow coefficient (C) for gravel covered roof = 0.5 in Table 9 pursuant to DIN 1986-100
- Reference rainfall $r_{(5,5)}$ for Rosenheim pursuant to KOSTRA-DWD = 452 l/(s)* ha

These figures are input into the following formula to calculate the rainwater flow capacity:

Reference rainfall $r_{(5,5)}$	x	flow coefficient C	x	effective roof area A	/	10.000	=	rainwater flow capacity Q
452	x	0.5	x	1.300	/	10.000	=	29.38 l/s

Preliminary considerations for selecting the flat roof drains

Because the downpipes can be connected directly to the flat roof drains, vertical downpipes will be used. Gravel baskets are required to optimally drain the rainwater from the gravel roof. Drain bodies only require one compression-sealing flange because the roof is air-insulated with only one sealing membrane. These considerations and calculations lead to the selection of the ACO Spin flat roof drain DN 100 made of stainless steel with a stainless steel gravel basket. According to the specifications table (see page 15) the flat roof drain has an outflow capacity of 5.6 l/s.

The number of flat roof drains required is calculated from the rainwater outflow divided by the outflow capacity of the flat roof drain:

Rainwater flow capacity Q	/	outflow capacity of the selected flat roof drain	=	number of flat roof drains required
29.38	/	5.6	=	5.246 drains

Discussion of the results

The calculated figure of 5.246 is rounded upwards. 6 flat roof drains are required for the proper drainage of the roof. Consideration also has to be given to the outflow capacity of the drainpipes (see Fig. 26 from DIN 1986-100 or Table 8 from DIN EN 12056-3).

The DN 100 downpipes can be assigned a degree of fill of f = 0.33 according to this table. This corresponds to an outflow capacity per pipe of 10.7 l/s.

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Gravity Drainage

Calculation example

Emergency drainage for a gravity drainage system

A gravity rainwater drainage system for a flat roof is planned for a large warehouse in Rosenheim/Germany. The roof will have an effective area of 1300 m^2 and is designed as an air-insulated roof with a gravel cover.
The dimensioning figures for the rainwater drainage are selected in accordance with the parameters. These are:

- Effective roof area (A) = 1.300 m^2
- Flow coefficient (C) for gravel covered roof = 0.5 in Table 9 pursuant to DIN 1986-100
- Reference rainfall for 100-year rain $r_{(5,100)}$ für Rosenheim pursuant to KOSTRA-DWD = 853 l/(s*ha)

This value is incorporated in the following formula to calculate the rainwater flow capacity.

$$(853 - 452 \times 0.5) \times \frac{1.300}{1.0000} = 81.51\ l/s$$

The Spin DN 100 Attika roof drain made of stainless steel (Article No. 0174.78.24) is selected for the emergency drainage in this example. The outflow capacity of this drain is 6.0 l/s according to DIN.

The number of flat roof drains required is calculated by dividing the rainwater flow capacity for the emergency drainage Q_{Emer} by the outflow capacity of the selected parapet roof drain:

Rainwater flow capacity for emergency drainage	/	Outflow capacity of a selected flat roof drain	=	Number of flat roof drains required
81.51	/	6.0	=	13.58 drains

Explanation of the results

The calculated figure of 13.58 is rounded upwards. This means that 14 emergency drains are required to properly drain the roof area. To ensure that the volumes of water which have to be drained during an emergency are transferred to the designated area, each parapet drain is drained by a separate pipe.

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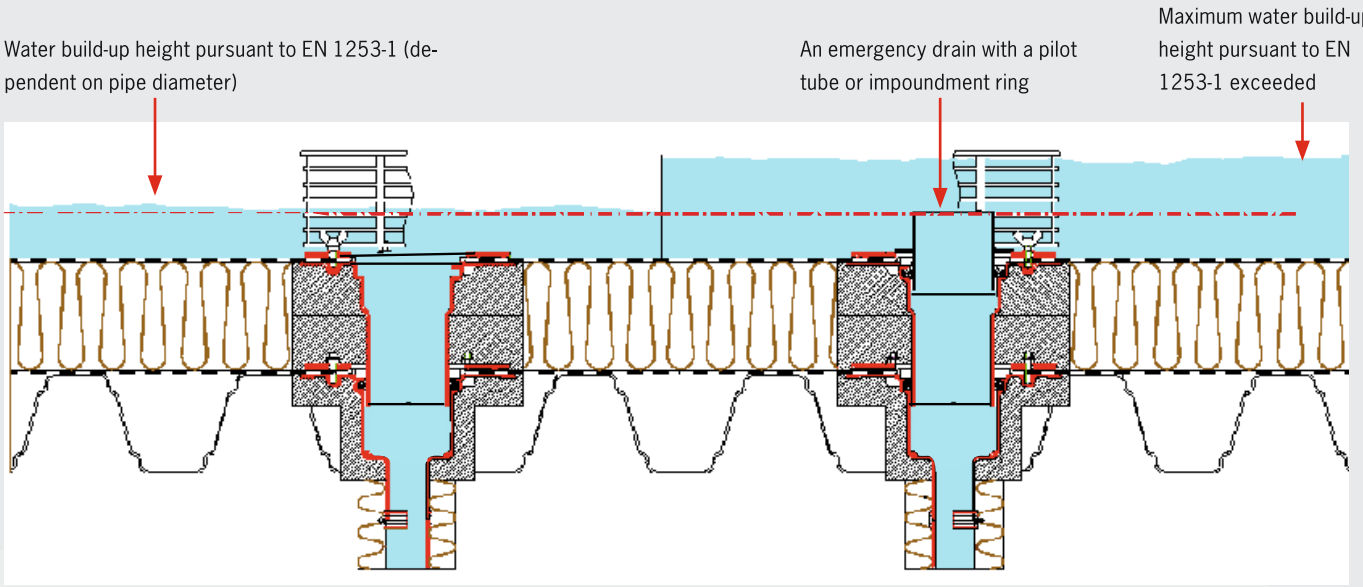
Gravity Drainage

Emergency drainage

The water build-up heights required for flat roof drains for gravity drainage and the associated emergency drains are specified in EN 1253-1, Table 10. The water build-up heights for nominal widths of DN 70 – DN 150 are as follows:

Nominal width	Maximum water build-up height
DN 70	35 mm
DN 100	35 mm
DN 125	45 mm
DN 150	45 mm

Water build-up height example
The maximum water build-up height for a DN 150 flat roof drain is 45 mm.
The emergency drainage system is ctivated when this height of 45 mm is exceeded. The maximum water build-up height at the emergency drain is again 45 mm pursuant to Table 10 in EN 1253-1. This means that the maximum water build-up height for the emergency drain is reached when the water level rises to 90 mm.



The reference rainfall for the emergency drainage Q_{Not} is calculated using the following formula:

$$(r_{(5,100)} - r_{(5,5)} \times C) \times \frac{A}{10.000} = Q_{Not}$$

Caution: note that the reference rainfall $r_{(5,5)}$ first has to be multiplied by the flow coefficient C before deducting the result from the reference rainfall for the one hundred year rainfall event $r_{(5,100)}$.

The emergency drainage system on its own should be capable of draining the 100-year rainfall if a building requires an unusual degree of protection (cf. EN 12056-3: 2001-01, Table 2).

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Gravity Drainage

Cast iron with fire protection insert

DN 100			Ball grating	Flat grating	Top frame with grating	Top frame with grating	Top frame with grating
Nominal width	Inclination	Model	Article No. 7000.10.00	Article No. 7000.20.00	Article No. 7000.40.00	Article No. 7000.28.00	Article No. 7000.41.00 7000.42.00
DN 100	90°	without upper part	7.4 l/s	7.3 l/s	8.9 l/s	6.8 l/s	11.8 l/s
DN 100	90°	with upper part	7.4 l/s	7.0 l/s	8.5 l/s	6.5 l/s	11.8 l/s

Stainless Steel

DN 70			Plastic gravel basket	Stainless steel gravel basket
Nominal width	Inclination	Model	Article No. 0174.46.66	Article No. 0174.46.59 0174.46.62
DN 70	1.5°	without lower part	2.6 l/s	2.7 l/s
DN 70	1.5°	with lower part	2.8 l/s	3.0 l/s
DN 70	90°	without lower part	2.5 l/s	2.6 l/s
DN 70	90°	with lower part	2.7 l/s	2.8 l/s

DN 100			Plastic gravel basket	Stainless steel gravel basket
Nominal width	Inclination	Model	Article No. 0174.46.66	Article No. 0174.46.59 0174.46.62
DN 100	1.5°	without lower part	5.0 l/s	5.9 l/s
DN 100	1.5°	with lower part	4.7 l/s	5.3 l/s
DN 100	90°	without lower part	4.7 l/s	5.6 l/s
DN 100	90°	with lower part	5.1 l/s	5.7 l/s

DN 125			Plastic gravel basket	Stainless steel gravel basket
Nominal width	Inclination	Model	Article No. 0174.46.66	Article No. 0174.46.59 0174.46.62
DN 125	1.5°	without lower part	8.3 l/s	9.9 l/s
DN 125	1.5°	with lower part	8.7 l/s	8.9 l/s
DN 125	90°	without lower part	8.5 l/s	8.4 l/s
DN 125	90°	with lower part	8.5 l/s	8.4 l/s

Stainless steel with fire protection insert

DN 100			Stainless steel gravel basket
Nominal width	Inclination	Model	Article No. 0174.46.59 0174.46.62
DN 100	90°	without lower part	4.7 l/s
DN 100	90°	with lower part	4.7 l/s

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Gravity Drainage

Outflow capacity

ACO Spin flat roof drains

The outflow capacities of the flat roof drains are dependent on the nominal width of the drain body, the type of grating used, the inclination of the pipes, and whether an upper part with a compression sealing flange is placed on top of the drain body. Make sure that the pipes used are properly dimensioned.

Cast Iron

DN 70			Ball grating	Flat grating	Top section	Cast iron top section
Nominal width	Inclination	Model	Article No. 7000.09.00	Article No. 7000.19.00	Article No. 5141.81.00 5141.87.00 5141.89.00	Article No. 5141.83.00
DN 70	1.5°	without upper part	6.0 l/s	5.4 l/s	5.2 l/s	4.8 l/s
DN 70	1.5°	with upper part	5.5 l/s	4.4 l/s	4.2 l/s	3.8 l/s
DN 70	90°	without upper part	7.0 l/s	6.7 l/s	6.2 l/s	5.8 l/s
DN 70	90°	with upper part	6.5 l/s	5.7 l/s	5.2 l/s	4.8 l/s

DN 100			Ball grating	Flat grating	Top section	Cast iron top section	Top frame with grating
Nominal width	Inclination	Model	Article No. 7000.10.00	Article No. 7000.20.00	Article No. 7000.40.00	Article No. 7000.28.00	Article No. 7000.41.00 7000.42.00
DN 100	1.5°	without upper part	9.0 l/s	8.4 l/s	10.7 l/s	7.6 l/s	12.1 l/s
DN 100	1.5°	with upper part	9.0 l/s	8.4 l/s	10.7 l/s	7.6 l/s	12.1 l/s
DN 100	90°	without upper part	8.0 l/s	6.2 l/s	10.7 l/s	7.6 l/s	15.2 l/s
DN 100	90°	with upper part	8.0 l/s	6.2 l/s	10.7 l/s	7.6 l/s	15.2 l/s

DN 125			Ball grating	Flat grating	Top section	Cast iron top section	Top frame with grating
Nominal width	Inclination	Model	Article No. 7000.10.00	Article No. 7000.20.00	Article No. 7000.40.00	Article No. 7000.28.00	Article No. 7000.41.00 7000.42.00
DN 125	1.5°	without upper part	12.0 l/s	10.2 l/s	12.6 l/s	7.6 l/s	16.4 l/s
DN 125	1.5°	with upper part	12.0 l/s	10.2 l/s	12.6 l/s	7.6 l/s	16.4 l/s
DN 125	90°	without upper part	12.0 l/s	10.2 l/s	12.6 l/s	7.6 l/s	16.4 l/s
DN 125	90°	with upper part	12.0 l/s	10.0 l/s	12.6 l/s	7.6 l/s	16.4 l/s

DN 150			Ball grating	Flat grating	Top section	Cast iron top section	Top frame with grating
Nominal width	Inclination	Model	Article No. 7000.10.00	Article No. 7000.20.00	Article No. 7000.40.00	Article No. 7000.28.00	Article No. 7000.41.00 7000.42.00
DN 150	1.5°	without upper part	14.5 l/s	12.6 l/s	15.0 l/s	7.6 l/s	21.2 l/s
DN 150	1.5°	with upper part	14.5 l/s	12.6 l/s	15.0 l/s	7.6 l/s	21.2 l/s
DN 150	90°	without upper part	13.5 l/s	11.0 l/s	15.0 l/s	7.6 l/s	18.5 l/s
DN 150	90°	with upper part	13.5 l/s	11.0 l/s	15.0 l/s	7.6 l/s	18.5 l/s

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Gravity Drainage

Regulations and standards
Regulations and standards must be observed when planning and executing roof drainage systems. The following lists a number of extracts from the most important regulations:

Roof greening regulations version 2008/DIN 1986-100

Roof drains in planted surfaces
Flat roof drains within planted surfaces have to be fitted with a control shaft to protect the drains from dirt and penetrating roots. This control shaft should not hinder drainage in any way. The drains can be protected by gravel or paved surrounds (Roof greening regulations, Chapter 6.5.3.1).

DIN 1986-100 (Chapter 5.8.3) also specifies in the same way as the Roof greening regulations that drains must be protected from the encroachment of plants. For instance, this standard recommends that the drains are surrounded by an at least 50 cm wide gravel protection zone.

Roof drains away from greened surfaces
Flat roof drains which do not lie within greened surfaces are usually installed in a gravel strip and are equipped with a gravel basket to prevent gravel from entering the drain (Roof greening regulations, Chapter 6.5.3.2).

Emergency drainage
Caution: Ensure that the layered structure of the green roof does not block the inflows to the emergency drains. Emergency drains must also be planned to ensure that they are kept free of encroaching vegetation.

In addition, the emergency drainage systems for greened flat roofs must comply with the same principles as for conventional flat roofs. It is therefore essential that the emergency drainage system is not connected to the normal drainage system: it must be connected to a dedicated outflow from which the water can drain safely onto floodable land without causing any damage.

Extensive greening

Intensive greening

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Gravity Drainage

Heating
Flat roof drains can also be installed with auxiliary heating to prevent the drain from freezing. To reduce energy consumption to a minimum, it is recommended that the heated drains be controlled by an additional thermostat. Installation of an FI switch (30 mA) is recommended. When Spin two-piece cast iron flat roof drains are installed, the heating is always installed on the drain body (below the lower sealing level).

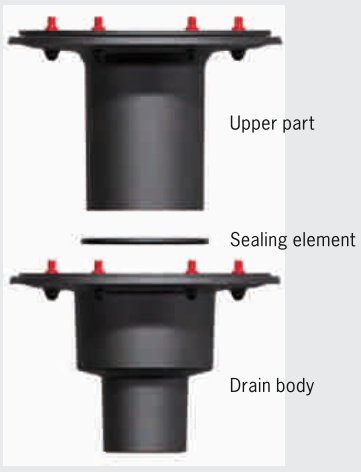
2-piece Spin flat roof drain with heating (Article No. 7000.85.00) and thermostat (not supplied)

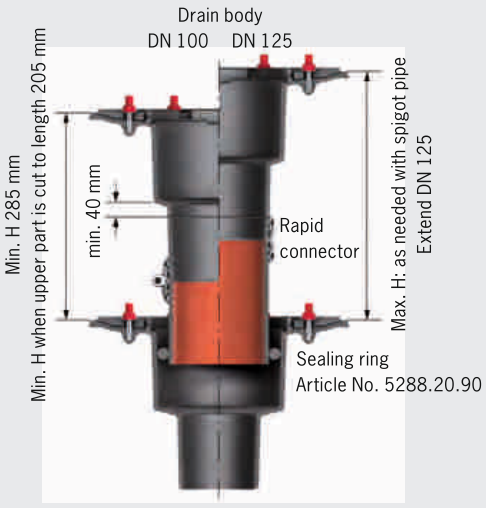
Installing the sealing membrane
Bitumen membranes as well as high polymer sealing membranes can be connected to the Spin cast iron flat roof drains by the compression sealing flange.
One spacer below and one spacer above the sealing membrane must be put into place when connecting thin high polymer sea-ling membranes to the compression sea-ling flange. These spacers ensure that any unevenness in the fixed and loose flanges on the drain are compensated for to ensure that a watertight seal is created when the flanges are tightened up. The spacers can also be made on site from spare material from the same sealing membrane.

After placing the loose flange on top, the nuts must be tightened up one after the other with a torque.

Using the extension element (= top section)
DIN 1986-100, Chapter 5.7.3.1 stipulates that in the case of two-piece flat roof drains, there must be a tight seal between the drain body and the top section. This ensures that the thermal insulation is not damaged by rainwater in the event that wastewater backflows up the pipe.

The upper parts for cast iron flat roof drains are always supplied as standard with a sealing ring. This is installed between the drain body and the upper part.





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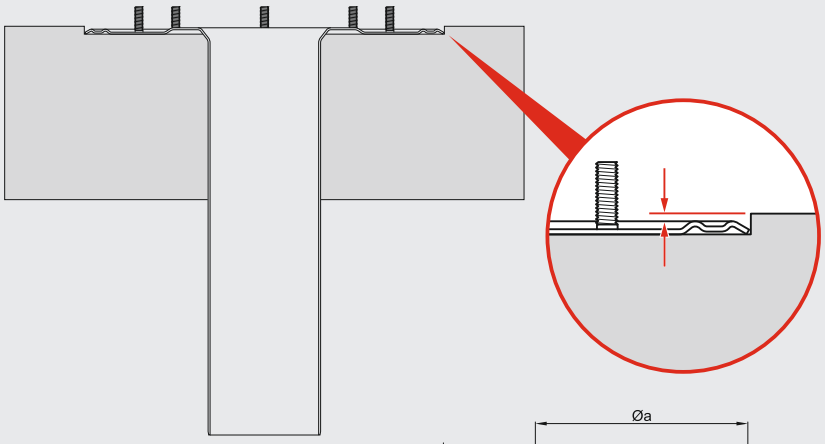
Gravity Drainage
Installation

ACO Spin flat roof drain made of stainless steel

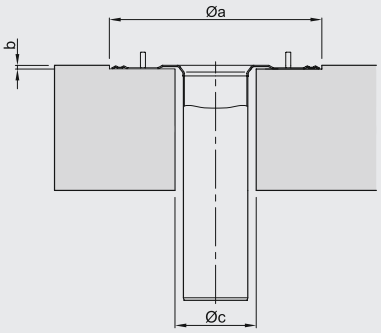
Concrete roof: Pouring in
Flat roof drains can be installed on site when the concrete is poured in. Caution: Ensure that the fixed flange is positioned slightly below the top surface of the concrete because a gradient towards the drain body must be created when the sealing membrane is installed.



Concrete roof: Core boreholes
Core boreholes with two different diameters and two different heights have to be cut to install the flat roof drains.

- Ø a x b: core borehole dimensions for the flange (flange support)
- Ø c: core borehole dimension for the drain body

The core hole for the flange support must be cut to enable the sealing membrane to be laid towards the drain body with a gradient as stipulated in DIN EN 18195.



Trapezoidal sheet metal roof
Stainless steel drains cannot be installed directly onto a trapezoidal sheet metal roof. A fastening plate is required.

The fastening plate and the trapezoidal sheet roofing must be connected pursuant to DIN 18807. The fastening plate must be connected to the trapezoidal sheet roof as follows:

- Two connecting elements on the transverse side in the top beam
- One connecting element next to every covered gutter

Caution: Every hole cut in the trapezoidal roof reduces its load-bearing capacity. Verification of the load-bearing capacity of the combined mounting plate and trapezoidal sheet roof can only be issued by a structural engineer.