Soil and waste for high-rise

1.2 Soil and waste systems for high-rise

Because skyscrapers are designed evermore extreme, a single stack soil and waste system offers you the possibility to aim higher.
Today, whether a consultant or installer, you need drainage solutions capable of responding to the commercial challenges faced by your clients

1.2.1 Advantages of the Akavent system

Akatherm soil and waste systems for high-rise offer the following advantages:

- Saving space that can be used for other installations or as usable space for the occupants of the building
- Higher flow capacity of the stack
- Less installed cost by a welded plastic (HDPE) pipe system with low weight
- Reduced hydraulic pressure
- Full peace of mind from a sophisticated risk management system

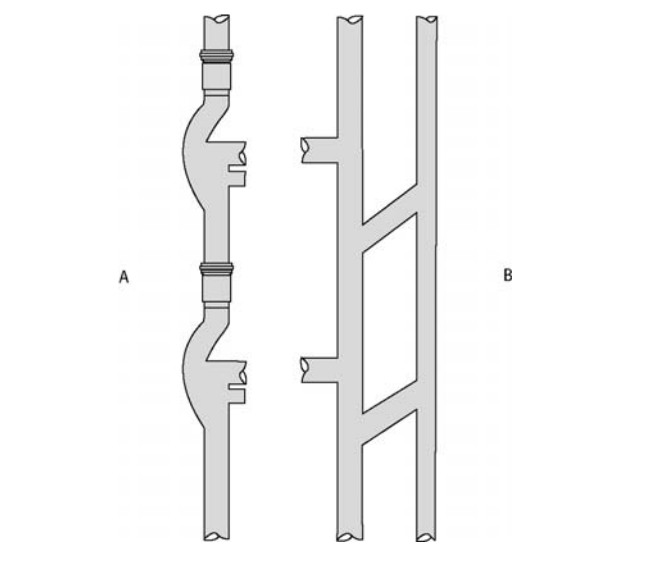


Illustration 1.6

Akatherm system with Akavent aerator (A)
- Single stack system
- No limits in height
- One diameter and limited number of fittings
- Multiple connections per floor*
- Low speed

Traditional stack with vent pipe (B)
- Two stacks
- Limited in height
- More dimensions and fittings
- One connection per floor
- High speed

* *The Akavent aerator has 3 connections d_1 = 110 mm and connections d_1 = 75 mm.*

Elements of the system

The Akatherm soil and waste system for high-rise consists of the following elements:

1. Akavent aerators on each floor with the 3 horizontal branches d_1 = 110 mm and 3 horizontal branches d_1 = 75 mm.
2. A stack made of standard Akatherm pipe and fittings sized by fixture unit load.
3. A de-aerator assembly at the bottom of the stack to make a transition to the general sewerage drain possible.
4. Relief vent where the stack is offset over a distance greater than 45°.

Akatherm soil and waste system for high-rise buildings have no height limitation, and sizing is determined solely on the number and type of fixtures connected.

1.2.2 The manner in which the Akavent branch functions

The high velocity in the down pipe of a tall building causes a 'hydraulic prop' to be created. Due to air resistance (larger at high velocities), the water closes off the entire diameter of the down pipe. This causes a substantial pressure difference in both a positive and a negative sense.
The pressure difference causes the evacuating force or pull in the siphon.
In an Akatherm waste water drainage system for high-rise buildings, velocity is limited by breaking the fall on each storey.
This enables greater air flow by pressing the waste water to the side of the pipe and, consequently, making room for an open connection in the middle of the pipe. The pressure difference remains far within +/- 30 mm WK (see illustration 1.7). The down pipe remains in a single line.

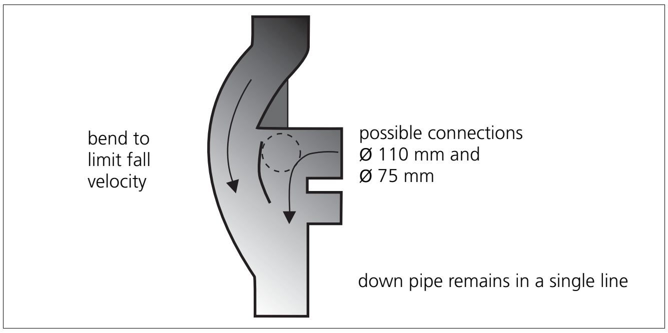


Illustration 1.7

With a standard connection on a down pipe, the incoming waste water flow from the storey and the flow in the down pipe affect or even block each other. In the Akatherm soil & waste system for high-rise, the waste water from the storey is channelled through a separate 'compartment' in the Akavent down pipe branch before flowing into the down pipe. The merging with the waste water from above-lying storeys occurs in a gradual manner. The continuously open connection to the down pipe keeps the pressure in balance and the pipe for the storey can extend over a greater length without any secondary pressure-relief vents. For the dimensions of the Akavent down pipe branch, see the 'Product range' chapter.

1.2.3 Connection to Akavent branch

The connection to the Akavent can best be performed using Akatherm snap sockets. This unique push-fit socket joint with additional snap ring has the following advantages:
- Firm tensile joint if a snap groove exists in the pipe to be connected.
- The pipe is centred in the seal, offsetting any extra load on this seal as a result of the weight of the pipe.
- Prevention of any soiling of the seal due to 'scraping' it over the pipe.

Illustration 1.8

A top joint can best be accomplished with an expansion socket in order to compensate for any expansion of the down pipe (see illustration 1.8).

A side joint is made using the standard snap socket (see illustration 1.9).

Illustration 1.9

1.2.4 Designing the Akavent system

An Akatherm soil & waste system for high-rise doesn't have any height restrictions: the dimensions are only determined by the number and types of drain fixtures that are connected to it. The Akavent system is preferably always equipped with one Akavent for each floor.

Follow the guidelines in this chapter in order to design the Akavent system for high-rise. Detailed calculations and examples of such designs can be found in paragraph 1.2.7.

The basic Akavent system for high-rise consists of the following elements:

- Akavent branch on every floor
- A down pipe with standard Akatherm pipes and fittings
- A vent pipe through the roof of the same diameter as the down pipe
- A vent pipe on the first floor

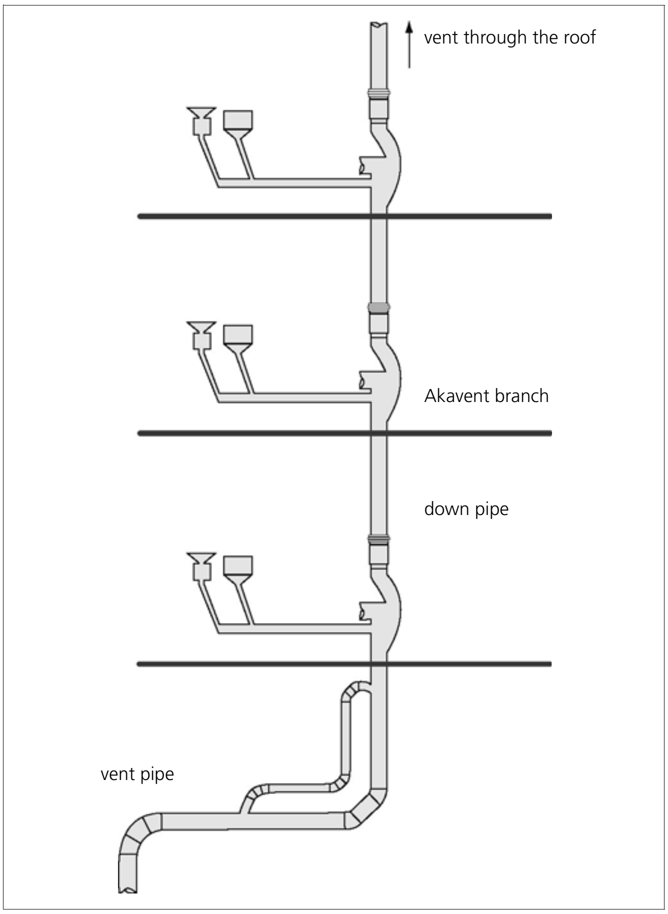


Illustration 1.10

Akavent branch in the down pipe

An Akavent down pipe branch fitting must be installed on each storey with a waste water connection. When the distance between two Akavent down pipe branches is larger than 6 m, a double offset must be placed in the down pipe (see illustration 1.11).

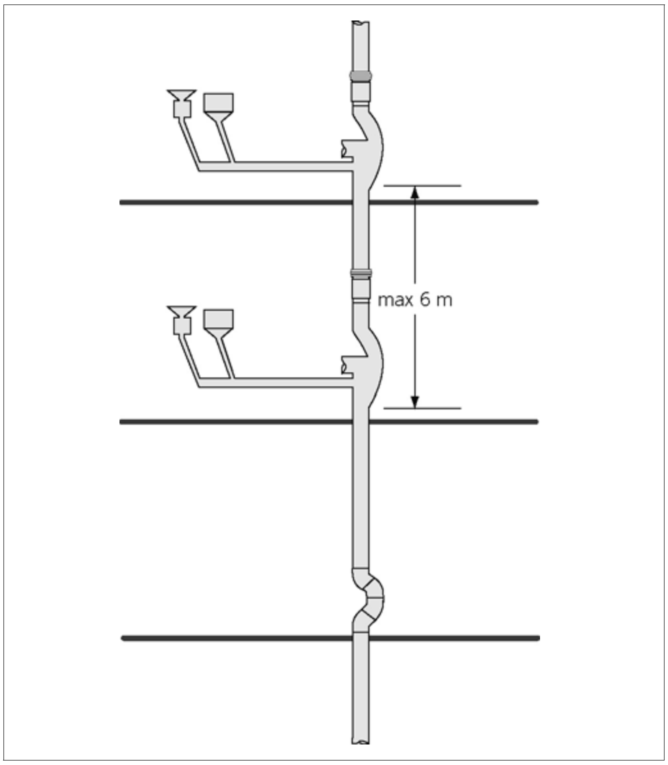


Illustration 1.11

Zone division for each Akavent down pipe

If the building design requires more than one down pipe or the maximum capacity of a single down pipe will be exceeded, the storeys must then be divided into zones, each draining into different Akavent down pipes.

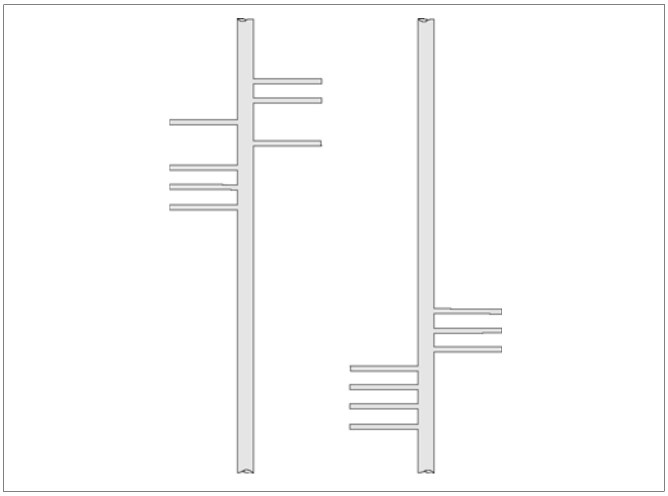
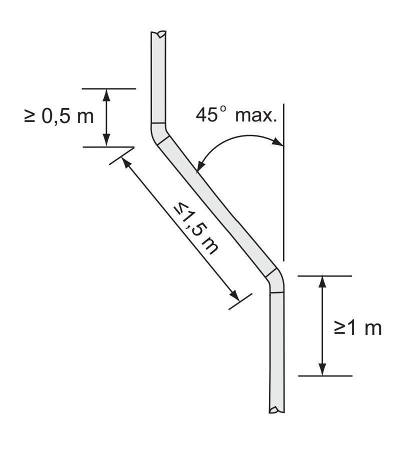


Illustration 1.12

Soil and waste for high-rise

Deflecting the Akavent down pipe



The axis of an Akavent down pipe can be deflected without use of an equalisation pipe if the transition is constructed as shown in illustration 1.13.

The angle of the offset must be 45° or less and the length of the offset pipe shorter than 1,5 m. No joint can be installed closer than 0,5 m above the offset and 1,0 beneath it.

Illustration 1.13

If the axis of the Akavent down pipe can't be deflected in accordance with the illustration 1.13, the offset must be equipped with an equalisation line, to be designed in accordance with illustration 1.14.

If collectors have to be connected at this point, these connections can be made on the equalisation pipe, which is also called a diverter. There are also joint-free zones on the diverter pipe as indicated in illustration 1.14. The equalisation or diverter pipe must have the same diameter as the down pipe.

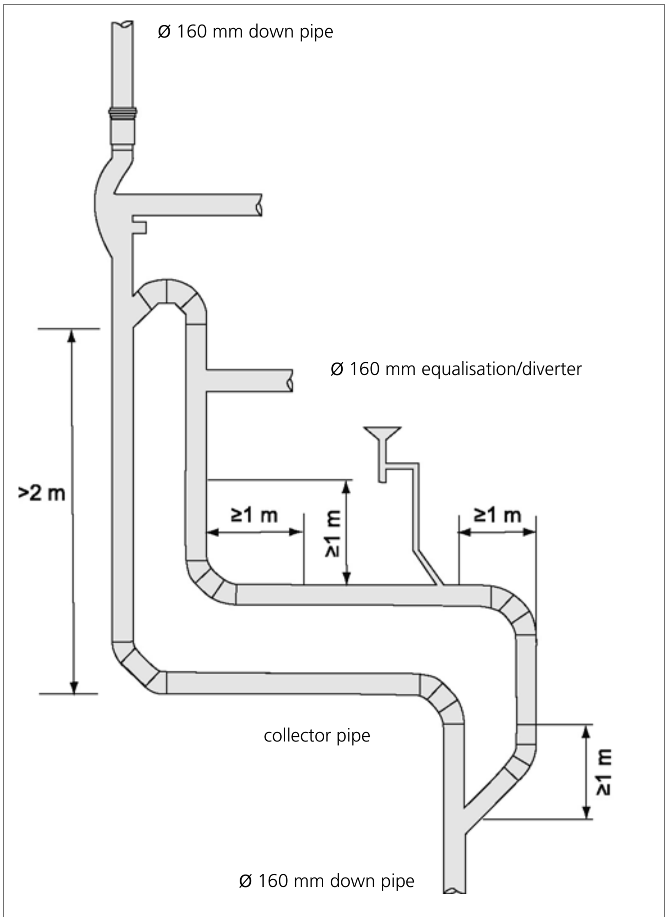


Illustration 1.14

Floor connectors

The maximum length for an unvented floor connector (or collector pipe) is 4 m at an incline of at least 1,0% (1:100) with no more than three 90° bends. The floor connector must be sized in accordance to national standards and guidelines.
Floor connectors that exceed these limits must have connections to the down pipe involving secondary pressure-relief pipes (vents). The joint of the relief pipe to the down pipe must be slanted downward at 45°, as shown in illustration 1.15.

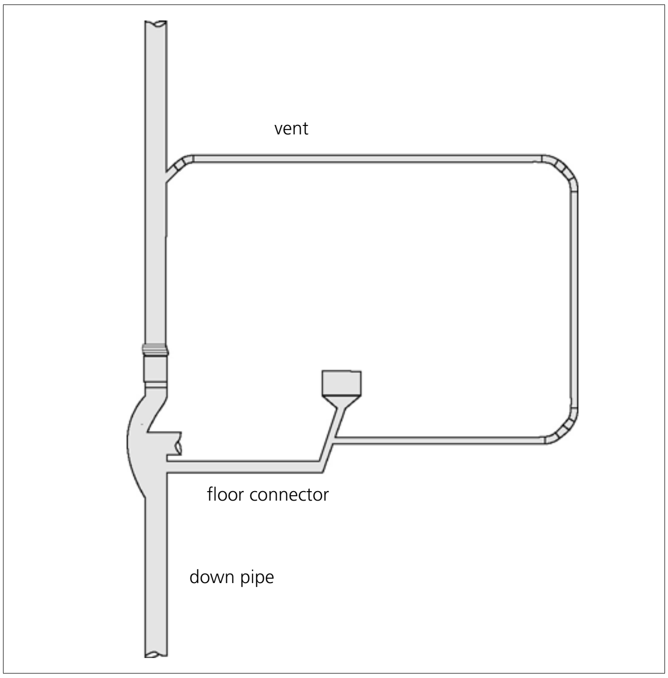


Illustration 1.15

Connectors are pipes that link a single drain fixture to the floor connector. According to EN 12056-2, the maximum length of an unvented connector is 3,5 m (without any specification of slope or number of 90° bends). If the 3,5 m is exceeded, the connector must be provided with secondary pressure relief as illustrated in illustration 1.15.

All toilets must be connected to the Akavent down pipe branch using a 110 mm pipe. Directly opposing connections on the Akavent are not permitted.

Details about maximum total and per-storey drainage flows that may be handled by an Akavent down pipe can be found in paragraph 1.2.7 'Akavent system calculation'.

End of the Akavent down pipe
At the bottom of the Akavent down pipe, there must be an equalisation line in order to release all the built-up pressure. Fixtures can be attached to the equalisation line outside the joint-free zones. This equalisation pipe must be designed in accordance with illustration 1.16.

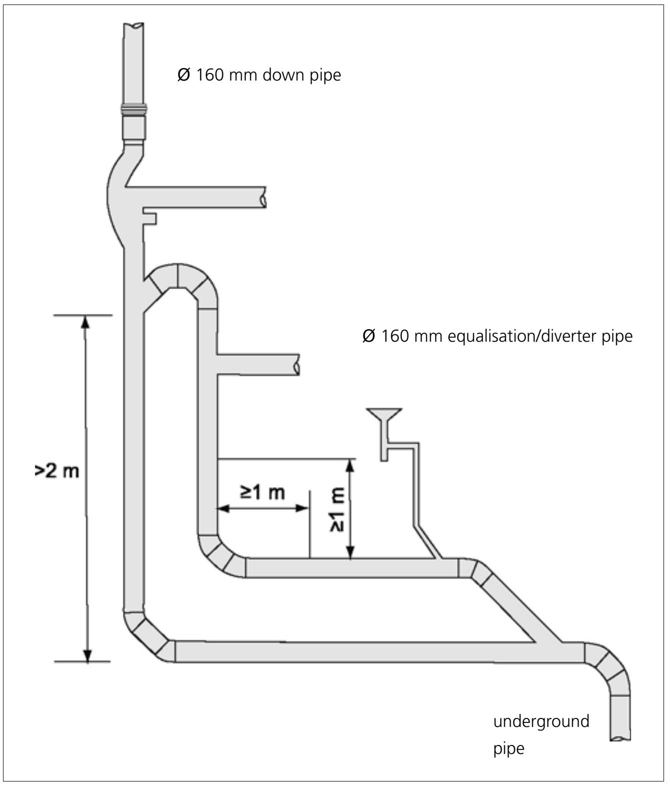


Illustration 1.16 End of the Akavent down pipe

Venting the Akavent down pipe
The diameter of the down pipe must remain the same without reduction until roof level is cleared. Exceptions to this rule involve the construction of multiple down pipes with a combined pressure-relief pipe. The pressure-relief pipes may be joined together beyond a point 1 m above the highest joint. For the Akavent system, this is only permitted if the internal surface area of the combined pressure-relief line is equal to or larger than the sum of the internal surface areas of the individual pressure-relief lines.
The maximum number of combined down pipes is 8 x 110 mm or 3 x 160 mm, as long as the combined pressure-relief pipe has a diameter as specified in table 1.3. Illustration 1.17 provides an example of 4 down pipes ø 110 mm with combined vent pipes.

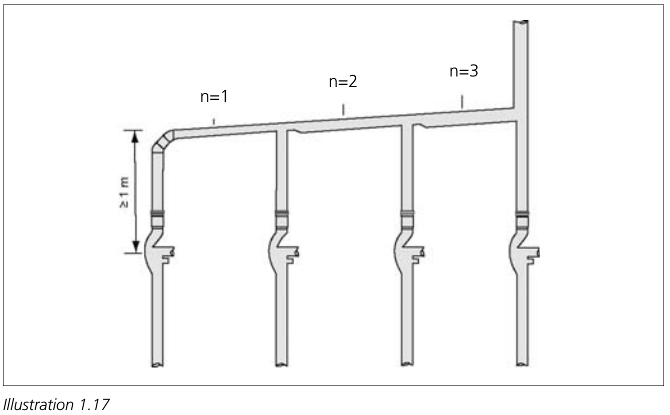


Illustration 1.17

	Minimum ø of combined pressure-relief pipe	
Down pipe (n)	**Akavent 110 mm**	**Akavent 160 mm**
1	110	160
2	160	250
3	200	315
4	250	
5	250	
6	315	
7	315	
8	315	

Table 1.3

The flow opening must be at least equal to the surface area of the connected pressure-relief pipe. The position of the opening for the roof duct on the roof must be designed in accordance with national standards and guidelines, so that moisture and waste material is not allowed to enter.

From down pipe to underground pipe
One or more down pipes may be connected to an underground pipe provided that the capacity of the underground pipe is great enough. The maximum capacity of an underground pipe is described in EN 12056-2, and depends on the diameter and incline. The total drainage flow is the simultaneous flow from all connected drain fixtures. The relevant calculation for an underground pipe will be performed in paragraph 1.2.7.

1.2.4 Fixing system
For fixing the Akatherm soil and waste system for high-rise to the building structure the standard guidelines for fixing apply. The Akavent aerator needs to be fixed to the building on the top and bottom with an anchor bracket.

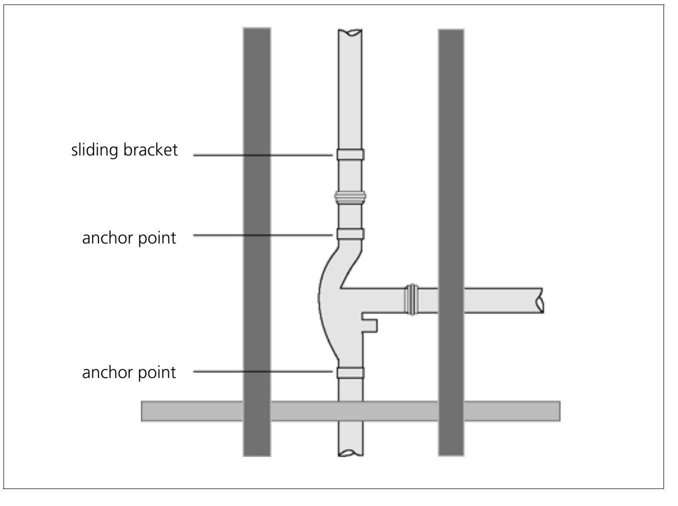


Illustration 1.18

1.2.5 Duct size
The minimal duct size that is needed for an Akavent system can be found in table 1.4. The branch possibilities 1 and 3 are not to be used simultaneously for connecting soil and waste systems (see illustration 1.19).

		Duct size		
		only branch 2	**branch 1 of 3**	**branch 2 and (3 or 1)**
110	**A**	300 mm	350 mm	350 mm
	B	400 mm	350 mm	400 mm
160	**A**	270 mm	320 mm	320 mm
	B	400 mm	350 mm	400 mm

Table 1.4

Soil and waste for high-rise

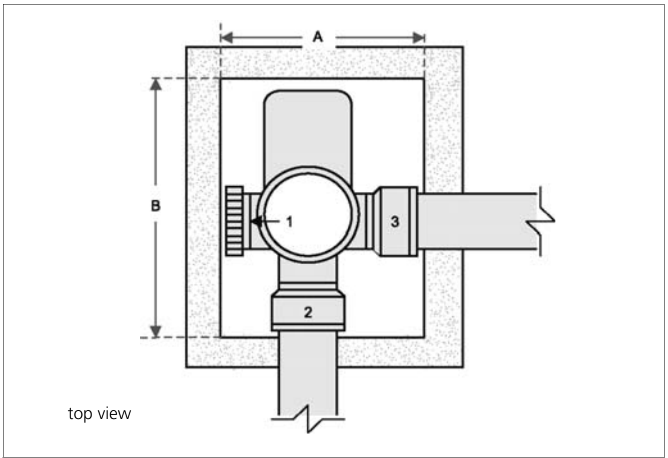


Illustration 1.19

1.2.7 Akavent system calculation

The basic calculation for an Akavent system involves determining the number of required down pipes and their diameter(s). For this purpose, the (composite) drainage flow for the collector pipes on the storeys must be compared to the maximum permissible capacity of the down pipe into which the Akavent is incorporated.

Basic drainage unit Q_i

The basic drainage unit (Q_i) of each drain fixture that can be connected to a collector pipe is expressed in l/s and one Q equals 1 l/s. Table 1.5 indicates a few devices with the basic drain values according to the standard.

Drain fixture	Q_i (l/s)
Sink, bidet	0,50
Washing machine, urinal	0,75
Bathtub, 70 mm floor drain	1,00
7 l toilet	2,00

Table 1.5 Q_i according to EN 12056

Simultaneity coefficient

Not every drain fixture will be used at the same time and, therefore, the simultaneity coefficient p exists to take this factor into account. This coefficient will differ for each type of building (see table 1.6).

Type of building	p
Residential and similar	0,50
Detention, health care and lodging	0,70
Office, education and retail	0,70
Other uses	0,70
Sport and meeting	1,00

Table 1.6 Simultaneity coefficient

The simultaneity coefficient is employed in equation 1.16 to combine the drainage from all drain fixtures into a comparable drainage flow.

$$Q_a = p * \sqrt{\sum_{i=1}^{n} Q_i}$$

Equation 1.16 Combined drainage equation (l/s)

Q_a = Combined simultaneous drainage (l/s)
p = Simultaneity coefficient as indicated in table 1.6 ($(l/s)^{0,5}$)
n = Number of drain fixtures (-)
Q_i = Basic drainage unit for drain fixture i as stated in table 1.5 (l/s)

In this equation, the element $\sum_{i=1}^{n} Q_i$ is the combined simultaneous drainage (every drain fixture being used simultaneously).

Akavent capacity

This combined simultaneous drainage (Q_a) must be handled by one or more Akavent down pipes. Every down pipe incorporating the Akavent has a maximum capacity based on diameter. Table 1.7 provides a summary of this.

Akavent type	110 mm	160 mm
Design diameter standard (DN)	100 mm	150 mm
Maximum simultaneous drainage for Akavent	7,6 l/s	19,6 l/s
Number of basic drainage units (Q_i)*	231 l/s	1537 l/s

Table 1.7 Akavent capacity

* *The last row in table 1.7 shows the permitted number of basic drainage units for the down pipe. The number is calculated by re-writing equation 1.16 and by inserting the maximum capacity of the Akavent from table 1.7 as Q_a.*

A residential building (p = 0,5) with a single Akavent 110 mm down pipe can have drain fixtures with a total capacity of 231 l/s connected (see equation 1.17 for this calculation).

$$\sum_{i=1}^{n} Q_i = \left(\frac{Q_a}{p}\right)^2 = \left(\frac{7,6}{0,5}\right)^2$$

Equation 1.17 Re-written combined drainage equation (l/s)

This amounts to 462 bathroom sinks, for example (basic drainage unit Q_i = 0,5 l/s) or 231 bathtubs (basic drainage unit Q_i = 1,0 l/s).

Conditions affecting Akavent capacity

Table 1.8 describes conditions concerning the maximum drainage flow of the collectors that may be connected to an Akavent down pipe in detail.

Max. capacities of one Akavent down pipe (l/s)	110 mm			160 mm		
	(l/s)	Q_i	Toilets	(l/s)	Q_i	Toilets
Total drainage from all floors	7,6	231	-	19,6	1537	-
Toilet drainage from all floors	4,7	85	42	11,8	562	281
Total drainage from one floor	4,5	81	-	11,6	537	-
Toilet drainage from one floor	2,0	16	8	5,2	106	53

Table 1.8 Connection conditions

Sample calculation

Example of a residential building with 100 storeys and 4 flats on each storey. Each flat has drain fixtures with the following basic drainage units (Q_i).

Drain fixture	Q_i
Kitchen	1,0
Bathroom	2,5
Toilet (6 l)	2,0
Total per flat	5,5
Total per storey	22,0
Total for building	2,200

In this building, the $\sum Q_i$ is 2.200 l/s and the simultaneity coefficient 0,5. The total flow Q_a is therefore:

$$Q_a = 0,5 . \sqrt{2200} = 23,45 \text{ l/s.}$$

The maximum capacity for a 110 mm Akavent down pipe is 7,6 l/s. 4 x 110 mm Akavent down pipes are required or 2 x 160 mm Akavent down pipes having a maximum capacity of 19,6 l/s, if the conditions of the standard are to be met.

Logically, the choice will be made for 2 x 160 mm, as a result of which 100 x 2 = 200 toilets can be connected to each Akavent down pipe. The maximum number of toilets connected to a 160 mm Akavent down pipe is 281, and therefore the basic condition is satisfied.

Underground pipe calculations
Usually, several down pipes are incorporated in a high-rise building, and this combination connected to an underground pipe. The diameter of the underground pipe can be calculated in accordance with the following example.

Illustration 1.20 illustrates a situation in which the 2 down pipes in the above sample calculation are connected to a single underground pipe with a 2% incline (1:50).

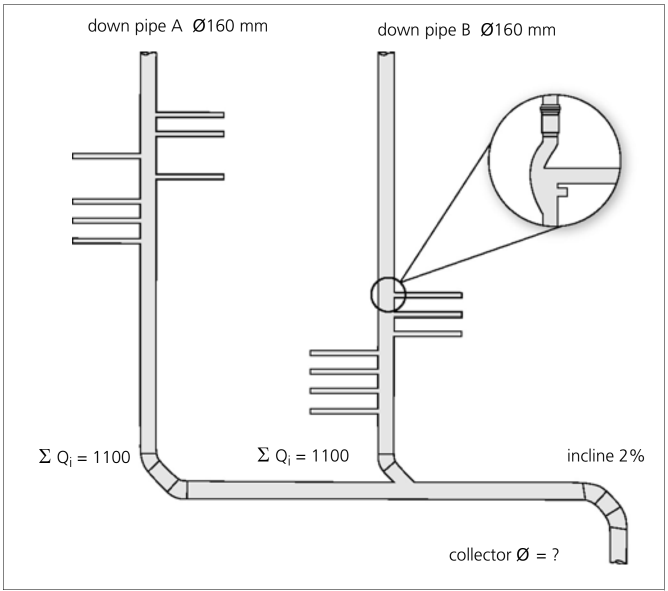


Illustration 1.20

The total capacity can be calculated by inserting the flow from all the drain fixtures into the simultaneity calculation.

$$Q_a = 0{,}5.\sqrt{2200} = 23{,}45 \text{ l/s}$$

The table below is a part of a table in EN 12056-2. It indicates the maximum flow per diameter and incline, based on 50% pipe filling.

Pipe Ø	1:100 1,0%	1:67 1,5%	1:50 2,0%	1:40 2,5%	1:33 3,0%	1:20 5,0%
110	2,50	3,10	3,50	4,00	4,40	5,60
125	4,10	5,00	5,70	6,40	7,10	9,10
160	7,70	9,4	10,9	12,2	13,3	17,2
200	14,2	17,4	20,1	22,5	24,7	31,9
250	26,9	32,9	**38,1**	42,6	46,7	60,3
315	48,3	59,2	68,4	76,6	83,9	108,4

Table 1.9

The 23,45 l/s can be found in the 2% column between 20,1 and 38,1. Take the highest value of these and the pipe diameter associated with it. In this case, the underground pipe must have a diameter of 250 mm.