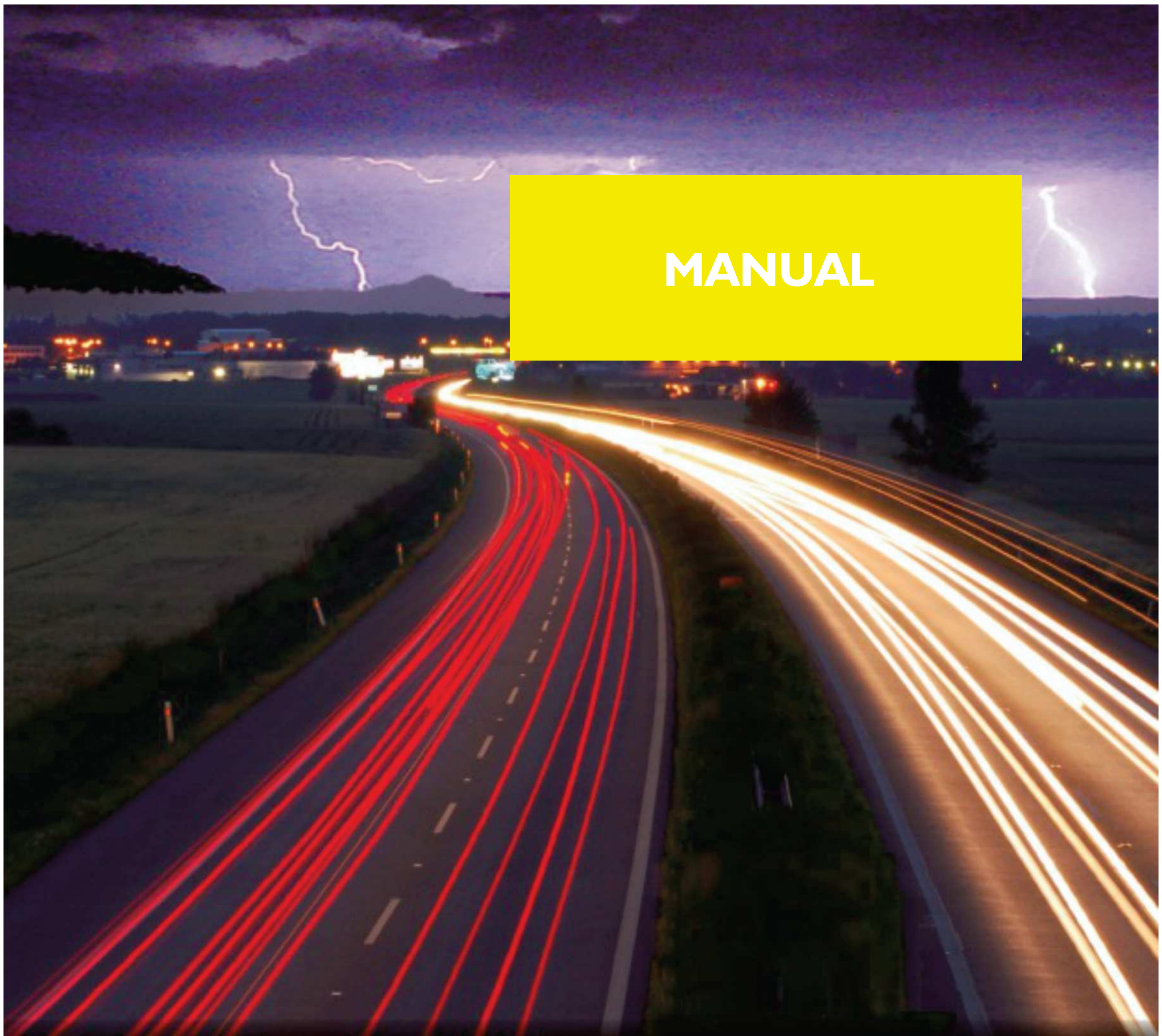
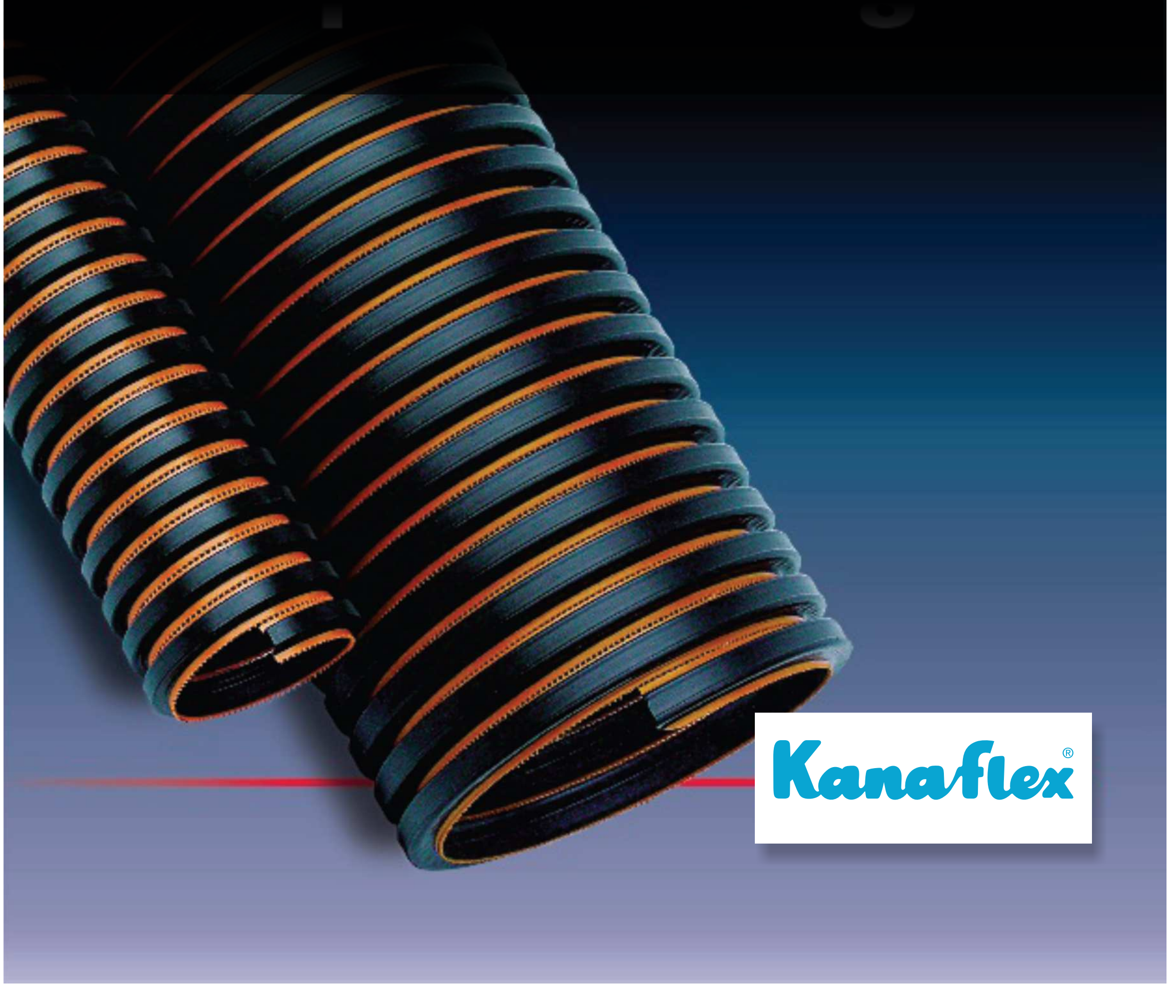
KanaNET



MANUAL

Drain pipe made of HDPE (High Density Polyethylene)



Kanaflex®

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1. INTRODUCTION

The Kananet is a corrugated, circular section drain pipe made of HDPE (High Density Polyethylene), with an excellent radius of curvature, for collecting and flowing excess liquid that has infiltrated in the soil aimed at protecting engineering works, providing better conditions for using an area with an elevated water table or marsh, and for avoiding contact (access) with undesirable liquids in protected areas.
In its most encompassing definition, drainage is the removal of liquid from one site to another using gravity.

It has the following characteristics:
- High resistance to chemical products;
- High resistance to diametrical compression;
- High resistance to impact;
- Easy curvature due to great flexibility;
- Simple handling due to greater lightness;
- Greater savings in installation.

MAIN CHARACTERISTICS OF KANANET DRAIN PIPES					
Kananet drain pipe	DN 65	DN 80	DN 100	DN 170	DN 230
Radius of curvature (mm)	350.0	400.0	420.0	800.0	1000.0
Resistance to compression, minimum (Kgf)	20.0	40.0	45.0	30.0	60.0
Resistance to impact (J)	15.0	15.0	15.0	30.0	30.0
Open perforated area (cm^2/m)	80.0	110.0	130.0	190.0	240.0
Influx flow ($cm^3/s.m$)	2730.0	3250.0	5490.0	11140.0	15850.0
Manning's roughness coefficient (n)	0.016	0.016	0.016	0.016	0.016

Table 1

It is supplied in diameters of DN 65, 80 and 100 in 6.0 (six) meter bars or 50.0 (fifty) meter rolls. In diameters of DN 170 and 230 mm, they are only supplied in 6.0 (six) meter bars.

2. ADVANTAGES

The main advantages in using Kananet drain pipes are shown below:

a) Due to their corrugated structure and narrow pitches, they have great flexibility;

b) Large open area per linear meter, the largest among pipes available in the domestic market, they are responsible for the fast and uniform capturing of infiltrated water with great influx flow capacity (Table II).

Nominal ∅ (mm)	Open perforated area (cm2/m)	Number of holes/meter
65	80	2787
80	110	3833
100	130	4530
170	190	6620
230	240	8362

Table II

c) The mass water flow capacity in the drain pipes is directly proportional to inner wall roughness.
Kananet drain pipes have a Manning roughness coefficient, n, equal to 0.016.

d) Their corrugated shape grant them high resistance to diametrical compression and to impact.

They have excellent resistance to chemical products, enabling installation in the most diverse types of soil (Table III).

RESISTANCE TO CHEMICAL PRODUCTS					
PRODUCT	T (°C)		PRODUCT	T (°C)	
	20	60		20	60
LEAD ACETATE	E	E	SODIUM CHLORIDE	E	E
ACETONE 100%	E	E,D	ZINC CHLORIDE	E	E
GLACIAL ACETIC ACID	E	G,D,c,f	CHLORINE (GAS AND LIQUID)	F	N
HYDROBROMIC ACID	E	E	CHLOROBENZENE	G	F,D,d,c
CARBONIC ACID	E	E	CHLOROFORM	G	F,D,d,c
CARBOXYLIC ACID	E	E	DETERGENTS	E	E,c
HYDROCYANIC ACID	E	E	DICHLOROBENZENE	F	F
HYDROCHLORIC ACID	E	E,d	DIOCTYL PHTHALATE	E	G,c
CHLOROSULFONIC ACID	F	N	LIQUID SULFUR DIOXIDE	F	N
CHROMIC ACID 80%	E	F,D	SULFUR	E	E
HYDROFLUORIC ACID 1-75%	E	E	ESSENCE OF TURPENTINE	G	G
PHOSPHORIC ACID 30-90%	E	G,D	ALIPHATIC ESTERS	E	G
GLYCOLIC ACID 55-70%	E	E	ETHER	G	F
NITRIC ACID 50%	G,D	F,D,f	PETROLEUM ETHER	G,d,i	F,d
NITRIC ACID 95%	N,F,f	N,c	GASEOUS FLUORIDE 100%	N	N
PERCHLORIC ACID 70%	E	F,D	GASOLINE	E	G,c
SALICYLIC ACID	E	E	AMMONIA HYDROXIDE 30%	E	E
SULFOCHROMIC ACID	F	F,f	POTASSIUM HYDROXIDE CONC.	E	E,c
SULFURIC ACID 50%	E	E	SODIUM HYDROXIDE CONC.	E	E,c
SULFURIC ACID 98%	G,D	F,D,f	SAT. CALCIUM HYPOCHLORITE	E	E
SULFUROUS ACID	E	E	SODIUM HYPOCHLORITE 15%	E	E,D,d
TARTARIC ACID	E	E	ISOOCTANE	G	G
TRICHLOROACETIC ACID 50%	E	E	METHYL ETHYL KETONE	E	F
TRICHLOROACETIC ACID 100%	E	F	NAPHTHA	E	G
ACRYLONITRILE	E	E	SATURATED AMMONIA NITRATE	E	E
SEA WATER	E	E	SILVER NITRATE	E	E
BENZYL ALCOHOL	E	E	SODIUM NITRATE	E	E
BUTYL ALCOHOL	E	E	NITROBENZENE	F	N,c
ETHYL ALCOHOL 96%	E	E	EDIBLE OIL	E	E
METHYL ALCOHOL	E	E	DIESEL	E	G
AMMONIA	E,D,d	E,D,d	PHOSPHOROUS PENTOXIDE	E	E
ACETIC ANHYDROUS ALCOHOL	E	G,D	POTASSIUM PERMANGANATE	D,E	E
ANILINE	E	G	HYDROGEN PEROXIDE 30%	E	E,d
BENZENE	G,d	G,d,i	OIL	E	G
SODIUM BENZOATE	E	E	KEROSENE	G	G,c
POTASSIUM BICHROMATE 40%	E	E,D	NICKEL SALTS	E	E
SODIUM BORATE	E	E	METAL SULFATES	E	E
WHITENERS	E	G,c	SODIUM SULFATE	E	G
LIQUID BROMINE	F	N	CARBON TETRACHLORIDE	G,d,i	F,d,c
SODIUM CARBONATE	E	E	TRICHLOROETHYLENE	F,D	N,D
AMMONIA CHLORIDE	E	E	XYLENE (XYLOL)	G,d,i	F,d,c

CAPTION

D – Discoloration.
E – Exposure for 30 days, without loss of characteristics, able to tolerate contact for many years.
F – Some signs of attack after 7 days in contact with the product.
G - Slight absorption after 30 days of exposure, without compromising mechanical properties.
N - Not recommended. Detected signs of attack within minutes to hours, after beginning of exposure.
c – Shearing.
d – Deformation.
f – Fragilization.
i – Swelling.

INSTALLATION MODEL – KANALET SYSTEM

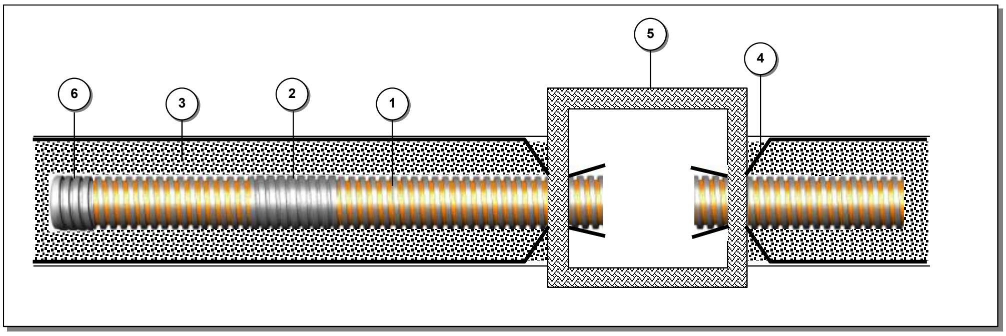


Figure 1

PRODUCT		PURPOSE
1	Kananet	Drain pipe for liquid collection and flow
2	Splice sleeve	Join Kananet drain pipes with the same nominal diameter
3	Wrapping	Draining means to facilitate the inflow of water in the pipe
4	Geotextile	Retain the fine and maintain soil stability
5	Junction/inspection box	Check mass flow
6	Cap	Avoid entrance of foreign elements in the pipe

Table IV

3. STANDARDS AND DEFINITIONS

3.1 Kananet Drain Pipe

Kananet is a corrugated drain pipe, with excellent radius of curvature, made of HDPE (High Density Polyethylene) for collecting and conducting drained water (Figure 2, Table V).

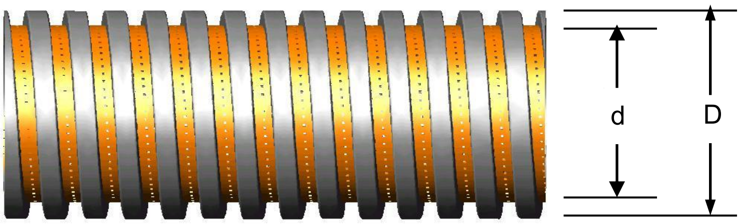


Figure 2

Standard measurements table		
. nominal (mm)	D (mm)	d (mm)
65	67.0	59.5
80	80.0	67.0
100	101.0	85.0
170	169.0	149.0
230	231.5	200.0

Table V

3.2 End Pipe

Non-perforated, corrugated pipe, with excellent radius of curvature, made of HDPE (High Density Polyethylene) used only for conducting drained water. It does not have the function of a drain pipe (Figure 3, Table VI).

Figure 3

Standard measurements table		
nominal ∅ (mm)	D (mm)	d (mm)
65	67.0	59.0
80	80.0	67.0
100	101.0	85.0
170	169.0	149.0
230	232.0	202.0

Table VI

3.3 Connection

Circular, threaded part made of HDPE (High Density Polyethylene) used to join Kananet drain pipes of the same nominal diameter (Figure 4, Table VII).

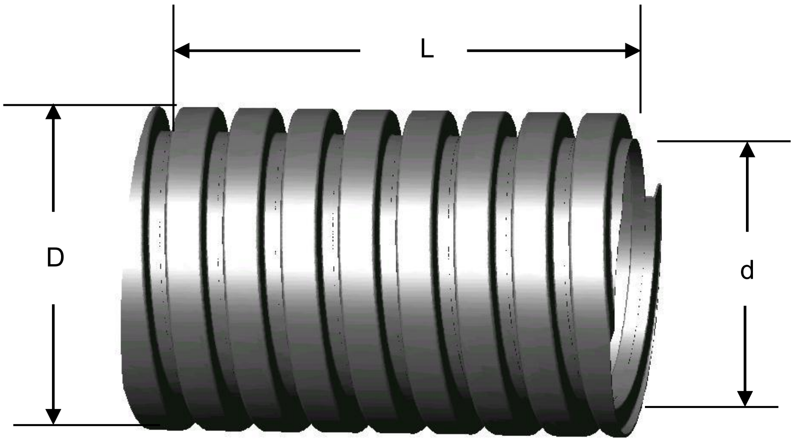


Figure 4

Standard measurements table			
nominal ∅ (mm)	D (mm)	d (mm)	L (mm)
65	71.0	65.0	min. 95.0
80	84.5	74.0	min. 130.0
100	106.0	92.0	min. 135.0
170	177.5	160.0	min. 145.0
230	241.0	210.0	min. 175.0

Table VII

3.4 Cap

Circular, threaded part made of HDPE (High Density Polyethylene) used to cap Kananet drain pipes thus avoiding the entrance of foreign elements in the pipe at the beginning or end of the line (Figure 5, Table VIII).

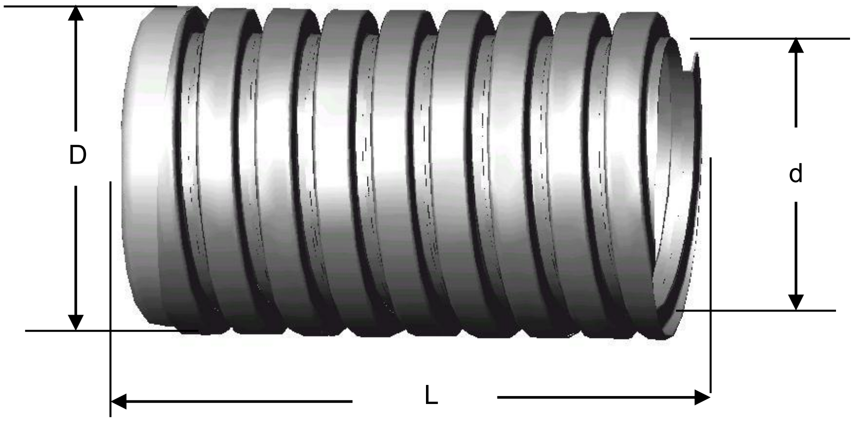


Figure 5

Standard measurements table			
nominal ∅ (mm)	D (mm)	d (mm)	L (mm)
65	71.0	64.4	min. 100.0
80	84.5	74.0	min. 135.0
100	106.0	92.0	min. 140.0
170	177.5	160.0	min. 160.0
230	241.0	210.0	min. 220.0

Table VIII

3.5 "T" Pipe Fitting

Part made of PVC (fitting) used to join Kananet drain pipes (Figure 6, Table IX).

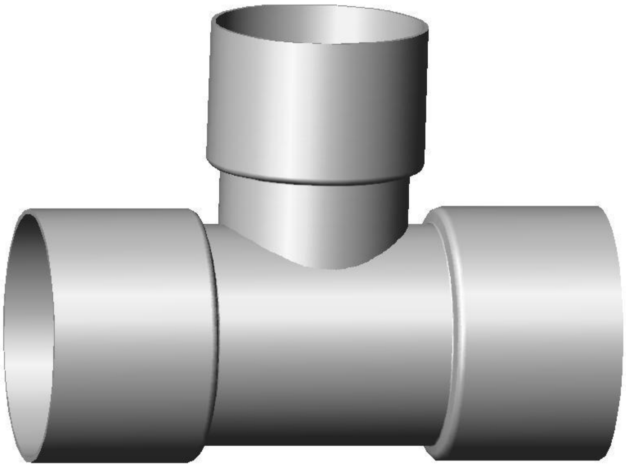


Figure 6

∅ nominal (mm)	d (mm)	d1 (mm)	L (mm)	L1 (mm)	L2 (mm)
65 x 65	68,2	68,2	mín. 60,0	mín.205,0	mín.70,0
80 x 100(KNS)	112,1	81,1	mín. 75,0	mín.250,0	mín.150,0
100 x 100	102,0	102,0	mín. 60,0	mín.250,0	mín.80,0
170 x 100	176,0	102,0	mín. 90,0	mín.380,0	mín.90,0
170 x 170	176,0	176,0	mín. 90,0	mín.380,0	mín.110,0
230 x 100	233,5	102,0	mín. 170,0	mín.520,0	mín.100,0
230 x 230	233,5	233,5	mín.170,0	mín.600,0	mín.190,0

Table IX

3.6 “Y” Pipe Connection

Part made of PVC (fitting) used to join Kananet drain pipes (Figure 7, Table X).

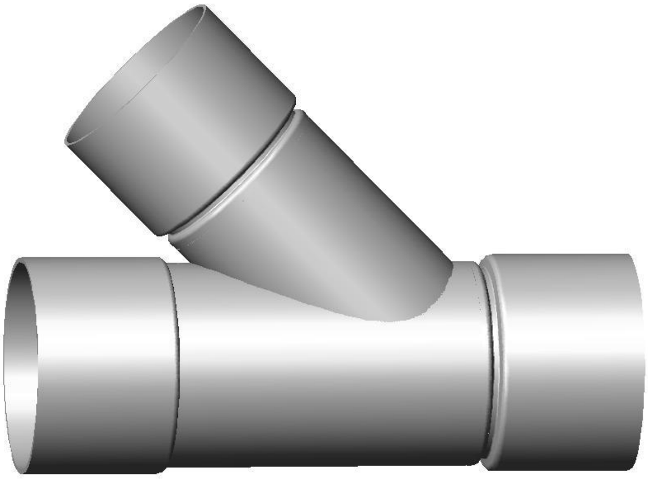


Figure 7

∅ nominal (mm)	d (mm)	d1 (mm)	L (mm)	L1 (mm)	L2 (mm)
65 x 65	68,2	68,2	mín. 60,0	mín. 225,0	mín 130,0
80 x 80	81,1	81,1	mín. 60,0	mín. 280,0	mín 145,0
100 x 100	102,0	102,0	mín. 60,0	mín. 290,0	mín. 170,0
170 x 100	176,0	102,0	mín. 60,0	mín. 400,0	mín. 200,0
170 x 170	176,0	176,0	mín. 90,0	mín. 450,0	mín. 250,0
230 x 170	230,0	170,0	mín. 90,0	mín. 650,0	mín. 360,0

Table X

3.7 Cross Fitting

White part made of PVC (fitting) used to join Kananet drain pipes (Figure 8, Table XI).

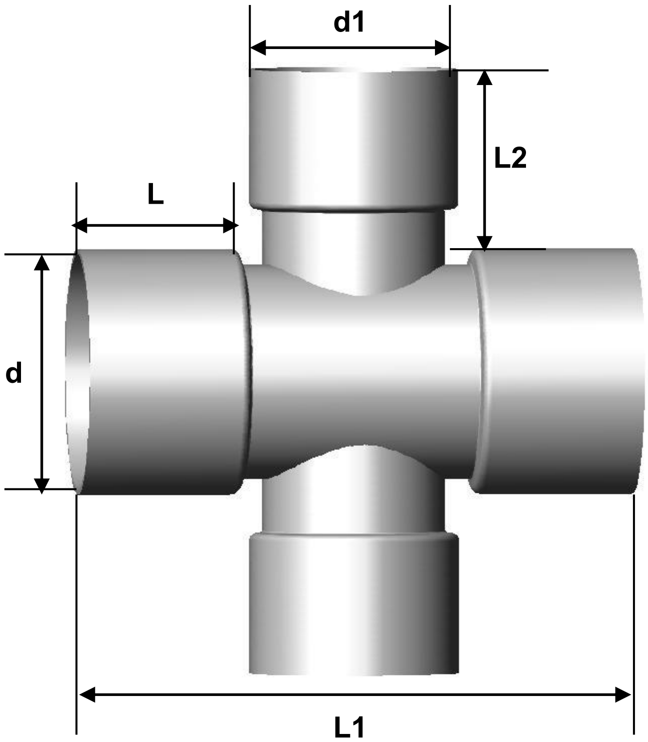


Figure 8

∅ nominal (mm)	d (mm)	d1 (mm)	L (mm)	L1 (mm)	L2 (mm)
65	68,2	68,2	mín. 42,0	mín. 175,0	- x -
100	102,0	102,0	mín. 60,0	mín. 240,0	- x -
170	176,0	176,0	mín. 90,0	mín. 380,0	- x -
170 x 100	176,0	102,0	mín. 90,0	mín. 330,0	mín. 80,0
230	233,5	233,5	mín. 170,0	mín. 590,0	- x -
230 x 100(KNS)	233,5	112,5	mín. 170,0	mín. 500,0	mín. 75,0

Table XI

3.8 Reduction

Threaded part made of HDPE used to join Kananet drain pipes (Figure 9, Table XII).

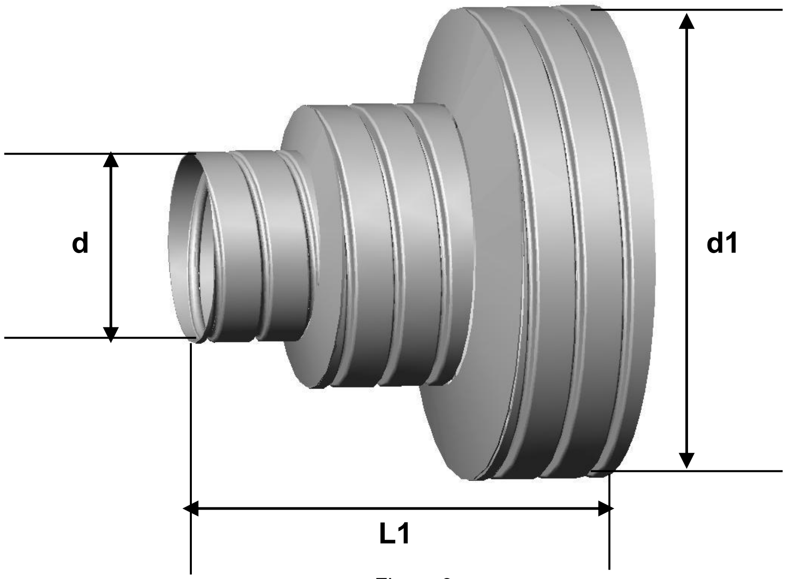


Figure 9

Standard measurements table			
nominal ∅ (mm)	d (mm)	d1 (mm)	L1 (mm)
230 x 170 x 100	92.0	212.0	min. 144.0
170 x 100 x 65	65.0	162.0	min. 127.0

Table XII

4. INSTALLATION OF THE KANANET DRAIN PIPE

4.1 Opening the ditch

The width of the ditch can be determined by the diameter of the Kananet drain pipe to be installed and the height of the backfill should be on average 0.20 meter. In cases where the load level is very high, it could vary from 0.50 meter.
Use of the backhoe or ditch witch is very advantageous, except when piping, rocks or other interferences impede their use.
Ditch depth should be uniform, obeying the declining slope stipulated in the project.
In order to begin Kananet drain pipe laying work, ensure they are sheltered from the sun, thus avoiding their softening and consequent crushing during handling and the backfill process.

4.2 Geotextile

The geotextile should be laid up against the bottom and sides of the ditch to avoid high stress and tension when filling the ditch with the draining material, thus avoiding risks of perforations and/or tears.
The geotextile may exercise one or more functions in the work.
The main functions are those that justify the existence of geotextile in the work, such as operating as a filter in a drainage ditch.
Complementary functions are those that geotextile should exercise to permit performance of the main functions, such as operating as a separator in a drainage ditch.

4.3 Wrapping

Also called a drainage means, this is any material wrapped around the drain pipe aimed at facilitating water flow from the soil into the pipe and thus avoiding any elevated hydraulic gradient at the soil x wrapping interface. Round pebbles, thick washed sand, gravel 1 or 2 are normally used.
The drainage material should be placed so it does not hamper the overlaying of the blanket to close the envelope and so it does not intercalate between the geotextile and the ditch wall.
Geotextile edges should be held back with overlays of at least 0.20 meter (in special cases up to 0.50 meter) and the upper part of the ditch should be quickly filled to avoid any entrance of solids in the case of rain.

4.4 Method of splicing Kananet drain pipes using a splice sleeve

Procedure:

a) Cut the ends of the drain pipes to be spliced without leaving any burrs (Figure 10).

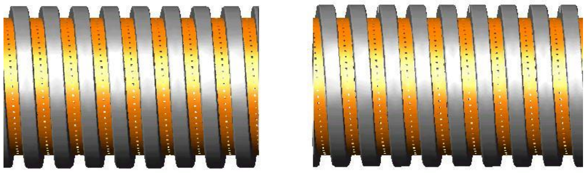


Figure 10

b) Totally screw on the splice sleeve on one of the drain pipes (Figure 11).

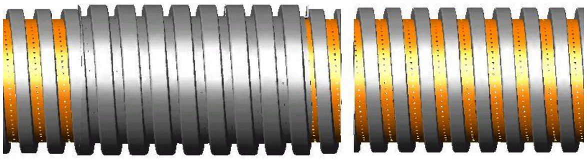


Figure 11

c) Position the top drain pipes and return the splice sleeve until it equally overlaps both (Figure 12).

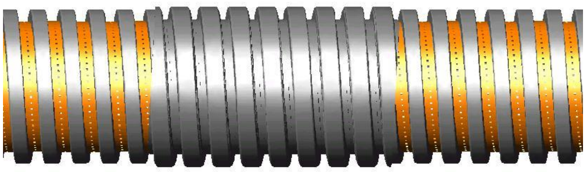


Figure 12

4.5 Ampliation suggestion

a) Material Needed:

- 1 (one) Reduction

b) Procedure

Cut the KN Reductions in accordance with the gauge to be used. The cutting points for the KN Reduction are indicated in Figure 13 below.

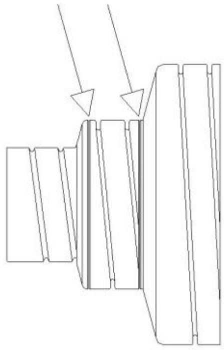


Figure 13 – Cutting points for the KN Reduction

After cutting, screw the Reduction onto the Kananet/Kanadrain Drain Pipe, more than two or three complete turns. This process is shown in Figures 14.

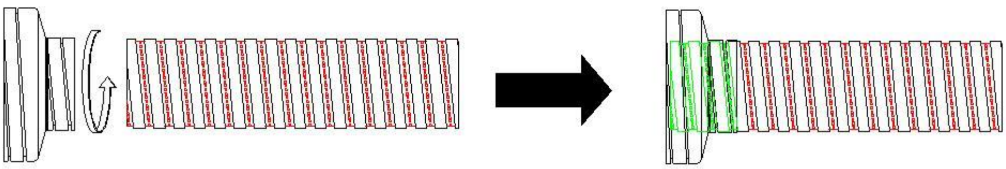
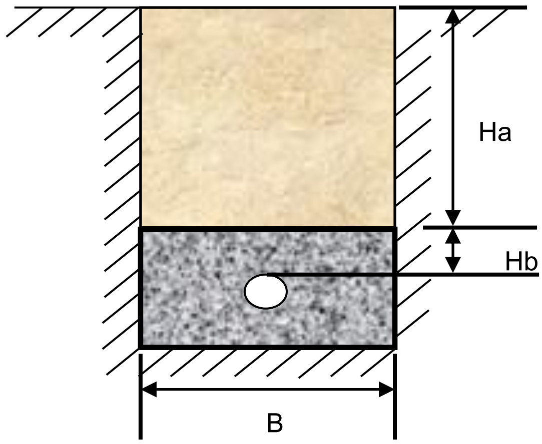


Figure 14 – Putting the Reduction on the pipe

4.6 Recovery of the Pavement

Material with good lateral support is projected for the backfill (for example: thick sand), especially when dealing with cases where the ground on top of the pipe is subject to vehicle traffic (Figure 15).



Ha = Backfill height
Hb = Gravel height
B = Ditch width

Figure 15

4.7 Method to repair Kananet drain pipes

Types of damage:

A) Light damage
- Crushing of spires and/or wear in outer wall

Repair: there is no need of repair since this will not compromise use.

B) Average or heavy damage
- Perforation or breaking of drain pipe

Repair: when there is greater damage (perforation or break), cut off the damaged section and replace it with another of the same length.
Screw on two splicing sleeves, one on each end of the replacement pipe; fit it from on top and return the sleeves until they overlay the pipe to be spliced equally (Figures 16 and 17).

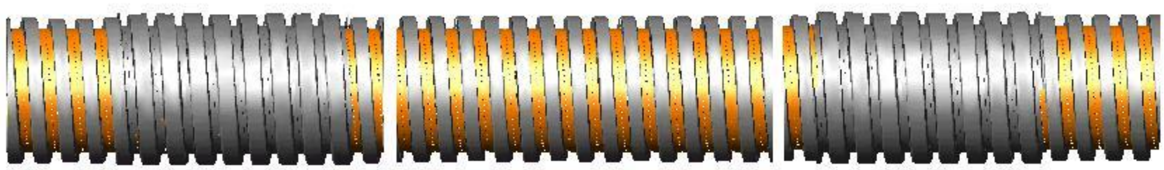


Figure 16

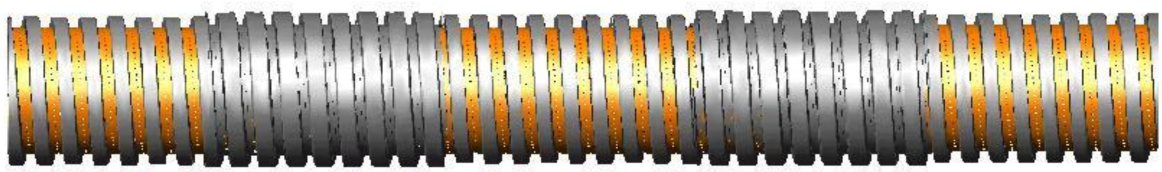


Figure 17

5. GENERAL PRECAUTIONS

a) Transport/Handling

During the transportation and handling of drain pipes, avoid impacts, attrition or contact with elements that may compromise their integrity, such as: metal or sharp objects with sharp edges, stones, etc.
Unloading should be done carefully and should not permit the laying of pipes directly into the soil to avoid crushing, breaking, perforations or the concentration of loads at a single point.

OCCUPATIONAL CAPACITY BY TRUCK						
NOMINAL Ø (mm)	SINGLE REAR-AXLE		GRAIN		MOVING	
	6 m	50 m	6 m	50 m	6 m	50 m
65	1200	70	2400	160	1200	100
80	800	60	1700	120	800	80
100	480	50	1000	100	480	80
170	150	- x -	300	- x -	170	- x -
230	90	- x -	250	- x -	120	- x -

Table XIII

TRUCK DIMENSIONS			
Type	Length (m)	Width (m)	Height (m)
SINGLE REAR-AXLE	6.0	2.4	2.8
GRAIN	12.0	2.4	2.8
MOVING	10.0	2.4	2.8

Table XIV

6. STORAGE

Storage of Kananet drain pipes should be in places where there are no elements that could damage the material, such as: rigid surfaces with sharp edges, cutting or pointed objects, stones, etc.
The bars of drain pipes should be arranged horizontally where the first layer should be placed over 0.10 meter wide, continuous wood boards, spaced no more than 0.20 meter from each other, and placed in the transversal direction of the tubes. Vertical braces should be positioned using a spacing of one meter between each other for side support of pipe layers.
When dealing with bars, store at a maximum height of 2.00 meters to facilitate placement and removal of the pipes on the last layer. When dealing with rolls, store at maximum layers of 6 (six) pieces. They should not be exposed to the open air for a period of more than 12 (twelve) months.
If there is any need to remain longer than the above stipulated period, we recommend covering the pipes with canvas or keeping them in shelters for more effective protection.

7. APPLICATIONS

There are countless applications for Kananet drain pipes in Engineering.
We will describe only the most common, pointing out the main benefits proper underground drainage can provide.

Airports

Whether the landing and take-off runways are made of flexible or rigid pavement, rainwater can infiltrate through the cracks, fissures or dilation joints.
A sub-surface drainage of the pavement to capture this water will certainly prevent dynamic overloads and their deterioration (Figure 18).

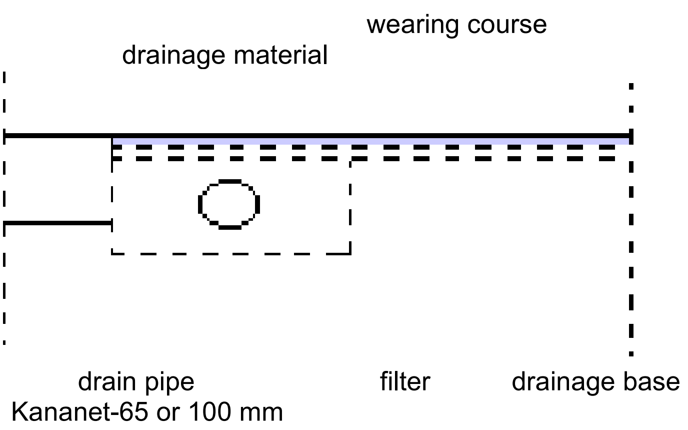


Figure 18 - Schematic cut of the airport pavement drain: for narrow runways, just two parallel drains on the edges of the pavement are sufficient; on wide runways, use one or more fishbones.

Green areas

In gardens, flower beds, seedbeds, etc., efficient drainage will avoid prolonged soaking of the soil and the killing of grass/flowers. If the green area is built on a slab, drainage will also prevent overloading structures and hydraulic efforts in waterproofing (Figure 19).

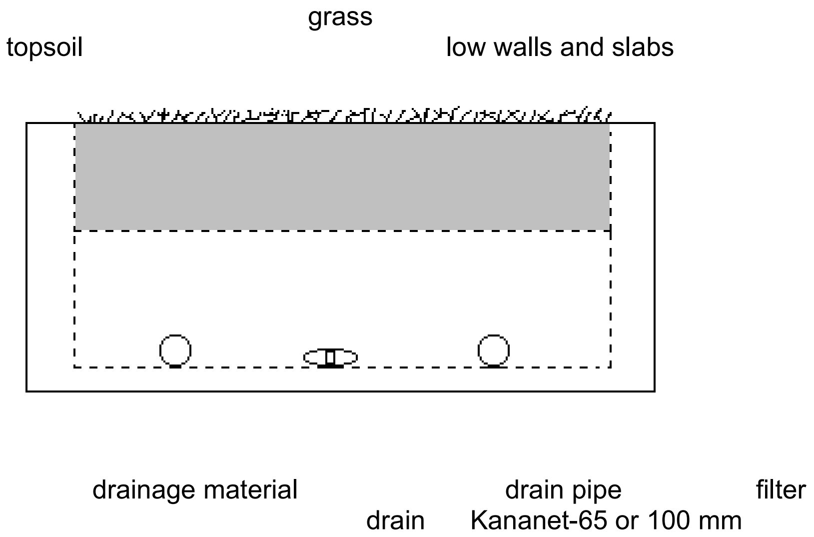


Figure 19 – Schematic section of draining mattress over the slab, placement of Kananet drain pipes permits faster capturing of water, reduction in height needed for the drainage mattress and more spacing between drains.

Landfills

In the construction of landfills on compressible soils, we recommend the construction of drains between the landfill and the soil.
Depending on the geographic location, thalweg drains, drainage mattresses and fishbones are common.
Besides that, the thalweg drain communicates between both sides of the landfill thus avoiding the damming of water.
The basic components of the leachate drainage system are: drainage layer, collection ducts and filtering layer.
Other important components are the monitoring wells, cleaning boxes, tanks, monitoring equipment and pumps.
The basic components of the drainage system for final coverage of the landfill are the drainage layers, filtering and drainage pipe system. The function of this system is to collect and drain surface water on the top of the coverage to prevent its entrance and infiltration in the garbage, generating more percolates.

A sanitary landfill should:

a) Be waterproofed at its base with a geomembrane to prevent contamination by garbage residue in the soil, subsoil and water table adjacent to the soil. This geomembrane should be made of materials that are resistant to residues generated by garbage during the useful life of the sanitary landfill.
   There should be a deep drain under this geomembrane so that at a given moment the clean water table water does not get in contact with the leachate or cause sub-pressure under the waterproofing blanket.

b) Have a leachate collection and removal system in the landfill cells, immediately above the geomembrane, with the pipe covered with gravel 4, creating a trench. At sanitary landfills we should use a filter of woven geotextiles avoiding the use of non-woven blankets. The project and operation condition does not permit leachate volume to exceed 0.30 meter over the waterproofed base of the landfill.

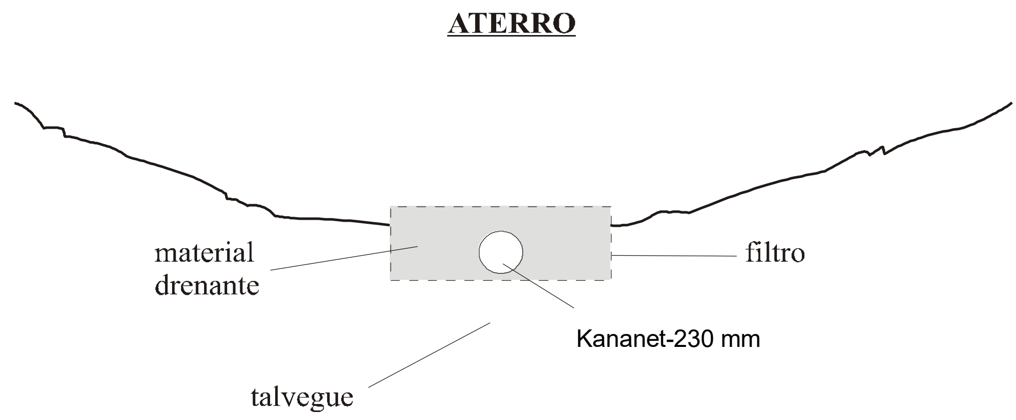


Figure 20 – Longitudinal cut of a landfill equipped with a thalweg drain, transversal to its axis.

Dams and dikes

Various internal drainage devices for dams and dikes are of vital importance to the work. Chimney drains, draining mats, drains at the foot of embankments, relief wells, etc., are systems that avoid the development of internal erosion and/or instability in works from the development of sub pressures (Figure 21).

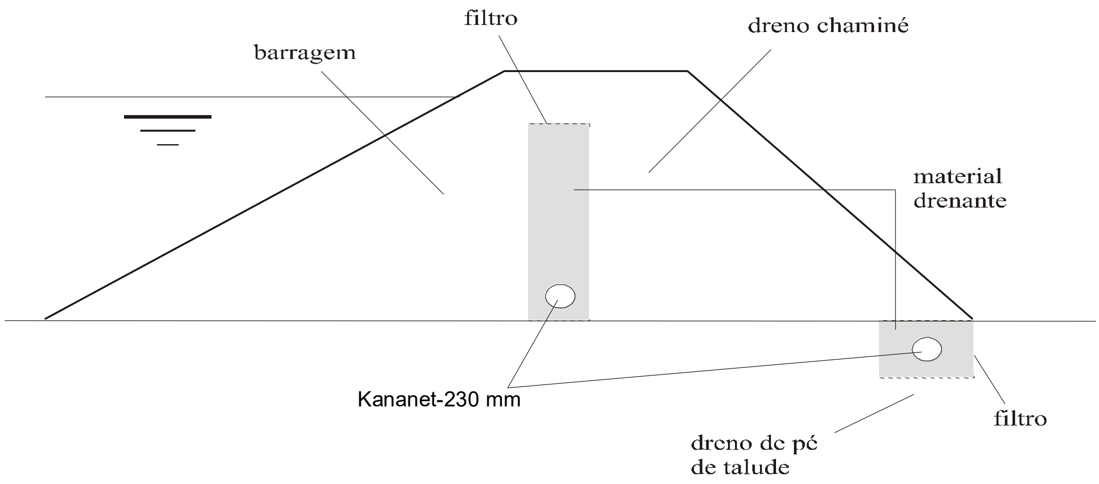


Figure 21 – Cross section of the earth dam equipped with a chimney drain to intercept water infiltrated by the upstream embankment and the drain at the foot of the embankment to intercept the flow from the foundations.

Sports areas

The main problem for sports fields is when they are soaked by intense rainfall that hampers or impeded their use for hours or even days. In these cases, draining mattresses and/or fishbones are used in soccer and society soccer fields, golf courses, tennis courts, multisport courts, fields suspended on slabs, etc.
It is also possible to include the permanent drainage of constructions located in high water table zones where installations are constructed at underground levels, such as garages, etc.

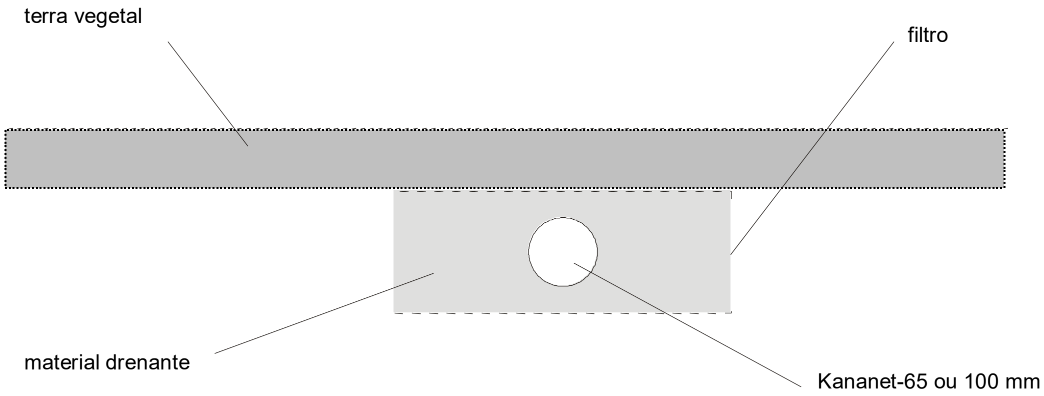
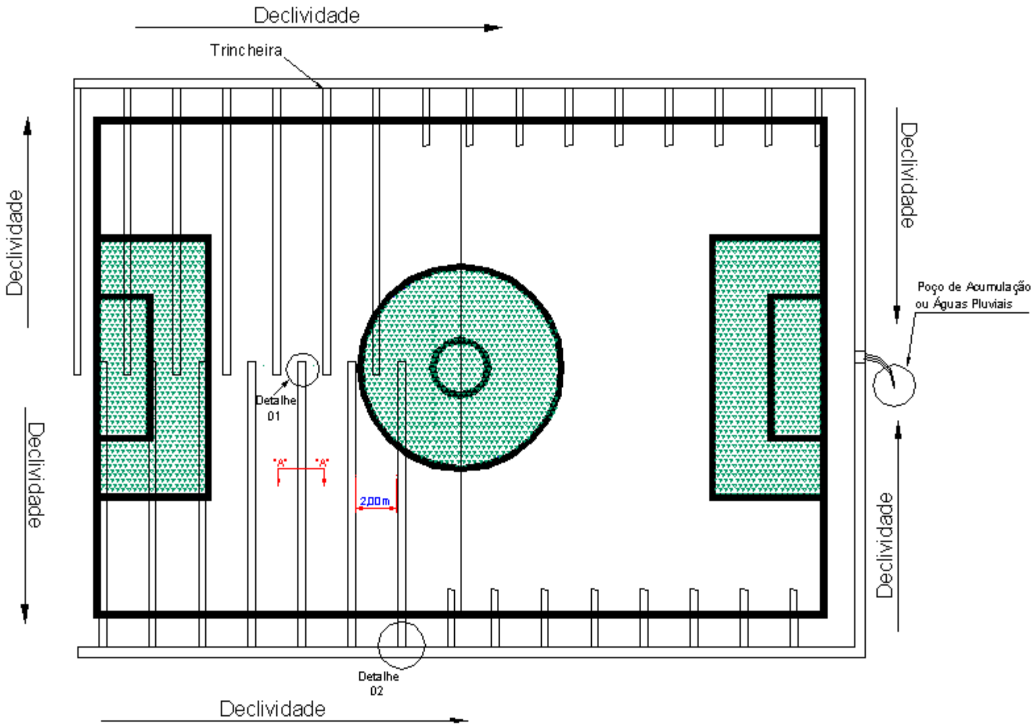


Figure 22 – Cross section of a sub-surface drain that is part of a fishbone in a soccer field. Observe the great width (the water penetrates on top) and the reduced depth.

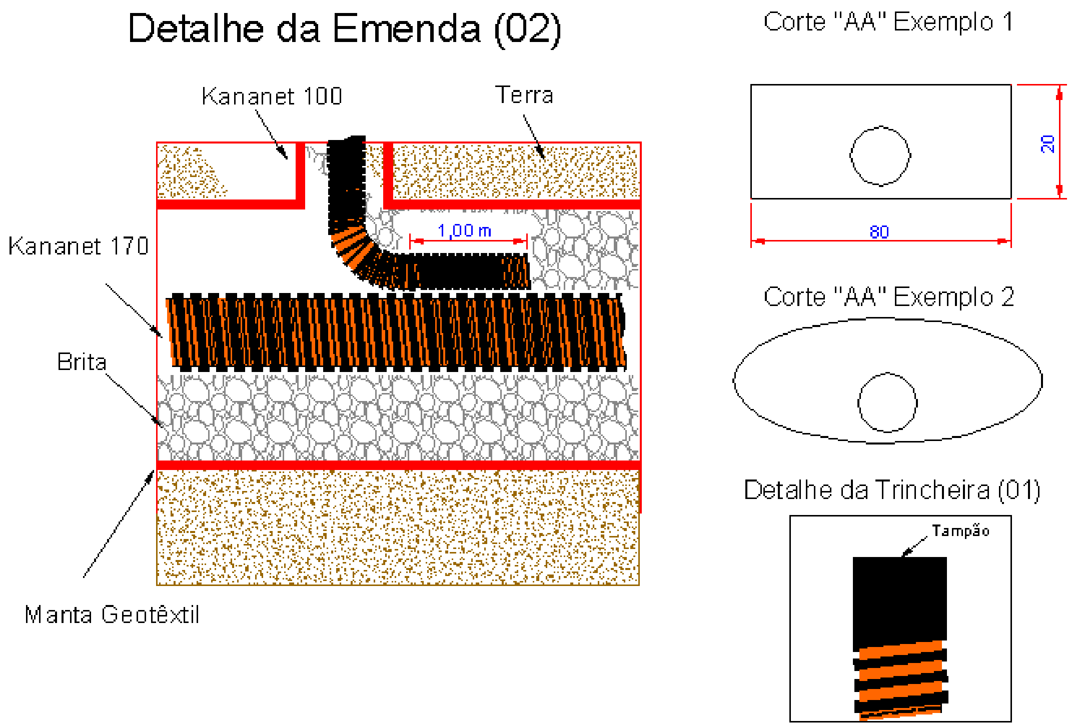


Declividade = Declivity
Trincheira = Trench
Detalhe = Detail
Accumulation Well or Rainwater

Figure 23 – Example of the parallel drainage system in the soccer field.

In order to avoid the use of fittings and the higher cost of the drainage line, we can use the system shown below (Details of Figure 24).

The “fishbone pipe” must have at least one segment, 1.0 meter in length, parallel to the main pipe, so there are no losses when the water is passing between them.



Detail of Splice (2) Cut “AA” Example 1
Kananet Earth Kananet 170 Gravel Geotextile Blanket
Cut “AA” Example 2 Detail of Trench (1) Cap

Details of figure 24

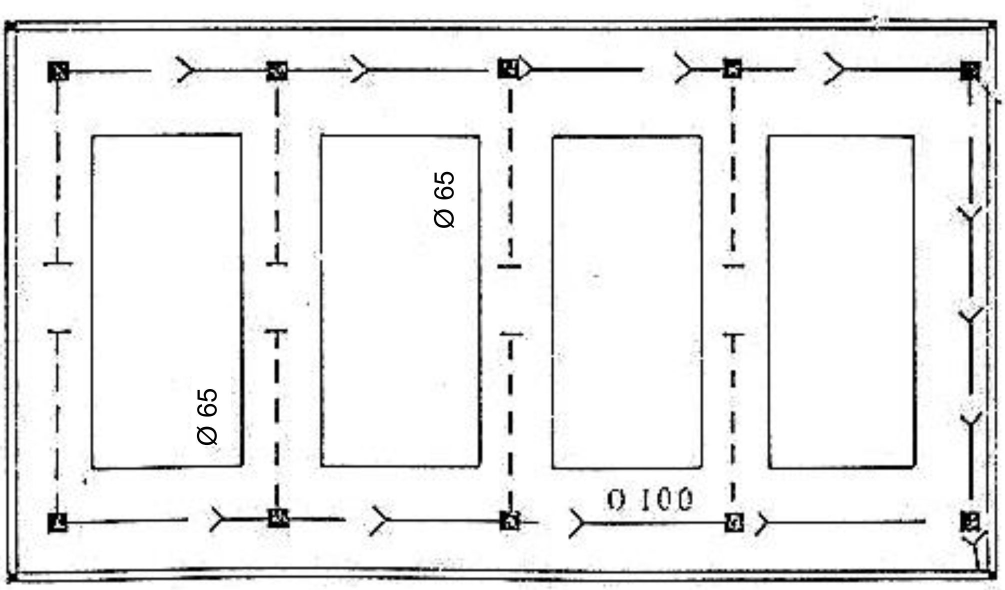


Figure 25 – Example of the drainage system at a Tennis Court

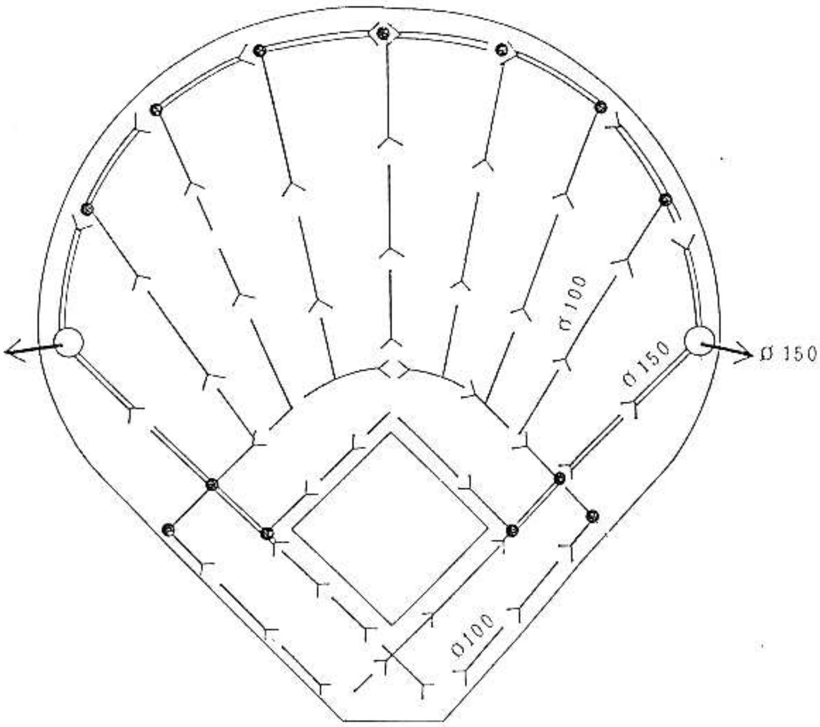


Figure 26 – Example of the drainage system at Baseball fields

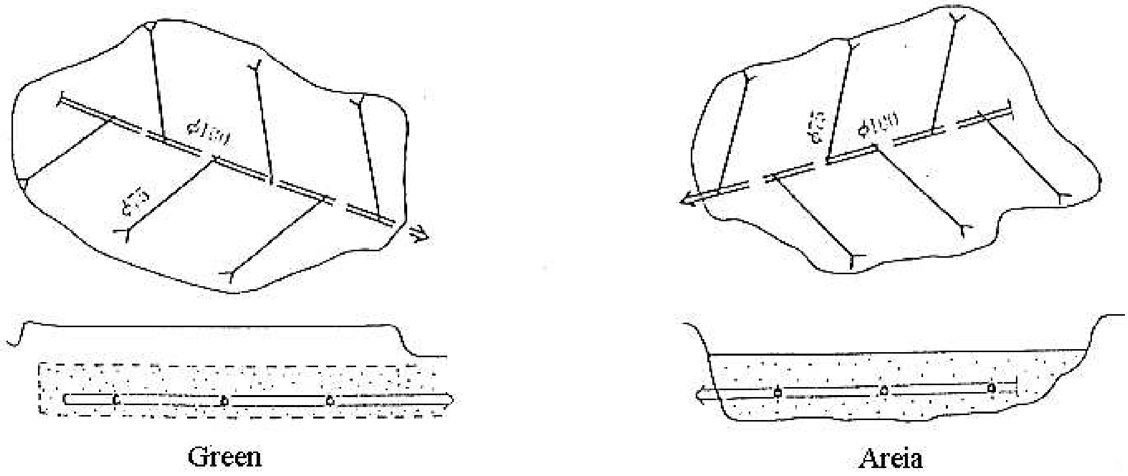


Figure 27 – Example of the drainage system at golf courses

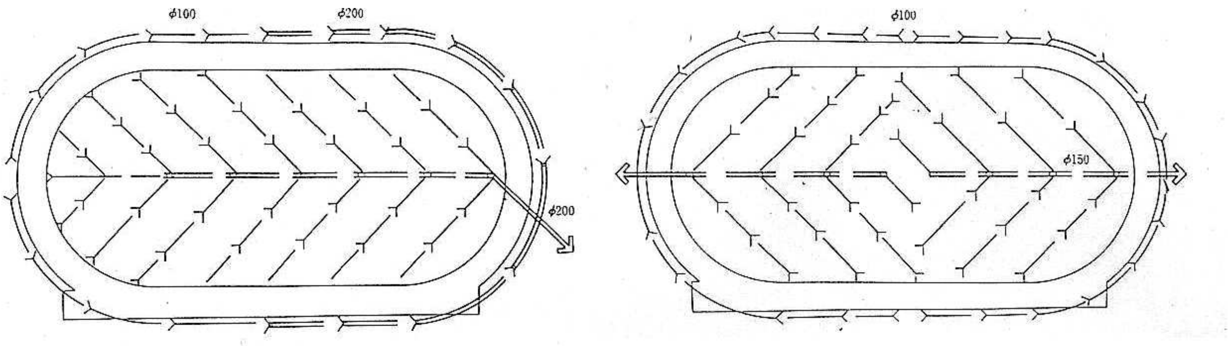


Figure 28 – Example of the drainage system at track and field sites

Railroads

The water that sprouts from the water tables as well as the water that infiltrates the ballast reduce the resistance of the soil-base that supports the railway structure.
Deep and/or sub surface drainage is of great importance in these cases because it prevents the pumping of fine materials into the ballast and keeps the soil/ballast interface dry and resistant.
These drains are generally installed in sections of cuts or lowlands, where there is the formation and ascension of water table to levels that may compromise system load capacity.

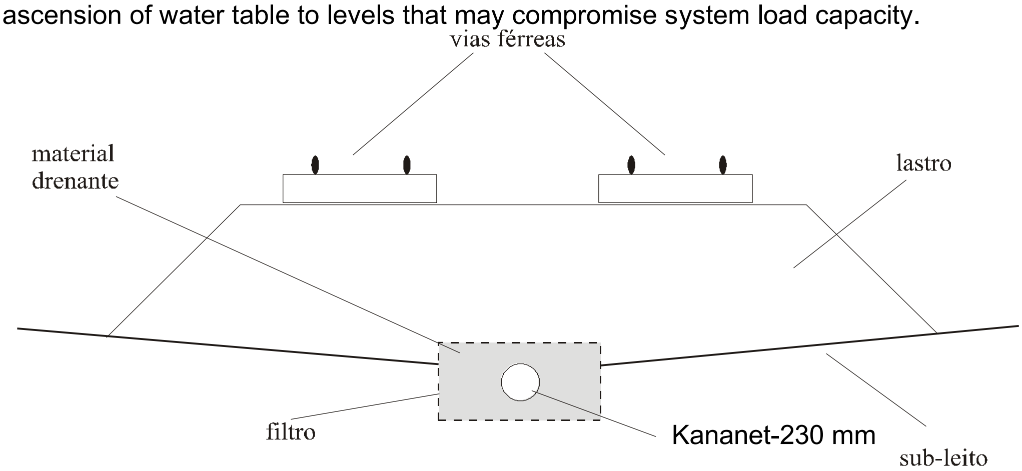


Figure 29 – Longitudinal drainage trench for capturing local infiltration waters, positioned between the tracks.

Containment works

When retaining walls are subject to action from water infiltrated in the soil, the presence of a drainage system increases job site safety and permits thinner structures because the structural design is relieved from neutral pressures.

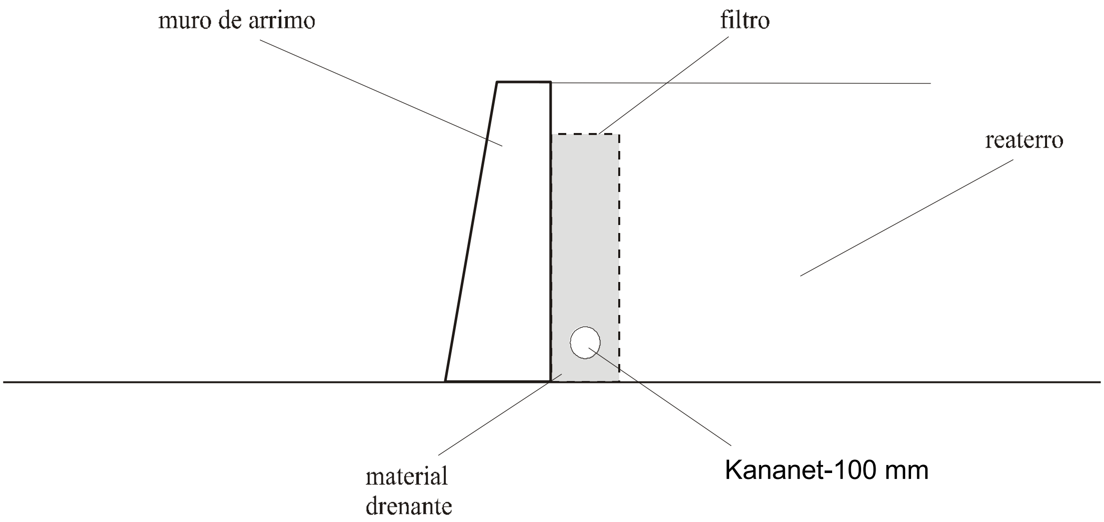


Figure 30 – Intercepting drainage curtain, behind the retaining wall

Yards and parking lots

Several types of pavement are used in yards and parking lots: stones, crushed gravel, asphalt layer, concrete sheets, articulated blocks, etc. In general, they are very flat areas with large volumes of traffic and subject to a high degree of rainwater infiltration. Rapid flow of these waters captured immediately after their infiltration by the pavement will avoid the pumping of fine particulates phenomenon and the development of wheels and tracks (See Figure 18 in the Airports topic).

Highways

The most common underground drainage systems in highways are:

DLD: Deep longitudinal drains, in the form of trenches, generally designed for lowering the water table.

Pavement drains: Sub surface drains, designed to capture water infiltrated locally by fissures and cracks (see Figure 18 in the Airports Topic).

The use of these two types of longitudinal drains guarantees that the sub bed, the base and the wearing course remain free of the presence of water, prolonging the useful life of highways for many years (see Figure 29 in the Railways topic).

Underground

In all works involving digging, the most economical and efficient tool for combating deep water action is drainage.
Several possible systems can be employed: for isotropic (homogenous) underground conditions, a fishbone system is generally used or a draining mattress under the floor is sometimes sufficient.

In extractified soils (layers with great horizontal permeability) it may be necessary to construct drainage curtains along the subsoil walls (see Figure 30 in the Containment Works topic).

Cesspool drainage using horizontal sinkholes.

This is an atypical case where there is indeed cesspool drainage using a horizontal sinkhole system.
In this case the sinkhole system with perforated pipes installed in ditches has an inverse function of underground drainage, that is, its function is to lose and not capture water.
The system is installed in a manner identical to the previous cases but with the purpose of creating a large infiltration area and thus facilitating water flow from the cesspool to the soil.
This is a low cost and very efficient practice, especially in dealing with soil areas that have a waterproofed layer located near the surface or zones that have high water tables.
The system also provides favorable conditions for the sub irrigation of fruit trees, which is quite positive, especially when they are in regions subjected to periods of prolonged drought.

8. Technical economical comparison between drains

A relative comparison between the most used types of underground drains in Brazil, highlighting their estimated cost, maximum flow, cost/benefit ratio and relative efficacy between drains with and without drains.

Note: drain costs shown were calculated presenting the TCPO, Revista Construção/SP and product manufacturer compositions.
We adopted 30% BDI, 1% declining slope for all drains, Gravel 2 as drainage material and non-woven geotextile as a filtering element.

Drain type no.	Type of drain – Summary description	Maximum flow (l/s)	Cost (R$/m)	Cost/benefit ratio (R$ / l / s)	Effectiveness ratio
1	Pavement drain, without drain pipe	0.30	7.03	23.40	1
2	Pavement drain, with Ø 65 mm drain pipe	1.76	9.99	5.68	6
3	Pavement drain, with Ø 100 mm drain pipe	2.90	10.87	3.75	10
4	Deep longitudinal drain, without drain pipe	0.63	15.16	24.06	1
5	Deep longitudinal drain, with Ø 100 mm drain pipe	3.23	19.00	5.88	5
6	Deep longitudinal drain, with Ø 170 mm drain pipe	13.46	22.85	1.69	22
7	Deep longitudinal drain, with Ø 230 mm drain pipe	28.63	27.39	0.96	45
8	Drain for green or sports areas, without drain pipe	0.40	9.48	23.70	1
9	Drain for green or sports areas, with Ø 65 mm drain pipe	1.86	12.44	6.69	5
10	Drain for green or sports areas, with Ø 100 mm drain pipe	3.00	13.32	4.44	7

Table XV

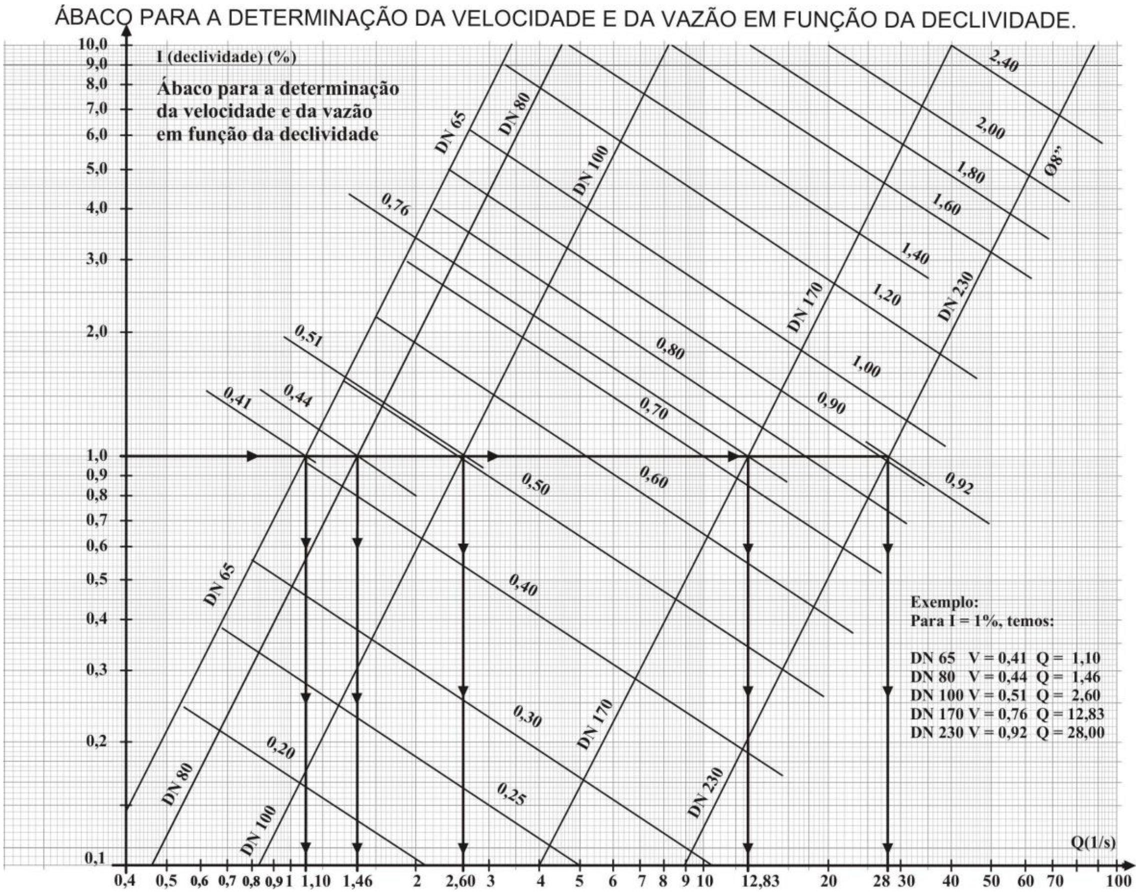
9. Hydraulic dimensioning

The hydraulic dimensioning of Kananet drain pipes can be summarized by determining mass flow in relation to average longitudinal declivity for the entire drain extension and/or defined segments.
These declivities should be defined in the drainage project. Even when the project already specifies the pipe diameter to be used, it is advisable to check with the data provided by the abacus (Page 26) or Table XIX (Page 27).
Sometimes, we don't have various diameters of drain pipes at job sits, or we want to take advantage of leftover drain pipes with different diameters from what is indicated in the project.

Diameter equivalence table					
Specified diameter (mm)	Number of parallel Kananet drain pipes that conduct the same flow for a given declivity				
	65	80	100	170	230
65	1	1	1	1	1
80	2	1	1	1	1
100	3	2	1	1	1
170	9	6	3	1	1
230	22	19	10	3	1

Table XVI – Quantities of smaller diameter parallel drain pipes that equal a single larger diameter pipe

Example: a specified pipe with Ø 170 mm can be replaced with 3 Ø 100 mm pipes



ABACUS FOR DETERMINING FLOW AND FLOW SPEED AS A RESULT OF DECLIVITY
(declivity) (%)
Abacus for determining flow and flow speed as a result of declivity.
Example:
For I = 1 % we have:

Abacus 1: Flows and flow speeds for Kananet drain pipes (n = 0.016) as a result of longitudinal declivity

Kananet drain pipes – Flows and flow speeds										
I	Kananet - 65		Kananet - 80		Kananet - 100		Kananet - 170		Kananet - 230	
(%)	V (m/s)	Q (l/s)	V (m/s)	Q (l/s)	V (m/s)	Q (l/s)	V (m/s)	Q (l/s)	V (m/s)	Q (l/s)
5.0	0.92	2.47	0.98	3.26	1.14	5.83	1.70	28.70	2.07	62.56
4.0	0.82	2.21	0.88	2.92	1.00	5.21	1.52	25.67	1.85	55.96
3.0	0.71	1.92	0.76	2.53	0.88	4.51	1.32	22.23	1.60	48.46
2.0	0.58	1.56	0.62	2.01	0.72	3.68	1.07	18.15	1.31	39.57
1.0	0.41	1.11	0.44	1.46	0.51	2.60	0.76	12.83	0.92	27.98
0.5	0.29	0.78	0.31	1.03	0.36	1.84	0.54	9.07	0.65	19.78
0.4	0.26	0.70	0.28	0.92	0.32	1.65	0.48	8.12	0.58	17.69
0.3	0.22	0.61	0.24	0.80	0.28	1.43	0.42	7.03	0.51	15.32
0.2	0.18	0.49	0.20	0.65	0.23	1.17	0.34	5.74	0.49	12.51
0.1	0.13	0.35	0.14	0.46	0.16	0.82	0.24	4.06	0.29	8.85

Basic Formulas:	Parameters:
$Q = 20.7 . D^{2.67} . I^{0.50}$ (m³/s) $V = 27.2 . D^{0.67} . I^{0.50}$ (m/s)	Q = Mass low (m^3/s) V = Average flow speed (m/s) I – Average drain declivity (m/m) D – Inner diameter of drain pipe (m)

Table XII - Flows and flow speeds for Kananet drain pipes (n = 0.016) as a result of average longitudinal declivity

10. Assays conducted on Kananet drain pipes and on end pipes

10.1 Diametrical compression

A test body measuring 323 mm in length is submitted to compression force F to cause diametrical deformation of 5% in relation to the outer diameter, and it cannot be less than what is shown in Table XVI.
This assay should be conducted at a temperature between 20 and 25°C.

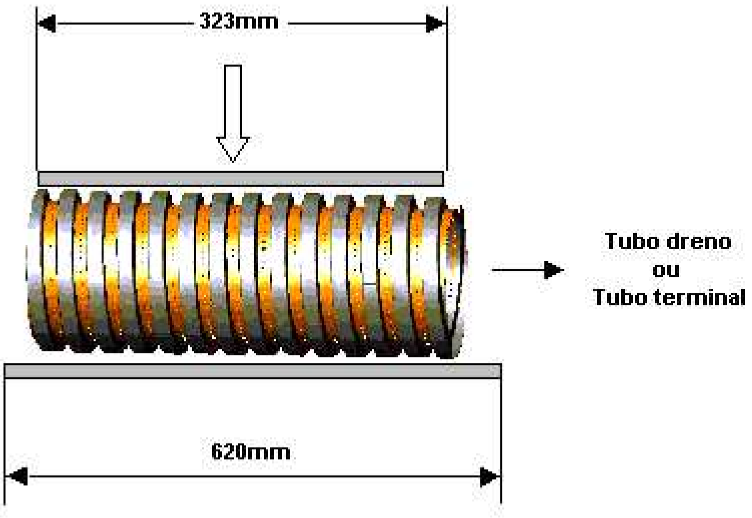


Figure 31

Measurement Table		
nominal ∅	**Minimum F**	
(mm)	**(Kgf)**	**(N)**
65	20.0	196.0
80	40.0	392.0
100	45.0	441.0
170	30.0	294.0
230	60.0	588.0

Table XVIII

10.2 Impact

A rigid cylinder with a mass equal to 5.0 Kg with a flat impact face and diameter (D) of 90 mm, free falls from predetermined heights onto a test body measuring 500 mm in length.
For each height H a new test body is used.
Immediately after the impact, the variation of the outer diameter of the Kananet drain pipe or end pipe is determined, calculated as shown below:

$$VDE = \frac{\varnothing_i - \varnothing_f}{\varnothing_i} \times 100$$

where:

VDE = Variation of the outer diameter (%)
$\varnothing_i$ = Initial diameter of the Kananet drain pipe or end pipe measured at the point of impact (mm)

$\varnothing_f$ = Final diameter of the Kananet drain pipe or end pipe measured at the point of impact (mm)

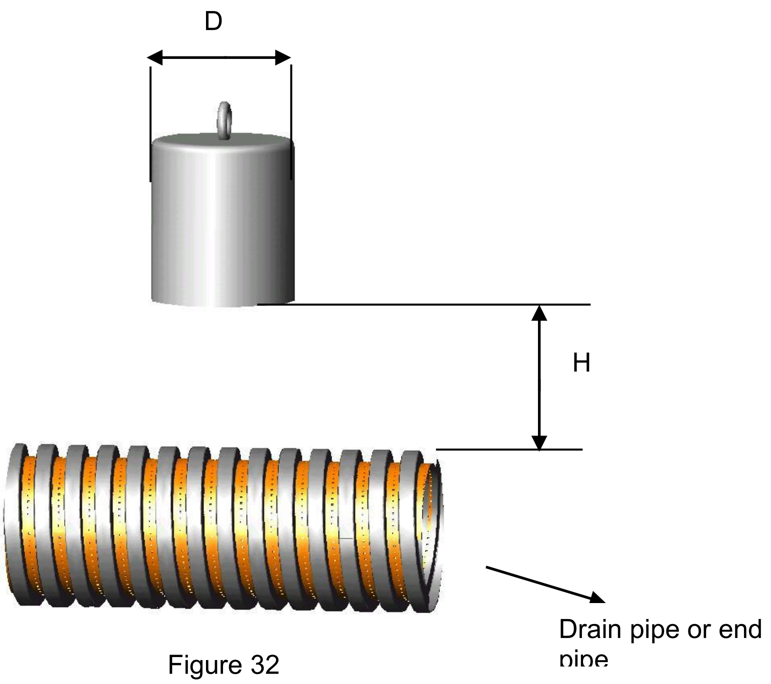


Figure 32

Measurement Table		
nominal ∅ (mm)	Height H (m)	Load (J)
65	0.3	15.0
80	0.3	15.0
100	0.3	15.0
170	0.3	30.0
230	0.6	30.0

Table XIX

NOTES

1) Kanaflex S.A. Indústria de Plásticos has the continuous improvement of those products it manufactures as its core principle.
Possible changes, corrections and additions may be made in their specification without prior notice always aimed at their improvement.

2) This procedure aims at collaborating with Kananet drain pipe users in underground drainage works.
If any particularities or doubts arise in your jobs that are not contemplated in this procedure, please contact our Technical Assistance Department.

3) Kanaflex has and provides technical assistance services at job sites. This service aims at orienting installers regarding the correct procedure for pipe installation and cannot be considered an inspection. Our technicians are instructed to not interfere in engineering procedures and projects, which are the responsibility of the contractors and installers.

Doubts?

Call +55 (11) 3779-1685

Kanaflex®

Oficina Comercial
Rua José Semião Rodrigues Agostinho, 282
Bairro Quinhau – Embu das Artes/SP - Brazil
CEP 06833-905 **ISO 9001**
www.kanaflex.com.br douglas@kanaflex.com.br

13th Edition – October 2021