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Some considerations on the use of small diameter PVC pipes for drainage collectors on populated hearth centers

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SUMMARY

In the paper work are highlighted the current technical regulations on the use of PVC pipes, with small diameters, for channeling domestic waste water from the populated hearth centers.

In the case of small or very small debits leakage, are recommended tubes with minimum limits allowed for diameters and maximum limits allowed for degrees of filling, to avoid, clogged drain sections with the most toxic or combustible gases resulting by anaerobic fermentation of the organic masses from drainage waters.

These phenomena can occur when changing pipes DN 250 mm of concrete, more rugged, with PVC-KG, smoother, even with DN 200 mm and DN 150 mm.

These substitutions are allowed for economic reasons and by the fact that the transport flows is equivalent.

Reducing the diameter drain pipes, even for equivalent flow rates, causes high degrees of filling, over the allowed limit of 0.6 for pipes with diameters less than 250 mm. By reducing the diameters under minimum allowed limits is possible only if the filling degrees do not excess the maximum allowable levels.

1. GENERAL CONSIDERATIONS

Drainage networks are constructions and installations which collect and carry sewage and the rain coming from hearth places, urban and rural, from assemblies and residential districts, industrial units and agrozootechnical buildings.

Drainage networks, as part of public drainage systems, are designed to collect drain from buildings and from other types of activities, for reasons of public health and hygiene, to prevent flooding of areas in population centers and the protection of the environment [12], [13].

These fundamental requirements can be satisfied only if the regulations in force with regard to the design, execution, operation and proper maintenance of sewage networks are respected. [1], [6], [8] [9] [11].

The space above the wastewater from pipes serves to renewal and air circulation, but also to avoid the formation of air stoppers which could lead to clogged drain sections, that disturb the proper functioning of networks that carry drain wastewater.

In a normal operation of the drainage network, the suspension must be transported by water currents continuously. If this condition is not satisfied, the heavier suspensions will lay down on the bottom of the channels, causing their storage and will reduce the section of the drain. Because these deposits are removed by mechanical means, there are required considerable expenses, it is necessary to ensure minimum self-cleaning velocity of 0.7 m/s in order to avoid sedimentation of the suspensions, and hence, the formation of deposits [3], [April], [8] , [12], [13].

The flow speed in closed drainage's collectors, are determined by: the size of transported flow, the shape and size of cross-sectional section, the channel's roughness and its slope hydraulic.

2. HYDRAULIC SIZING OF COLLECTORS FOR DRAINAGE

The drainage contains suspended substances, colloidal or in solution, which can have animal or vegetable organic origin. Lightweight materials float to the surface and the heavy materials will lay down on the bottom of the channels, causing irregularity of shape and flow like on the confluence and changing of the slope etc. [2],[5],[8].

Hydraulic determination of size the drainage collectors shall be made in a simplified way, in a permanent and uniform treatment of movement, although the treatment of movement is not permanently and uniform.

Hydraulic estimate of drainage networks with circular profile is:

$$Q = 0,\ 3115\ k\ D^{8/3}\ I^{1/2} \quad (1)$$

$$V = 0{,}396\ k\ D^{2/3}\ I^{1/2} \quad (2)$$

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where Q is the flow, in m³/s; D-diameter of drain, in m, V-flow rate, the average speed in m/s; I-hydraulic slope; k-coefficient of roughness channel which is considered: 90 – for polyvinyl channels; 83-channels of tubes of cast iron, basalt, sandstone ceramics; 74-channels of concrete tubes, stone walls, brick brickwork [6].

For seizing the sewage pipe we can use diagrams and monograms for concrete and PVC pipes [1], [3], [6].

The flow estimation is considered as the flow is passing through the downstream section channel, been given by the amount of transit flows, and associated side.

Hydraulic gradient or slope of the channel must be equal with the slope of the land or as close to it. By depending on the profile in the long run, will be designed a channel with a constant slope, on as many sections of main and secondary collectors. Minimum slope condition result from minimum speed to ensure self-cleaning and maximum slope is given by the maximum permissible speed on the channel. For a proper use of small diameter channels requires that the slope is not decline below 0.001. In the case of channels with large diameters, because of the difficulty of the execution, it is recommended that the slope of the channel not to be declined below 0.0005.

Drainage networks in outlying districts of urban centers and especially those of rural places, due to low flows and very low leakage, are provided, for economic reasons, KG PVC tubes with diameters of 200 mm and even 150 mm although the regulations in force, it is recommended that the minimum diameter will not fall below 250 mm. With these modifications is possible to increase degrees of filling above the maximum allowed [11], [14].

For the proper functioning of drainage networks rates using small and very small size is necessary to check the degree of filling for each section of the channel. This size must not exceed the maximum allowable: H / D = 0.6 in case pipes with DN 250-300 mm; h/D=0.7 in case pipes with DN 350-450 mm; h/D=0, 75 if DN tubes 500-900 mm and h/D=0.8 in case pipes DN>900 mm [1], [2], [3], [6] [9] [11] [12].

The maximum speeds that are permitted in closed drainage channels to prevent erosion, must not excess 5.0 m/s for channels made of plain concrete, ferro-concrete, ceramic tile, PVC, polyethylene, polypropylene, ductile iron and cement and 8,0 m/s for metal pipes, channels made of dark basalt, centrifuged ferro-concrete and prestressed concrete [1], [2], [6], [8] [9], [10].

If the designer admits, for some technical and economic considerations, the design of collector drain smaller than 250 mm becomes necessary to verify the degrees of filling, so that their size won't excess the maximum allowed. By excessing the maximum permissible limit of 0.6 for degree of filling, the discharge water will be disturbed by gas leakage from the anaerobic digestion process of loads contained by the organic wastewater.

In Table 1, were determined the fill ranks of PVC pipe - PVC 200 mm - 200 mm, compared with different slopes of drainage channels for minimum flow carried by concrete channels with DN 250 mm.

Calculations have revealed exceeding the maximum permissible filling degree (0.6), both for PVC pipe - 200mm and 150 mm for the PVC. There are also situations where wastewater flow is pressure, size of issue highlighted by the degree of filling (h / d> 1).

Microbiological processes in drain networks that collect and transport wastewater are enhanced by temperature increases in May weather warm. In this situation turns drainage collectors' bioreactors producing toxic gas or biogas, making explosives and sources of pollution dangerous to human beings and the environment. Failure to reflect the degree of filling may be safe and sound operation of the sewerage system consisting of networks, accessories, pumping stations, wastewater treatment plant and the mouth of the natural emissaries.

The filling degrees which depends on the size of the minimum flow of drainage, slope and channel material.

3. CONCLUSIONS

Appropriate design of drainage networks to collect and transport the drain, involves the determination of the flow estimation, the choice of slopes for drainage, setting and choice of diameters, determine the minimum velocity to prevent deposition of sediments and m aximum speeds to prevent the erosion of the channels and the verification of the degrees of filling, to combat the phenomena that could disturb the smooth functioning of the drainage network. By checking the degree of filling, it becomes a compulsory measure for designers to accept sewage collectors and even 200 mm diameter 150 mm. At these diameters, even for PVC pipes - KG maximum permissible filling degree is 0.6. The compliance, can avoid disturbance to the proper functioning drainage channels with small diameter DN <250 mm by filling sections of the leakage of toxic gases and combustible form of biogas. The proper operation of drainage systems is determined by the way they are designed, constructed, operated and maintained the networks for the collecting and the transport of the drainage.

Table 1

I	B – 250 mm				PVC – 200 mm			PVC – 150 mm		
	h/D	Q_p	Q_u/Q_p	Q_u	Q_p	Q_u/Q_p	h/D	Q_p	Q_u/Q_p	h/D
1	2	3	4	5	6	7	8	9	10	11
0,001	0,7	19	0,83	15,77	13,50	1,17	>1	6,50	2,42	>1
	0,6	19	0,65	12,40	13,50	0,92	0,76	6,50	1,91	>
	0,5	19	0,47	8,93	13,50	0,66	0,61	6,50	1,37	>
	0,3	19	0,20	3,80	13,50	0,28	0,37	6,50	0,58	0,56
	0,1	19	0,03	0,57	13,50	0,03	0,12	6,50	0,08	0,20
1 0,002	0,7	26	0,83	21,58	17,50	1,23	>1	8,50	2,53	>1
	0,6	26	0,65	16,90	17,50	0,97	0,80	8,50	1,98	>1
	0,5	26	0,47	12,20	17,50	0,69	0,62	8,50	1,43	>1
	0,3	26	0,20	5,20	17,50	0,29	0,38	8,50	0,61	0,57
	0,1	26	0,03	0,78	17,50	0,44	0,47	8,50	0,56	0,55
0,005	0,7	40	0,83	33,20	29,00	1,14	>1	14,00	2,37	>1
	0,6	40	0,65	26,00	29,00	0,89	0,75	14,00	1,85	>1
	0,5	40	0,47	18,80	29,00	0,65	0,60	14,00	1,34	>1
	0,3	40	0,20	8,00	29,00	0,28	0,37	14,00	0,57	0,55
	0,1	40	0,03	1,20	29,00	0,04	0,15	14,00	0,08	0,17
0,010	0,7	58	0,83	48,14	40,00	1,20	>1	18,00	2,67	>1
	0,6	58	0,65	37,70	40,00	0,94	0,90	18,00	2,09	>1
	0,5	58	0,47	27,30	40,00	0,68	0,62	18,00	1,51	>1
	0,3	58	0,20	11,60	40,00	0,69	0,36	18,00	0,64	0,60
	0,1	58	0,03	1,74	40,00	0,04	0,15	18,00	0,09	0,20

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