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Criteria of minimum shear stress vs. minimum velocity for self-cleaning sewer pipes design

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Abstract

Sedimentation in Urban Drainage Systems is a huge problem that allow changes in cross-sectional area, and therefore changes in pipe´s roughness. The increase of suspended solids deposition and consolidation in pipes affect the velocity and shear stress distribution inside these elements [1]. Some authors have proposed methodologies to prevent sedimentation phenomena in sewer pipes. However, such methodologies requires variables estimation that result very difficult in most cases and their estimation could affect the resulting network pipes design. This paper aims to evaluate different methodologies and equations proposed to ensure self-cleaning in sewer and pluvial pipes systems design. Comparison was made by graphical analysis of values established in literature in order to assess restrictions of each design. Three methodologies were compared: Traditional criteria, Equation of Macke (1982), and Tractive Force Methodology (ASCE). A design methodology was proposed as an optimization problem considering a cost variability analysis using cost functions. Results shows that self-cleaning criteria during design process must be included in cases where the relation between pipes' flow and terrain slope exceeds the relation found by this study.

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Keywords: self-cleaning; minimun shear stress; sewer design.

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1. Introduction

Particle sedimentation is a huge problem that affects the majority of drainage systems. Changes in cross sectional area and in material roughness are caused by sedimentation, especially in dry periods. Roughness variations influence the velocity distribution and the stress shear distribution. Bong [2] did a classification in three groups of criteria and methodologies that seeks to prevent the sedimentation phenomena, as shown in figure 1.

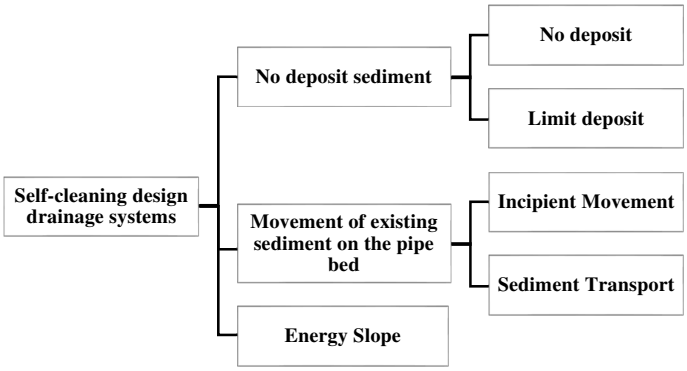

Fig. 1. Self-cleaning criteria classification.

1.1. No deposit sediment

The majority of world´s technical design norms are compound by traditional design criteria. No one of these criteria has a formal justified background; they actually rely on empirical knowledge of designers. Table 1 shows some of these values of minimum velocity and minimum shear stress used for wastewater, combined and stormwater drainage systems design.

Table 1. Values of minimum velocity and sheer strees

Entity	Country	Norm	Year	Type of Drainge System	V min	Shear Stress min
[-]	[-]	[-]	[-]	[-]	[m/s]	[Pa]
EPM	Colombia	Guía para el Diseño Hidráulico de Redes de Alcantarillado	2009	Sanitary	0.45	1.5
				Storm & Combined	0.75	3
MinDesarrollo	Colombia	RAS - 2000	2000	Sanitary	0.45	1.5
				Storm & Combined	0.75	3
IBNORCA	Bolivia	NB 688	2007	Sanitary	-	1
				Storm & Combined	-	1.5
INEN	Ecuador	CPE INEN 5	1992	Sanitary	0.45	-
				Storm	0.9	-
CNA	Mexico	Manual de Agua Potable, Alcantarillado y Saneamietno	2007	Sanitary	0.6	-
				Storm	0.3	-
INAA	Nicaragua	Normativa Alcantarillado Sanitario Condominal	-	Sanitary	0.6	1
Great Lakes	USA	Recommended Standars for Wastewater Facilities	2004	Sanitary	0.6	-