MODIFIED HAZEN-WILLIAMS FORMULA

THESIS
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by,
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Abstract

A dimensionally homogeneous and accurate formula has been derived in this research for the estimation of surface resistance in pipes based on explicit friction factor relationship and Darcy-Weisbach equation. The new relationship has been designated as Modified Hazen-Williams formula. The values of coefficient of roughness for commercial pipes have been estimated experimentally and a rational approach put forth to account for reduction in carrying capacity of pipes with age.

Chapter 1 delineates the goals of Government of India in water supply and sanitation sectors along with concomitant investments during the International Drinking Water Supply and Sanitation Decade. The need for and scope of present research are also brought out in this chapter.

Chapter 2 critically reviews pipe friction formulae in respect of their utility to Environmental Engineers.

Chapter 3 brings forth the limitations of widely used Hazen-Williams and Manning’s formulae and quantifies errors in the estimation of frictional resistance through these formulae.

Chapter 4 presents a dimensionally homogeneous and accurate Modified Hazen-Williams formula, similar in form to that of Hazen-Williams, based on explicit friction factor relationship and Darcy-Weisbach equation. A nomograph for the solution of water supply and wastewater systems design and analysis problems is also presented.

Chapter 5 demonstrates the applicability of Modified Hazen-Williams formula to the design and analysis of rural and urban water supply systems.
Chapter 6 deals with the application of Modified Hazen-Williams formula, through the development of hydraulic elements for partful conditions, to design and analysis of wastewater collection systems.

Chapter 7 presents the details of experimental estimation of $C_R$ values for commonly used commercial pipes. A comparison of $C$ and $C_R$ values on f-R diagram is also provided.

Chapter 8 reviews prevalent practices for the reduction in carrying capacity of pipes with age. The data on existing systems in some cities is analysed along with experimental information gathered during this research to bring out a rational approach to the reduction in carrying capacity of pipes over design period.

Chapter 9 underscores salient conclusions and recommendations drawn from the present research.

Appendix I presents a rationale for ascertaining dimensional homogeneity of empirical formulae.

Appendix II provides the derivation for explicit equations for pipe diameter and velocity.

Appendix III presents a case study on the application of Modified Hazen-Williams formula to the design of a real-life rural water supply system.

Appendix IV presents the derivation of hydraulic elements for partful conditions in wastewater lines based on Modified Hazen-Williams formula.

Appendix V provides derivation of Modified Shields equation for the estimation of self cleansing velocity in wastewater lines incorporating Modified Hazen-Williams formula.
Appendix VI describes the procedure adopted in this research for calibration of pitotmeters for experimental estimation of values for coefficient of roughness.

The thesis concludes., with a list of references on researches and articles relevant to the present research.