DEVELOPING GUIDELINES TO SUPPORT WATER PIPELINES ACROSS WATERWAYS AND HIGHWAYS

THIS THESIS IS SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF ENGINEERING IN STRUCTURAL ENGINEERING DESIGN

by

Thummini Abeywardena

Supervised By

Dr. (Mrs.) M.T.P. Hettiarachchi

Senior- Lecturer - Department of Civil Engineering

DEPARTMENT OF CIVIL ENGINEERING

UNIVERSITY OF MORA TUWA

SRI LANKA

2009

Abstract

Guidelines are developed for above ground water pipelines across waterways and highways.

Research is mainly based on the prevailing practices of the NWS&DB and a literature review.

Of the two main groups of crossing, first is when the pipeline can be run directly across the bridge and straight in to the soil which can often simplify many aspects of the design, and second is crossing by raising the level (by using multiple offsetting bends in the approach areas of the water way/highway) of the pipe line at the abutments to avoid the disturbance to the flow of the waterways. This study is on the first method where pipeline runs directly across the bridge and straight in to the soil.

Having reviewed the available data and after designing the supports for selected diameters and spans it was found that the span is the major criteria for selecting the type of the crossing. Design was carried out for 300mm dia. And for 500mm dia Spigot and Socket pipelines and Flanged pipelines, of 18m span and 24m span crossings. Space trusses were designed using angle iron sections and compound structures were designed using universal beam (UB) sections with rolled steel channels (RSC). Design was carryout according to BS5950 1990'. Analysis was done using SAP 2000.

The data obtained through the questionnaire survey shows that for socket and spigot pipes where the span is less than 10m concrete supports at ends were adequate, for spans greater than 10m supports were required at intermediate positions, for spans less than 18m compound sections were used while for larger spans space trusses were used.

According to the literature survey and the analysis of the results of this study, guidelines were prepared for the pipelines run directly across the waterway/highway and straight in to the soil span exceeding three meter. Design guidelines to support water pipelines across waterways and highways are described in this report. It is recommended to use only end supports for spans less than 10m, compound structures for spans up to 25m, plate girders or space trusses for spans up to 100m. Where the construction depth is not sufficient, it is better to select a space truss as the pipe support.

Results of the detailed design shows that the weight of the compound structures is lesser than the space trusses but when the span increases the depth of the UB needs to be increased to satisfy the deflection criteria. Therefore, it is recommended to use space trusses for larger spans.

Cost was calculated for all supports designed based on current market prices of steel and the pipe supply cost from NWS&DB rate book.

The comparison of overall costs (inclusive of material, fabrication, supply and laying of pipes, corrosion protection, and maintenance), shows that the cost of the compound structures is less than the space trusses. The comparison of , support cost according to the span and the diameter shows a significant cost variation in the type of the support where the diameter of pipes and the span increased. This shows that, when the span and the diameter of the pipe increase, the support structure should be selected very carefully.

It is recommended to use one end fixed and the other roller to facilitate the expansion and contraction. If the pipe supports are at a lateral bend of the pipe line, the unbalanced horizontal load at the bends also should be arrested adequately.

Though, the practice In Sri Lanka is to use double flanged (DF) pipes in crossings, use of Socket and Spigot (So/Sp) reduce the total cost of the crossing by 10 to 17% for 300mm dia. and 19 to 28% for 500mm dia. pipes, depending on the type of the

structure. These So/Sp pipes can be used in direct crossings. However, in So/Sp type lateral effects due to wind load condition could cause the pipe to malfunction. Therefore, wind effects on So/Sp type pipe lines should be checked very carefully.

By considering the life cycle it is advisable to use hot dip galvanizing for corrosion protection rather than painting, Cost reduction percentage of galvanizing is 270% to 680% comparing with painting (including 25years maintenance for painting).

DECLARATION

I hereby declare that the work included in this thesis, in part or whole has not been submitted for any other academic qualification at any Institution.

Eng. (Mrs.) Thummini Abeywardena

Certified By :

Dr. (Mrs.) M.T.P.Hettiarachchi,
Project Supervisor,
Department of Civil Engineering,
University of Moratuwa,
Sri Lanka.

ACKNOWLEDGEMENT

I wish to express my heartfelt appreciation and gratitude to Dr.(Mrs.) M.T.P. Hettiarachchi for her guidance, encouragement and all the support given to me throughout the course of this thesis.

I am grateful to Project Director (Greater Kandy Water Supply Project-Phase I Stage II) Eng.. P.H. Sarath Gamini for his invaluable ideas and guidance to fulfill this study. I am thankful to Deputy General Manager (Regional Support Centre-Western central), Eng. (Mrs.) P.N.S. Yapa and the management of National Water Supply & Drainage Board for granting me leave and encouraging following the course. I am thankful to all the Engineers in National Water Supply and Drainage Board who helped me by collecting data for my questionnaire survey to find out the details about the existing supporting arrangements for water pipeline across waterways and highways. I am thankful to Mrs. Sandya Kulatunga and M.W. Chandani for helping me in costing and Mr. Champilal Gamage for helping me in drawings. I am thankful to Mr. S. Muraoka Structural Engineer JICA study team of Outer Circular Highway for giving me the details of the pipe support structures used in Japan.

I am very grateful to the National Water Supply and Drainage Board for the financial support extended to me to follow this course.

Finally, I would like to thank my family for encouraging and supporting me to achieve the target.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

APPENDICES