RESEARCH HIGHLIGHT

Technical Series 01-136

Protection of Basements Against Flooding Trends and Impacts of Drainage Regulations

INTRODUCTION

The flooding of basements due to sewer surcharge is a problem for homeowners in both older and newer housing developments across Canada. In recent years, this issue has become more critical because basements are increasingly used as dwelling spaces.

Protection of Basements Against Flooding Trends and Impacts of Drainage Regulations presents an holistic assessment of basement flooding. The authors review both the causes of the problem and various state-of-theart techniques for identifying, preventing and mitigating it. The assessment also links aspects of the drainage problem with plumbing and house-building procedures.

RESEARCH PROGRAM

Methodology

To evaluate the problem, the authors reviewed recent studies on basement flooding and remedial projects and undertook discussions with municipal engineers and specialists in cities across the country. The information presented in the report is based primarily on projects conducted in Quebec, Ontario and Alberta. To a lesser extent, it draws on studies done in the United States for comparing the Canadian and U.S. experiences.

FINDINGS

Dual Drainage systems

One of the remedies for basement flooding due to sewer surcharge in new housing developments is the Dual Drainage system with Inlet Control Devices. This solution consists of a minor and a major drainage system. The minor system comprises roof gutters, rainwater leaders, service connections, swales, street gutters, catch basins and storm sewers. The major system includes natural streams, valleys and man-made streets, swales, channels and ponds. During heavy storms, special restrictors or catch basins called Inlet Control Devices control storm sewer surcharge by limiting the flow of runoff into the sewer. Overland storm water flow (part of the major system) is stored in depressed areas in parks.

Guidelines for the use of the Dual Drainage system have existed in Canada since 1979, but there have been problems of a non-technical nature related to its implementation. Poor communications and coordination between designers and hydrologists in engineering firms have hampered its application. In addition, firms have lacked the necessary experience in urban hydrology or have conducted the hydrologic analysis and the design separately. This has led to inconsistencies between assumptions in the computations and the design details.

Canada

CMHC SCHL
HOME TO CANADIANS

The research also found that municipalities needed specialized staff or outside consultants to conduct the verification of the more complex analyses required by this system. Improper verification could cause a lack of adequate control of discharge into a trunk sewer in one subdivision that could lead to flooding in another.

Other techniques including the use of parks for storing overland flows and the installation and operation of sump pumps in homes have required significant efforts to obtain the public's cooperation.

Aspects of the Canadian experience

The research also considers the Canadian experience with infiltration and inflow volumes. (Infiltration is the seepage of water into the storm sewer system from the ground, while inflow refers to the surface runoff entering the system through catch basins.) The following are some of the main findings in this area.

While there are many sources of infiltration and inflow, it is difficult to identify their specific locations because monitoring typically occurs at only a few spots along the system.

Accurate results are difficult to obtain when conducting flow measurements in sewers. There are many methods used to take such measurements, and even the best equipment can give significantly different results depending on its limitations and the hydraulic conditions at the monitoring site.

Sophisticated measurement programs are also relatively new for most municipalities, and requirements for frequent cleaning of the equipment and verifying of its performance have not yet been defined in policies. Consequently, measurement equipment often fails, and only a few of the results can be used for analysis.

There is also no uniform policy for municipalities across the country indicating an acceptable level of protection for basements once remedial measures have been implemented.

In addition, most studies recognize the need for two approaches to the elimination of basement flooding. One approach focusses on measures in the public system, while the other addresses local procedures such as disconnection of the weeping tiles and provisions for sump pumps, which require the co-operation of homeowners. This study addresses the first category, which does not require public co-operation.

U.S. experience with infiltration and inflow studies

The report also compares Canadian and U.S. experience with infiltration and inflow. In the United States, implementation projects include monitoring to verify infiltration/inflow after the rehabilitation works have been completed. It was found that the reduction in infiltration/inflow was less than expected in the U.S. studies because most of the infiltration/inflow was generated in the private part of the system. Canadian practices do not usually include verification programs.

Further, in the United States, major public participation and education efforts were part of the remedy, as were legal advice and detailed work conducted on each property based on very stringent verification by a municipality. This approach was not found in the Canadian studies.

The U.S. studies also indicated that rehabilitation measures taken on some parts of the system could increase infiltration/inflow on other parts of the system. This can be avoided only by a detailed analysis of all factors including groundwater levels.

CONCLUSIONS

Many of the solutions to basement flooding are relatively new, are not reflected in municipal guidelines and policies, and are being implemented cautiously, primarily through local initiatives. Consequently, there are considerable differences across Canada in the level of implementation of various techniques, types of models and monitoring standards.

One such technique, the Dual-Drainage-Inlet-Control-Device procedure has had problems with a lack of public acceptability, difficulties in coordinating the specialties involved in implementations and a lack of training programs.

Sewer back-up caused by infiltration and inflow is complex and difficult to resolve, particularly on a national level. Solutions require sophisticated measurement programs, which may include long-term flow monitoring as well as smoke or dye tests and TV inspections. There is also a need for national standards or guidelines to provide benchmarks such as an adequate duration for measurements, an adequate number of monitoring stations, quality control of equipment and error analysis.

Studies of current Canadian practices also indicate areas for improvement. For example, the economic benefits resulting from the reduction in treatment plant loading are not considered; the cost-benefit analyses of the rehabilitation work is inadequate; and the proposed level of servicing varies from one municipality to another. Further, legal liability for basement flooding has not been systematically analyzed.

Finally, Canadian solutions focus on changes to the municipal part of the system. However, recent experience in the United States shows the privately owned part of the system may be a major contributor to infiltration and inflow.

Research Consultant: Paul Wisner and Associates Inc.

This project was funded (or partially funded) by Canada Mortgage and Housing Corporation (CMHC) under the terms of the External Research Program (ERP), an annual research grant competition. The views expressed are the personal views of the author(s) and do not represent the official views of CMHC. For more information on the ERP, please visit the CMHC website at **www.cmhc.ca** or contact the Project Officer, Responsive Programs by e-mail at erp@cmhc-schl.gc.ca, or by regular mail: Project Officer, Responsive Programs, External Research Program, Policy and Research Division, Canada Mortgage and Housing Corporation, 700 Montreal Road, Ottawa ON K1A 0P7.

62735