RESEARCH HIGHLIGHTS

Technical Series 01-137

EVALUATION OF URBAN DRAINAGE FOR BASEMENT FLOOD PROOFING

Introduction

For many years, basement flooding due to sewer surcharge was accepted as unavoidable by homeowners, engineers and municipal officials, and as an "act of God" by insurers.

However, in recent years, with the increase in the use of finished basements as living spaces, flooding with its associated damages, inconveniences and health hazards has become less tolerable to the public. Because of its potential for increased political pressure and higher municipal taxes, basement flooding has become an important problem for many municipalities.

Evaluation of Urban Drainage for Basement Flood Proofing examines a number of North American studies on basement flooding. Its objective is to assess the extent of flooding problems in Canada and the financial resources needed to resolve them by means of relief sewers. The report also evaluates alternative flood-proofing techniques and reviews strategies for selecting the alternatives. Recent advances in the computer modelling of flood-proofing techniques are also reviewed.

Research Program

Methodology

The report examines the causes of actual basement floodings in Ottawa, Edmonton, Regina, Winnipeg and St. Laurent, Quebec. It also assesses various studies on basement flooding, with emphasis on solutions such as roof disconnections, street ponding, inlet control, backwater valve sump-pump systems and storage. In addition, the researchers conducted a survey of engineers in 34 municipalities across Canada and homeowners on streets with different densities of flooded homes in the city of Ottawa.

Findings

Causes of basement flooding

A number of events not directly related to the capacity of storm sewers can cause basement flooding. Therefore, protecting basements against flooding requires complex measures including the control of overland flows of drainage water and the inflow of storm runoff into sanitary sewers.

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Overland flows enter a basement through leaks in the walls, floors and windows, through inadequate window wells and over low door sills. Other sources include overtaxed sump pumps, back-ups in roadside ditches and blocked catchbasins.

Inflow into sanitary sewers is the result of depressed driveways, perforated manhole covers, interconnections with the storm sewers, connection with foundation drains, broken pipes and the cracking of roadway facings around manhole covers.

New alternatives for flood proofing

Many of the flood-proofing techniques presented in this report have been considered in previous studies, but there were reservations about their implementation. Some remedies were considered difficult because they required the cooperation of homeowners. For example, backwater valve-sump pump systems in basements require ongoing homeowner maintenance, and the public acceptance of street ponding is unknown. Backwater valves have also been known to increase flooding in other basements.

Survey results — municipal engineering departments

Municipal engineering departments viewed basement flooding as a serious problem. Cost estimates for the construction of relief sewers ranged between $10-50 million, and their implementation required very high annual expenses.

It was generally agreed that relief works by traditional methods would take many years to complete. Sixty-five per cent of the areas with flooding problems had sewer systems more than 25 years old. Sixty-six per cent had separated storm sewers, mostly without backwater valve-sump pump systems. While relief sewers were the preferred solution to flooding, other approaches were considered.

Computer simulation for relief studies had been used by 53 per cent of respondents. Municipal engineers also thought the public and decision-makers were not well informed about drainage problems, and that many decisions were not taken on a technical basis.

Survey results — homeowners

The homeowners surveyed in the city of Ottawa reported varying values for damages to basements and furnishings due to flooding with an average of $3,000. Thirty per cent of the homes in the flooded areas experienced structural damages to their basements.

It was found that homeowners were not well informed about flood protection measures and the technicalities of storm water management. However, 88 per cent were willing to contribute to the cost of implementing preventative measures. Most respondents considered an expense of $1,000 acceptable.

Strategies for the selection of flood proofing alternatives

A review of flood-prevention strategies reveals that even if costly relief works are undertaken, public perception of the risk of flooding can persist. In addition, unless homeowners are contributing more directly to the cost and maintenance of flood-proofing systems, they are likely to continue to demand flood protection at the expense of the community.
A cost/benefit analysis per flooded house favours the installation of backwater valve-sump pump systems, and solutions such as roof disconnections and inlet control require a better-informed public.

Strategies for updating existing systems should emphasize public education and incentives for local solutions. They should also combine the use of relief sewers with non-conventional solutions such as inlet control, underground storage, increased conveyance, and so on.

The strategy for implementing new solutions in new housing developments is easier and aims to eliminate sewer surcharge not only for frequent storms but also for rare storms. It uses combined inlet control with adequate street grading and the provision of overflows at low points in parks. This should be combined with local measures such as backwater valves for sanitary sewers, the elimination of roof inflow in foundation drains and the sealing of manhole covers.

Conclusions

The conclusions point to the need to adopt new solutions to prevent basement flooding. The authors suggest that the engineering profession should review the conventional approach to drainage design to address problems such as the following:

- the probabilistic methods used to predict the drainage systems performance are difficult for laymen to understand;
- system performance cannot be checked after a major storm and flooding complaints; and
- the real level of service is not uniform.

New solutions can be implemented mainly in new housing developments, but can also be considered, in conjunction with relief sewers, in older areas. In new developments, appropriate street grading and inlet controls can minimize sewer surcharge even for very rare storms. When combined with increased measures taken by homeowners, these techniques can provide several lines of defense against different causes of flooding. In every case, the key to effective application of new solutions seems to be public education and participation in the choice of alternatives.

There is also need for a change in the design philosophy for drainage systems. Without such a change, new systems will perpetuate the problems of the older ones, take many years to complete and delay the protection of homes. However, it is harder to get municipal funding for pilot projects related to alternative solutions than it is for relief-sewer schemes.

To this end, provincial and federal agencies have an important role to play in accelerating the adoption of new solutions. Specifically, there is role for Canada Mortgage and Housing Corporation (CMHC) because the prevention of basement floods requires a holistic approach including subdivision planning and recommendations for building aspects related to foundation drains. CMHC could also help bring about change by disseminating information to the public and promoting improved participation in decision-making and greater involvement by homeowners.

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Housing Research at CMHC

Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

This fact sheet is one of a series intended to inform you of the nature and scope of CMHC's research.

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