THE USE OF REAL TIME CONTROL TO REDUCE SPILLS FROM COMBINED SEWER OVERFLOWS IN A MULTI TANK CATCHMENT

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1. Introduction

This paper describes part of a research project jointly funded by the DoE and members of the RTC steering group. The objective of the RTC steering group is to develop manual methods of optimisation for sewerage networks using Real Time Control. As part of this work IHS conducted a study to apply Real Time Control to a theoretical catchment model. The purpose of the study was to use the lessons learnt from this application to develop broad methodologies for carrying out RTC studies for urban drainage systems.

The sewerage system contains 11 overflow structures that are all located at detention storage sites. All tanks have the design criteria of 15 spills per annum except two tanks that can only spill 5 times per year because of their environmentally sensitive locations.

The study focused on three elements of RTC.

- The selection of design criteria
- Different levels of optimisation
- Presentation of results

2. The Selection of Design Criteria

It is reasonable to expect as a minimum criteria that the implementation of RTC should provide a level of performance at least as good as the static (no variable control) solution.

There are many possible design criteria applicable to sewerage systems. This study addressed spills from overflows (primarily the number of spills, but also the quantity) as a measure of the storage required and flooding on the catchment surface.

Perhaps the most important element in the definition of design criteria is the selection of an appropriate rainfall data set. 3 types were considered.

- Synthetic rainfall
- Stochastic rainfall data (STORMPAC)
- Annual time series

The synthetic design storms were initially favoured because the derivation of a single design event would significantly reduce the number of simulations required, however it was later rejected for two reasons. Firstly a single design return period could not be derived, because different tanks have different spill criteria. Secondly it is not possible to derive a single rainfall (critical) duration because the critical duration is different for each of the tanks.

Another problem with design rainfall events is that they are all single peaked and "normal curve" profiled. One of the concepts of RTC is to control the system to smooth the peaks and troughs which exist in a real rainfall event to maximise the available storage in a sewerage system. The single peak of a design event does not provide the possibility to do this.

The stochastic rainfall generator was rejected because a continuous simulation of many years worth of data would simply produce too much output data to be analysed feasibly. This means that a "typical" year would have to be determined which would be applied as an annual time series. However as an annual time series already exists, this replication of effort was not considered necessary for this study.

The annual time series rainfall data set was selected as the most appropriate because it represents the typical range of rainfall depths, durations and intensities likely to act on the catchment.

Spatially varying rainfall is thought to offer a great potential for improvement of the system through the use of RTC and this was demonstrated by some very simple tests. However there is not yet a suitable data set for a full analysis of spatial variation and this is suggested as an area of further work.

3. Different Levels of Optimisation

It is recommended that a staged approach is taken to the application of RTC. At each stage a cost/benefit analysis should be conducted to determine the feasibility of the proposals. The main stages are presented below.

- The existing system
- The optimised static system
- Local RTC control
- Global RTC control

The main advantage of global control over local control is that there can be communication between locations. Hence a global strategy can be developed to control the whole system.

Global RTC is based on the notion that during a rainfall event, parts of a catchment will be fully utilised and parts will have spare capacity available for storage. These utilised and un-utilised areas may change during an event. Global RTC can be used (in theory) to move or store water in certain areas to utilise the spare capacity and hence reduce the impact of the storm. The notion of spare capacity being available at different locations in the catchment at different times is described as "Time Windows".

To assess the availability of Time Windows, the storage available at any location (usually a tank) must be presented for each time step during an event. HydroWorks does not do this directly, but the results can be manipulated to provide a hydrograph of available storage.

4. Presentation of Results

It is expected that real time control will be applied to very large catchments and hence during many RTC studies, very large amounts of data will be created. It is important to analyse and present this data in a useful way. The study found ways of comparing the storage required to meet the design criteria for the different stages application and also to compare the total spill during all ATSR events and the spill from each tank for a number of events.

5. Conclusions

1. The results show that the implementation of RTC can produce savings in terms of the quantity of spill to local water courses from combined sewer overflows.

2. The risk of increased flooding cannot be totally removed for all rainfall events. However RTC can be used to limit possible increases in flooding. This study discusses the factors which are important when assessing the level of risk.

3. The study demonstrates the importance of the definition of design criteria, particularly the selection of rainfall data.

4. It is important to conduct careful data analysis and develop suitable methods of presentation.

5. The development of suitable global RTC rules is a very complex subject.