HYDRAULIC STRUCTURES IN URBAN DRAINAGE SYSTEMS

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Contents

1. Introduction

Large hydraulic structures are of major importance to sustained life-support systems and have an impact on the environment. Dams, reservoirs and open canals are such structures, the impact of which has been duly appreciated and addressed in environmental impact assessments and side-effects amelioration programs. Less obvious, but of vital importance, is the impact of urban drainage systems on humanity's immediate living environment. Water brought in for urban or rural consumption gives rise to effluent that has to be disposed of eventually. Manufacturing and consumption generate waste products and packaging materials that have to be dealt with by disposal of flushing systems, dependent on water.

Equally important is the handling of street drainage of storm rainfall. The interception, collection, conduction and effective disposal of storm water, household sewerage and industrial effluent are collectively dealt with under the title of Urban Drainage Systems. This article in what follows will examine the details of hydraulic structures created for this purpose. The waterborne sanitation systems of cities and towns have become an integral part of civilization. A network of sewers and out-fall systems blankets every urban complex, but is tucked in, out of sight underground. A vast array of hydraulic pipes and channels is built-in below the streets and edifices of the modern, and most of the ancient cities, as well as in towns and villages. Such hydraulic structures need to be well designed and constructed, in order to function reliably and lessen the negative impacts of concentrated living and working quarters on the environment. However, at rare intervals, these elaborate systems might temporarily break down, such as when deluges and floods strike, or earthquakes, or civil uprising, and consequently disruption of services may occur, possibly leading to outbreaks of disease of epidemic proportions. Domestic sewerage, industrial effluent and storm water have to be effectively collected, and conducted through and out of complex living, industrial and commercial areas.

Storm water run-off from paved areas and urban developments such as factory rooftops, is always greater than for the pristine state, and has to be appropriately designed for. Disruption of the urban drainage system, due to floods, can cause serious damage to water supply distribution systems leading to potable water shortage as a result of excess flood water. Generally a dual system of drainage and waste water disposal exists in most cities and towns: one system for storm water runoff and the other system for sewerage. These systems are in some localities combined into a single sanitation/storm drainage network system. This has obvious disadvantages and health hazards, and may under adverse circumstances lead to disease outbreaks of epidemic proportions.

Where streams and rivers become waste-water conveyances, besides being used as supply sources for domestic drinking-water or washing-up and gardening water, this hazard is evidently obvious. Rivers such as the Rhine and Danube, that are perennial, might be able to cope with this stress, but small, ephemeral river systems would not.

In addition to a discussion of separate (dual) and combined (single) drainage systems, in what follows, such hydraulic components as kerb-inlets, drains, pipes, channels, inspection chambers, head-walls, retention/detention ponds, out-falls are discussed. Water treatment works for potable water supply, contribute some effluent, and sewerage treatment works to handle domestic effluent (waste water and sewerage), are separately dealt with. These involve hydraulic structures such as grit channels, mixing basins and settling tanks, which are well documented in Water Treatment and Sanitary Engineering textbooks, for example those by Metcalf and Eddy, Fair and Geyer, etc. (see *Guidelines for Potable Water Purification*). The problem of urban litter finding its way into water courses is another serious concern and is addressed in the following section.

2. The Removal of Urban Litter from Waterways

One of the unavoidable products of well-being in a civilization is unfortunately the creation of waste, leading to litter that enter the environment via water courses. In primitive societies containers such as gourds, bags made from animal skin, clay pots and even ostrich eggshells served admirably for transporting and keeping life supporting products such as water, olive oil and wine. These containers were used repeatedly and being valuable to the possessor were not discarded or wasted.

With the development of effluence disposable containers, packages, plastic products and paper bags replaced the traditional gourds, skins and pots. This gave rise to the generation of waste products on an enormous scale requiring trash removal services.

A major problem with urban litter that arose was the indiscriminate discarding of waste material into the urban storm water drainage system, with the resulting malfunctioning and unhygienic state of affairs.

2.1 Background

Urban litter, consisting mainly of manufactured materials such as *bottles, cans, plastic and paper wrappings, newspapers, shopping bags and cigarette packets* - but also including items such as *used car parts, rubble from construction sites and even old mattresses* - accumulates around shopping centres, car parks, fast food outlets, markets, railway and bus stations, roads, schools, public parks, landfill sites and recycling depots.

Unless it is quickly swept up, it is only a matter of time before it is transported away by the wind and/or storm water run-off, and finds it way into the urban drainage system, where it has a serious detrimental effect. Since many of these types of waste material are not bio-degradable, they form a permanent pollution hazard to the entire hydrological cycle (see *Ageing of Plastics*).

2.2 Transport into Drainage and Waterways Systems

What happens to the transported litter depends on the type of drainage system provided. In the wealthy countries of the temperate zone where litter loads and rainfall intensities are low and the drains are likely to be underground, gratings are usually placed over the entrances to the drains. These gratings intercept the majority of the litter which may then be removed by the local authority.

Many of the drainage systems in these countries are of the *dual* or *combined* type, that is, storm-water and sewage are conveyed in the same network. It is therefore generally possible to remove a large percentage of the remainder of the litter at the sewage treatment works with the aid of mechanically raked screens, or other types of patented mechanical devices.

The main problems arise when storm runoff exceeds the capacity of the sewage treatment works and the surplus effluent is discharged into a nearby stream. Although dilution and the natural cleansing properties of the stream are often able to cope with the sewage component, urban litter, being largely of inorganic origin, steadily accumulates in the environment.

2.3 Disposal of Litter

In the poorer countries of the tropics and subtropics, litter loads and rainfall intensities are much higher - sometimes orders of magnitude higher. Underground drainage is not always feasible and even when provided gratings can seldom be placed over inlets without increasing the risk of blockage and consequential flooding to unacceptable proportions. Even when such basic services as litter collection and removal are supposedly provided, poverty and mismanagement often lead to their collapse. Litter is thus washed directly into the waterways with each storm event.

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Biographical Sketches

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