Gross solids in small sewers

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Abstract

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INTRODUCTION

This paper contains an examination firstly of the mechanisms of movement of gross solids in smaller sewers with intermittent flow, and secondly an examination of the changes in flushing habits over the last century or so. Finally the paper will examine how these two issues interact, and the implications for the future.

Movement mechanisms.

Major foul sewer systems consist of a number of different hydraulic regimes. The large diameter main trunk sewers will have flow at all times, and will carry both sediment loading and gross solids (solids that are greater then 6mm in any one direction). However, the smaller pipes near the head of the sewer system often carry intermittent flow, and can spend periods of time with no flow at all, particularly overnight. This has important implications on how large sanitary or gross solids flushed into the system from toilets/WCs are transported. In large pipes, solids are moved within the flow, at some proportion of the velocity, usually called a velocity decrement mechanism of solid movement, but in smaller pipes there is a different mechanism of movement. Observations made in an experimental test rig (Littlewood & Butler, 2002; 2003) show that, for many solids, the usual way that the solid moves is not by floating in the wave, but by sliding along the invert of the pipe. The solid remains in contact with the pipe at all times, and one of the critical drivers is the build up of head behind the solid. This means that the solid will move in response to a combination of forces, including the forces on the upstream end of the solid and friction effects. However, the solid will have an effect on the wave by acting as a dam, and so it will reduce the depth and velocity of the flow downstream of the solid. We have termed this a ‘sliding, leaking dam’ mechanism. The distance a particular solid will move is dependent on the subtle interplay of these forces, and these forces are in turn dependant on the nature of the solid, the gradient of the pipe, and the volume of the flush wave.

Flushing habits and composition of sewage

There were several articles in the press during 2004 (e.g. The Times Nov 22 2004) about the flushability of disposable products, and the possibility of these products causing blockages. These articles often imply that the new products cause blockages, by talking about the time that the products take to break down. However, the situation is not that simple.

People's flushing habits have changed significantly over the last century, due to a number of drivers. One driver has been the development of new products and materials. Over the last 50 years in particular there have been a number of new products developed which are intended to be flushed down the WC, and these have been developed in response to changes in habits and materials. Many of these new products use different materials to traditional products.

Examples of these are the development of "flushable" sanitary towels in the 1970s and 1980s. These towels often contained plastic, and one of their selling points was that they were flushable. Soft toilet tissue was introduced in the early 1960s, and this replaced newspaper and Izal style papers. More recently there are a number of wipes that are commonly flushed, even when the manufacturer does not intend them to be, as well as flushable toilet brushes, temporary wet strength toilet paper and nappy liners.

A second driver in what ends up down the WC is changes in lifestyle. One fundamental change in waste disposal has been the driven by the removal of fires for heating. These were once the favoured method of disposal for a number of items, such as sanitary towels and nappies, as well as organics, wood waste, paper, packaging and kitchen waste. Conversely ash, newspaper and coal were all commonly found in sewers in the 1950s (ISE (1954)), as the WC was used to dispose of the cleanings from the fire.

The removal of such a discreet and permanent method of disposal was one of the drivers behind the introduction of 'flushable' nappies and sanitary towels in the 60s and 70s. A move towards a more disposable society combined with the rise in the use of plastics in disposable products has lead to issues with disposable razors, cotton buds, disposable contact lenses, and more widespread use of condoms, all of which are commonly disposed of via the WC.

There are a range of attitudes towards the WC as a disposal mechanism, from people who only flush what it is intended for, to people who use the WC as a wet bin. This can be exacerbated by circumstances – for example, nappies may not be disposed of in the waste bin by people who do not have an outside dustbin because of the problems with storage of the bin, and the possibility of odours. Discretion can also be an issue for some items such as condoms, and the WC is of course used to get rid of illegal items discreetly on occasion.

Implications

The composition of sewage has therefore been changing significantly over the years, from a substantially biodegradable bulk, to one which contains a proportion of non-biodegradable material. Of course the bulk of sewage is made up of faecal material, but a 1995 study found that up to 16% was made up of sanitary towels (Meeds and Blamforth 1995)and there are interesting implications of these changes.

Within sewage, it is often the product that is visible that will be deemed to be the cause of the blockage, and many of these new products do not break down immediately, and so they can be identified in the material making a blockage. This means that they are often stated as being the cause of the blockage. However, it is highly likely that the real cause of the blockage is a fault in the sewer, or at the very least interactions between unsuitable items and a fault in the sewer. WRc have carried out a number of tests in our small bore

test rig that show that even a small misplaced joint will have a significant effect on solid transport in the intermittent flow regime, due to the mechanism of movement.

WRc bowl clearance and drain clearance test rig

It is the sliding dam mechanism of movement that is often the problem, as the product will fail to slide along the suffix of the pipe, and will strand, and then may act as a dam, collecting further solids, which can eventually lead to a blockage. In some cases, of course, unsuitable items are flushed, such as teddy bears, false teeth and pythons, and these will cause a blockage.

CSO screens

The other main implication of this is for the design of CSO screens. The most common item found on beaches by Beachwatch is now cotton buds. These can get through most CSO screens. CSO screens also blind quickly due to the presence of plastics from sanitary towels and panty liners.

THE WAY FORWARD

Gross solids were not important when our sewerage system was designed, as many of them did not exist. The transport of gross sanitary solids is not routinely and explicitly considered in the design of small sewers, and CSO screens are not designed to screen out some of these solids, for example, cotton buds.

An issue that the industry needs to consider is how acceptable the development of some of these products is, and how they wish to steer the development of these products in the future. An example of how they may wish to steer the use of these products is the development of Bag It and Bin It campaigns, which encourage users to dispose of items via the solid waste route. It may also be necessary for the Water Industry to develop standards of what they are prepared to accept in the sewers, so for example, nothing that contains plastics of any kind.

However, the major issue is that there is still a lack of understanding of the mechanisms of blockage formation, in particular how the solid, pipe and flow all interact, and when there is a blockage, we still don't know what we are looking for to ascertain the cause of the blockage. Blockages must be a function of the sewer type, material, gradient, roughness etc, along with the solid characteristics such as size, density, coherency, degradability and aspect ratio. These then interact with the flow regime, and blockages form, but the mechanism is highly complex, and may be affected by other issues such as the distance from the source of the flow, layout of the drain, and upstream appliances. This lack of

understanding may mean that there will be problems in the future with changing patterns of water usage.

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