The Affects of Pipe Types on Drainage Designs

The engineer is faced with an increasing choice of pipes, constructed using numerous techniques and materials. Aside from the differences in unit and laying costs, these differences can also affect how pipes perform hydraulically. This review introduces the importance of designing and modelling drainage networks using the correct parameters.

Firstly, the research simulated deformation in pipes. It is possible that some pipes will deform when under load. Micro Drainage research found that pipes subjected to a 10% compression could see flows reduced by up to 6%. Even greater affects on flows can be seen if the pipe roughness coefficient is changed from its default to the correct value for certain pipes.

Table 1.1 below shows the variety that can be expected in pipe roughness alone. The effect of using the correct roughness coefficient within a pipe design can be striking. Running a small pipe network for each of the above Manning's n values compared to the control of 0.6 k roughness coefficient (Colebrook-White) found that with corrugated pipes flows could be reduced by up to 46%.

Table 1.1: Manning's n Roughness Coefficients for a selection of commonly used pipe types

Pipe type	Manning's n Roughness Coefficients		
	High	Average	Low
Asbestos-Cement Pipe	0.011	0.013	0.015
Cast Iron (new)	0.012	0.0125	0.013
Clay Pipe	0.011	0.013	0.015
Concrete - steel forms		0.011	
Concrete - finished		0.012	
Concrete - Wooden forms		0.015	
Concrete - centrifugally spun		0.013	
Corrugated metal		0.022	
Galvanised Iron		0.016	
Plastic		0.009	
Polyethylene PE (corrugated inner walls)	0.018	0.0215	0.025
Polyvinyl Chloride (pvc)	0.009	0.01	0.011
Steel -smooth		0.012	

Such a reduction in some cases caused flooding, but in other models the slower flows resulting from the increased roughness created a form of 'attenuation' as the water is held back for a longer period of time at the upstream end of the network. The effect of which was that flows from the various branch lines no longer converged at the same point and time and so flooding no longer occurred. Furthermore, pipes with a higher roughness value can aid users trying to meet predefined discharge rate (such as reducing runoff to greenfield rates) by slowing the flows through the network.

The 46% reduction in pipe flows can be mediated if corrugated pipes are used at the initial design stage. The above comparisons were based on networks that were designed to meet sewers for adoption standards at the design stage, so used a default k roughness of 0.6 and designed with a fall adequate to achieve at least 1 m/s for self-cleansing velocities. They were then simulated using the correct roughness for the pipe. If the correct pipe roughness is applied for the pipes during their design Win*Des*® will auto-design and increase the fall and/or diameter of the pipes to meet the 1 m/s minimum velocity. When these files are simulated, the reduction in flow is a more reasonable 17.4%, nearly two thirds less than the systems that did not factor the pipe roughness at the initial design stage.

However, meeting the self-cleansing velocities during design comes at a price. In one Micro Drainage model, which contained just eight pipes, the outfall invert level was 2.087m lower than the control network. This has obvious implications for those trying to connect into existing systems. Furthermore, the pipe diameter required is often one size larger for corrugated sections compared to smooth bore pipes.

What is clear from the research is that the choice of pipes can make a substantial difference on a drainage design. In some cases the results of the simulation will be invalidated if the pipe details used do not match those of the pipes laid on site. With this in mind, both developers and checking authorities should be conscious of the pipe types when designing and checking drainage networks.

James Berryman

Micro Drainage Limited
Jacob's Well,
West Street,
Newbury,
RG14 1BD

Tel: +44 (0) 1635 582555
Info@microdrainage.co.uk
www.microdrainage.co.uk