

Sewerage —

Part 5: Guide to rehabilitation of sewers

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Civil Engineering and Building Structures Standards Policy Committee (CSB/-) to Technical Committee CSB/5, upon which the following bodies were represented:

- Association of Consulting Engineers
- Association of County Councils
- Association of District Councils
- British Ceramic Research Ltd.
- British Coal
- British Plastics Federation
- British Precast Concrete Federation Ltd.
- British Tunnelling Society
- Clay Pipe Development Association Limited
- Concrete Pipe Association
- Construction Industry Research and Information Association
- Convention of Scottish Local Authorities
- County Surveyor's Society
- Department of the Environment (Property Services Agency)
- Department of Transport (Highways)
- Federation of Civil Engineering Contractors
- Fibre Cement Manufacturers' Association Limited
- Health and Safety Executive
- Hydraulic Research Station Ltd.
- Institute of Water Pollution Control
- Institution of Civil Engineers
- Institution of Environmental Health Officers
- Institution of Public Health Engineers
- Institution of Structural Engineers
- Institution of Water Engineers and Scientists
- Royal Institute of British Architects
- Scottish Development Department
- Trades Union Congress
- Water Authorities Association
- Water Research Centre

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

This British Standard, having been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 28 October 1990

- British Steel Industry
- Federation of Sewer Renovation Contractors

Amendments issued since publication

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The following BSI references relate to the work on this standard:
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Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
Section 1. General	
1 Scope	1
2 Definitions	1
3 Abbreviations	2
4 Approach to sewer rehabilitation in UK and overseas	2
5 Sewerage Rehabilitation Manual (SRM)	4
Section 2. Rehabilitation procedures	
6 Planning procedure	6
7 Integrated approach	6
8 Maintenance	6
9 Project appraisal	7
Section 3. Technical application	
10 Structural performance	9
11 Hydraulic performance	12
12 Structural upgrading	13
13 Hydraulic upgrading	13
14 Safety	17
Appendix A Bibliography	19
Figure 1 — Rehabilitation options	8
Figure 2 — Example of SRM data sheet	10
Figure 3 — Details of information to complete SRM data sheet	11
Table 1 — Age/materials relationship for UK sewers	3
Table 2 — Example performance criteria	12
Table 3 — Rehabilitation options to reduce hydraulic input to the sewer system	14
Table 4 — Rehabilitation options to maximize the use of existing sewer system capacity	14
Table 5 — Rehabilitation options to attenuate peak flows	15
Table 6 — Rehabilitation options to increase sewer system capacity	16
Publications referred to	Inside back cover

Foreword

This Part of BS 8005 has been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee and is directed at general engineering practitioners who may either be embarking on a career in sewerage or be dealing with a particular aspect for the first time. It is not intended to be exhaustive in any field but sets out to present guidance on basic principles and good practice, indicating where a more detailed and comprehensive study may be made. BS 8005 supersedes and enhances CP 2005:1968, which is withdrawn, although some of the material incorporated is a restatement of the earlier text.

BS 8005 gives guidance on the planning, design, construction, operation and maintenance of works to convey sewage, including storm sewage, surface water and trade effluents to a sewage treatment works, tidal waters or other final place of disposal. Recommendations are given for the repair, renovation and replacement of sewers.

Many end users of this British Standard, such as governments, public authorities, sewerage authorities and consultants, issue their own recommendations and specifications for sewerage which BS 8005 is intended to complement rather than replace. This is particularly so with regard to the Sewerage Rehabilitation Manual (SRM) published by the Water Research Centre (WRc)[1].

BS 8005 is published in six separate Parts, as follows.

- *Part 0: Introduction and guide to data sources and documentation;*
- *Part 1: Guide to new sewerage construction;*
- *Part 2: Guide to pumping stations and pumping mains;*
- *Part 3: Guide to planning and construction of sewers in tunnel;*
- *Part 4: Guide to design and construction of outfalls;*
- *Part 5: Guide to rehabilitation of sewers.*

It has been noted that substantial one-part codes and guides take a long time to revise and if they are reviewed at infrequent intervals, they tend to become out of date quickly, especially in a field where technological development is rapid. The SRM was last revised in April 1986 and mentions a number of techniques as being “established”. Since that date a number of developing renovation techniques have been, or are in the process of being, tested and installed.

Appendix B of the SRM lists a number of systems at various stages of development which are being monitored by WRc at pilot scale or full scale control trials. Other systems are being developed independently of these trials. It is intended therefore to keep a constant watch on new developments and to update BS 8005, Part by Part, as well as the SRM as soon as the work can be justified.

BS 8301 sets out recommendations for building drainage and, while it relates generally to smaller pipelines, there is some overlap between it and BS 8005. BS 6297 gives recommendations for the design and installation of small sewage treatment works and cesspools.

Apart from Part 0, which is directed more specifically at the UK sewerage field, BS 8005 is for use both in the UK and, in appropriate circumstances, overseas.

Suggestions for the improvement of any Part of BS 8005 will be welcomed by the Secretary of SEB/43 at British Standards Institution, 2 Park Street, London W1A 2BS.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This Part of BS 8005 provides guidance on the procedures to be followed when considering the investigation and appraisal of the various options available to upgrade the structural and hydraulic performance of existing sewerage systems from the planning of the initial investigations to final completion.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover. Other references will be found throughout the text, indicated by bracketed numbers thus [7], and these are listed in the bibliography in Appendix A of this part.

The titles of British Standards not referred to in this Part of BS 8005 but of interest as dealing with closely associated subjects are listed in Appendix A of BS 8005-1:1987, and other publications that may be of interest are listed in Appendix B of BS 8005-1:1987.

2 Definitions

For the purposes of this Part of BS 8005, the definitions given in BS 8005-0 and BS 8005-1 apply, together with the following, some of which enlarge upon those given in the above standards.

2.1 catastrophic rainfall event

rainfall event of return frequency far in excess of any sewerage design performance criteria typically, say, a 1 in 200 year storm

2.2 core area

part of a sewer network containing the critical sewers, and other sewers where hydraulic problems are likely to be most severe and require detailed definition within a flow simulation model

2.3 crack

crack line visible on the pipe wall, with the pieces still in place

2.4 critical sewer

sewer where the potential consequences of structural failure justify detailed investigation and, where appropriate, pre-emptive rehabilitation

2.5 environmental impact

change to existing conditions within the environment brought about by a specific action

2.6 exfiltration

escape of flow from sewer into surrounding ground

2.7 flooding (from sewers)

condition where foul or surface water escapes from a sewerage system and lies either on the surface or enters basements

2.8 flow reduction

process of decreasing flows into a sewer system or of removing a proportion of the flow already in a sewer system

2.9 flow simulation

modelling of flows in surface water or combined sewer systems using a dynamic digital model

2.10 fracture

crack visibly open along the length and/or circumference with the pieces still in place

2.11 infiltration

entry of groundwater into sewer

2.12 sewer

pipeline or other construction, usually underground, designed to carry foulwater, waste water, surface water or other unwanted liquids

2.13 sewer connection

connection, that may be a saddle connection, of lateral pipe or drain to a sewer other than by a purpose made or preformed junction in the sewer run

2.14 sewer junction

purpose made or preformed junction pipe built into the sewer usually during construction

2.15 sewer lateral

pipe connected to a sewer

2.16 sewer rehabilitation

all aspects of upgrading of existing sewer systems to improve structural flooding and environmental impact performance

2.17 structural sewer rehabilitation

repair, renovation and renewal of sewer systems

2.18**hydraulic sewer rehabilitation**

replacement, reinforcement, flow reduction or attenuation, storm sewage overflow rationalization and some renovation of sewer systems

2.19**sewer reinforcement**

provision of an additional sewer which, in conjunction with an existing sewer, increases overall flow capacity

2.20**sewer renovation**

construction of a new sewer, on or off the line of an existing sewer, the basic function and capacity of the new sewer being similar to that of the old

2.21**sewer repair**

rectification of damage to the structural fabric of the sewer and the reconstruction of short lengths, but not of the whole of the pipeline

2.22**sewer replacement**

construction of a new sewer, on or off the line of an existing sewer. The function of the new sewer will incorporate that of the old, but may also include improvement or development work

2.23**sewer surcharge**

condition in which foul or surface water sewage is held within a gravity sewer system under pressure but does not escape to the surface

2.24**social cost**

cost incurred by society as a result of sewerage works and for which authorities have no legal responsibility

3 Abbreviations

For the purposes of this Part of BS 8005 the abbreviations given in BS 8005-0 and BS 8005-1 apply, together with the following:

CCTV	Closed circuit television
OCF	Overall cost factor
RCF	Repair costs factor
RQO	River quality objective
RWA	Regional water authority
SRM	Sewerage Rehabilitation Manual
SSO	Storm sewage overflow
WAA	Water Authorities Association ^a
WRc	Water Research Centre

NOTE Abbreviations for use on data sheets are given in Figure 3.

^a Now replaced by the Water Services Association of England and Wales.

4 Approach to sewer rehabilitation in UK and overseas**4.1 General**

In the UK and elsewhere the attention of engineers is increasingly being directed towards:

- the consideration of the performance of existing sewerage systems;
- the design of appropriate upgrading works to achieve desired levels of service and to maintain asset condition.

The approach to rehabilitation planning described in this British Standard can be applied universally but the emphasis should be varied depending on age and material of sewer together with functional and climatic factors.

The age/material relationship for UK sewers is shown in Table 1. It will be noted that although clay sewers make up nearly 80 % of the system, the older sewers of concern (critical sewers) are predominantly brick and the younger sewers of concern are predominantly concrete.

Table 1 — Age/materials relationship for UK sewers

Age	Brick	Clay	Concrete	Other	All
	%	%	%	%	%
Pre-1914	3 (95)	19 (26)	0.1	0.3	22
1914 to 1945	0.7 (100)	23 (24)	1.4 (71)	0.5	26
Post 1945	0.2 (100)	36 (18)	13 (69)	3	52
All	4	78	14	4	100
Critical	25	14	60	1	100 (90)
NOTE Figures in parentheses are percentages of sewers of 300 mm diameter or larger.					

In other countries the sewers tend to be younger than in the UK so brick sewers tend to be fewer and less of a problem.

In the UK about 70 % of systems are combined at least in part. Similar proportions are found in Germany and the Netherlands but in many other countries separate systems predominate. The environmental impact of combined and separate systems can be comparable but needs to be tackled somewhat differently. For example, with combined systems a major concern is pollution of receiving waters from premature operation of storm sewage overflows (combined sewer overflows). With separate systems the concern is often the overloading of foul sewers and the potential overloading of treatment works from extraneous flows arising from infiltration and from surface water drains being misconnected.

Climatic differences have to be considered. The UK has a temperate climate with moderate rainfall intensities. In hotter climates the rehabilitation procedures have to be adapted to take account of the higher risks of corrosion of cementitious materials and in colder climates account has to be taken of frost heave. In wetter climates the volumes of flow to be dealt with may make combined systems inappropriate, may rule out piped surface drainage systems and will certainly reduce the opportunities to use additional storage as an upgrading option for alleviating flooding.

4.2 Identification of need of rehabilitation

Identification of a need to carry out works on an existing sewerage system, as opposed to the construction of new sewers to serve specific developments, tends to arise as the system becomes older, overloaded, or damaged. Symptoms occur such as structural collapse, flooding of gardens, roads or properties at an increasing frequency, pollution of water courses or groundwater, ground settlement caused by leaking or collapsed sewers, and operational problems such as blockages. These may be associated with hydraulic overloading, structural failure, or a combination of the two.

Many of the developed areas of the world have drainage systems, the earliest parts of which date back to the nineteenth century. Often these have been added to over the years to meet increases in population without much regard for the effect on the rest of the system. The evolved network can be seriously out of balance when considering the drainage area as a whole, with substantial potential for optimization or rationalization.

In the UK, approximately 95 % of the sewer system is too small in diameter for effective manual inspection. Hence, until the advent of CCTV in the 1960s very little was known about the condition of the majority of the system and any action had to be on local reactive basis. By the time this stage has been reached, considerable damage and disruption may have been caused which could have been avoided by pre-emptive rehabilitation procedures.

Manual and CCTV inspection of sewers is not a cheap process and the costs of dealing with a problem sewer vary considerably according to location, depth and size. For instance, dealing with a collapsed small diameter sewer at a shallow depth in a lightly trafficked road is a very different problem from dealing with the collapse of a deep main sewer under a busy road in an inner city area.

4.3 Integrated strategy

With the development of inspection techniques, it became apparent that cost effectiveness could be achieved by the adoption of a selective inspection and repair policy linked to a fully integrated strategy. This has been developed and refined and is described in detail in the WAA/WRc "Sewerage Rehabilitation Manual". This philosophy has been accepted by the Water Industry in the UK which, having pioneered much of the early work on sewers, now has one of the highest proportions in the world of its population served by an existing public sewerage system.