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WAA Sewers and Water Mains Committee: Materials and Standards

Information and Guidance Note

ASBESTOS-CEMENT PIPES AND FITTINGS

1. INTRODUCTION

Asbestos-cement pipes consist of a highly compacted cement matrix containing approximately 11% by weight of asbestos fibres. They have been used by the UK Water Industry for over 50 years, during which time the manufacturing process has changed very little.

Whilst asbestos-cement pipes and fittings are no longer manufactured in the UK, imported pipes will be manufactured to the appropriate British Standards. BSI Kitemark Certification Schemes will either be established or continue to operate as appropriate.

2. APPLICATIONS

Pipes to BS 486 are used for water mains and sewage pumping mains, also for industrial purposes such as the transportation of slurries.

Pipes to BS 3656 are used for sewers and drains, and occasionally for non-pressure pipelines in water resource systems. They are suitable for low pressure applications up to 12m head of water.

Thrust boring and jacking may be catered for using pipes to ISO 4488. There are applications for asbestos-cement pipes, to other standards, in building and sanitary piping; these are not covered by this IGN.

3. DIMENSIONS

BS 486: Specification for asbestos-cement pressure pipes and joints is based on ISO 160; the ISO standard lists internal diameters from 50mm up to 2500mm without specifying outside diameters or tolerances.

BS 486 gives the outside diameter at finished ends for the range of internal diameters 50 to 900mm, which have been in general use in the UK. Beyond this, internal diameters up to 2500mm are listed, but without specifying outside diameters or tolerances. Some sizes are non preferred.

NOTE. Sizes 50mm and 60mm are no longer available in the UK.

The specified outside diameters of pressure pipes do not correspond with those of iron, steel or uPVC pipes. Prior to metrication of standards for iron pipes in 1970/1971 and asbestos-cement pipes in 1973, the outside diameters of pipes made in the UK were identical for both materials, except that until 1959, Class B asbestos-cement pipes above 10 inch diameter matched Class C iron pipes, and Class D 15 and 18 inch asbestos-cement pipes were unique in having outside diameters of 17.84 and 22.06 inches respectively. To connect asbestos-cement pipes to other pipe materials, adaptors are available.

BS 3656 — Specification for asbestos-cement pipes, joints and fittings for sewerage and drainage, is based on ISO 881, and lists a range of internal diameters (some of them non preferred) from 100 to 2500mm. Nominal thicknesses of the pipe barrels are to be specified by the manufacturer, who also establishes the diameters and tolerances of the finished ends. The standard specifies lower deviations of the tolerances for barrel thickness excluding machined ends.

BS 486 and BS 3656 each specify preferred minimum lengths of 3m for pipes up to and including 200mm nominal diameter, and 4m for larger pipes. For pipes of 150mm and below, BS 486 controls the breaking stress and BS 3656, the breaking load over a span of 2m, but neither specifies directly the beam strength of the pipe as a whole. Thus purchasers may need to consider the maximum pipe length which is acceptable in the light of the superimposed load and the degree of support to be expected from the trench bottom or bedding material.

ISO 4488 will remain should asbestos-cement pipes be required for thrust boring or pipe jacking but the equivalent BS 5949 is being withdrawn through lack of use. ISO 4488 lists a range of internal diameters from 150mm up to 2000mm, classified according to the maximum jacking forces.

Nominal diameters up to 2500mm are listed as well but without any further classification.

Nominal wall thicknesses are to be specified by the manufacturer. Designers should note that chemical resistance and transverse crushing strength requirements are optional.

4. USEFUL PROPERTIES

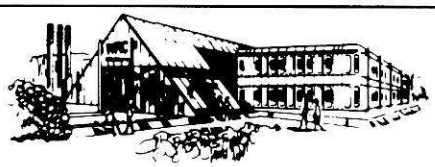
Water mains and sewage pumping mains

- Able to withstand fluctuating internal pressure (including negative pressure), and (with additional bedding support in the case of larger pipes and greater depths) external loads;
- Resistant to electro-chemical corrosion and normal sewage;
- No encouragement to biological growths;
- Low permeability to oil and gas;
- Low (and well maintained) hydraulic resistance;
- Joints retractable and allow limited flexibility;

Sewers

- Able to withstand external loads (with additional bedding support in many cases);
- Able to accept surcharge up to 12m head;
- Resistant to some chemicals;
- Infrequent joints;
- Joints retractable and allow some angular deflection;

WATER RESEARCH WRc ENGINEERING
Frankland Road, Blagrove, PO Box 85, Swindon, Wiltshire SN5 8YR
Tel: (0793) 488301 Telex: 449541



- Long radius bends;
- Tightness against infiltration and exfiltration.

5. DISADVANTAGES

General

- Special precautions needed when cutting or turning, both in the factory and on site, to prevent inhalation of asbestos fibres.

Water mains and sewage pumping mains

- Susceptible to lime leaching, particularly by soft waters, and to acid and sulphate attack by soils and conveyed waters of low pH and high sulphate content respectively;
- Heavier and more brittle than some competing pipes;
- More frequent joints and loose collar joints more complicated than competing socket designs;
- Lack of pipe barrel precision can cause difficulty with repair couplings;
- Low beam strength in smaller sizes;
- Permeable to low molecular weight organic solvents e.g. toluene;
- Not traceable underground (with current equipment) except by laying metal tracer during installation.

6. STANDARD TESTS

Tests specified as mandatory or optional in BS 486 and BS 3656 include:

Dimensional tolerances
Internal pressures and/or resultant stresses
Transverse crushing loads and/or stresses
Acid resistance (BS 3656 only)
Longitudinal bending test.

7. STANDARD STRENGTH CLASSIFICATION

Pressure pipes

BS 486 classifies pipes up to 1000mm according to the works hydraulic test pressure, by multiples of 5 up to 35 bar, and by multiples of 6 up to 36 bar. However for pipes in general use in the UK, the dimensions relate only to Classes 15, 20 and 25, **which correspond to maximum allowable working pressures (static or cyclic peak) of 7.5, 10 and 12.5 bar respectively.** The overall factor of safety varies from 4 for diameters below 125mm to 2.5 for diameters above 500mm. The standard requires pipes larger than 1000mm to be designed for the specific pipeline. The marking on pressure pipes may include the nominal diameter, pressure class (or wall thickness if not classified), and the thickness at the spigot end.

Sewers

BS 3656 classifies pipes into 7 series according to their ultimate transverse crushing loads and strengths. Series 1 to 4 appear in ISO 881, whilst Series L, M and H are peculiar to the BS, and represent pipes generally used in the UK in sizes up to 1050mm. BS 3656 recommends that, taking into account all the loads and method of laying adopted, a class is selected which gives a safety factor against crushing of at least 1.3 for diameters up to 1000 and 1.5 for diameters above 1000. The marking on sewer pipes may include the series, nominal diameter, the wall thickness in the body, the thickness at the spigot end and an indication that they are for sewerage use. Larger diameters up to 2500mm are available.

8. QUALITY ASSURANCE

British Standard Kitemark Schemes are in operation, based on the previous editions of BS 486 and BS 3656; these do not cover cast iron fittings for pressure pipes. Sampling and inspection clauses in the 1981 editions of BS 486 and BS 3656 are under review in relation to quality assurance and Kitemark licences. All asbestos-cement pipes and fittings to those standards should be specified to be Kitemarked.

9. FITTINGS

Only BS 3656 makes reference to fittings made of asbestos-cement. They are required to have the same composition, strength and characteristics as the equivalent pipes, and may be fabricated by cementing. Their longitudinal dimensions are left to the manufacturer.

Fittings available for use with sewer pipes include tees and angle branches, saddle connections, bends up to 90°, reducers, flanged adaptors and end caps.

For pressure pipes asbestos-cement bends are available ranging in size/angle from 200mm/90° to 1200mm/$5\frac{5}{8}$°.

Fittings (reducers, adaptors, flanged adaptors) are also available in cast iron or fabricated steel from the pipe manufacturer.

10. JOINTS

BS 486 and BS 3656 specify the requirements for asbestos-cement sleeves intended for jointing pipes or fittings. The standards require that other materials used for jointing devices shall comply with the relevant international standards.

The British Standards require sealing rings to comply with BS 2494. The revision of BS 2494, which includes Water Industry requirements, was published in 1986; complying sealing rings are resistant to biodegradation. Care should be exercised in the choice of rubber for specific industrial effluents. Further guidance is provided in IGN No. 4-40-01.

Assembled joints, when tested at the factory, are required to withstand specified test pressures when set to the maximum angular deflections recommended by the manufacturer.

Lubrication of the joint components is vital for successful jointing. Lubricants are not covered in the standards for pipes and if intended for use with pipes intended to carry potable water must be specified to comply with the requirements of the UK Water Fitting Byelaws Scheme IGN No. 5-01-02.

Push-fit joints comprising a loose sleeve and two rubber rings of stabilised "O" type are available for all sizes of pressure pipe. Pressure pipes may also be jointed with steel mechanical couplings, available in all sizes above 150mm or with cast iron detachable bolted joints, available in sizes up to and including

250mm; the long sleeved version is useful for providing latitude for the insertion of specials, or where unusual movement is expected. Stepped couplings, asbestos-cement or metallic, are a convenient means of connection to pipes of different diameter. Iron and steel joints and their bolts and nuts may be obtained nylon coated; otherwise protection by poured bitumen, waterproof wrapping or heat shrink sleeving is necessary.

Sewer pipes commonly employ fully retractable push-fit joints similar in principle to those for pressure pipes.

11. CONNECTIONS

Small services pipe connections to pressure pipes may be made by driving a ferrule of the (EBCO) Barber Hays type into a drilled hole, or by drilling and tapping for a screwed ferrule. Threads of adequate strength can be cut in the bare pipe, but it is common practice to give extra security by tapping through a suitable ferrule and saddle strap combination. The latter practice is particularly desirable in the size range 75-300mm, where the service pipe is rigid, or where the consequences of failure of the connection could be unusually serious. When making service connections to AC mains, tapping should be carried out against a counterflow of water to minimise the levels of cutting debris entering the supply.

Connections to sewers are made either with purpose-made branches or with asbestos-cement saddles which are attached to the pipe with an epoxy cement of mortar-like consistency. Some manufacturers have developed connections without saddles. The connections are directly branched onto the main pipe by means of epoxy cement.

12. PROTECTION

BS 486 and BS 3656 allow the asbestos fibres to be bound with either ordinary Portland cement to BS 12, Portland blast furnace cement to BS 146 or sulphate-resisting Portland cement to BS 4027. The requirements for acid resistance are the same in all standards. None of the current standards requires coating of the pipes but bituminous coatings complying with the Type II requirements of BS 3416: 1975 are recommended for normal use. For potable water supply the coatings should be listed by the UK Water Fittings Byelaws Scheme.

It is recommended that AC pipes (bitumen dipped) should not be used:

- for conveying waters where free CO_2 (mg/L) $\geqslant$ 20 + 0.51 $\times$ carbonate hardness (mg/L as $CaCO_3$), or
- where the conveyed water/soil pH $<$ 5.5, or
- where the sulphate content of either the conveyed water or the soil ground-water exceeds 5,000 mg/L (as SO_3), or
- where the sulphate content of the soil exceeds 20,000 mg/L (2%) (as SO_3),

as these will impair the engineering performance of the pipe. Furthermore, there will be an increased risk of fibre release into supply where the conveyed water is of an aggressive nature. For special applications coatings of epoxy and epoxytar are available.

13. PIPELINE DESIGN

General design considerations are covered in CP 2005 (BS 8005 from early 1987): Sewerage and CP 2010 (BS 8010): Pipelines, of which Part 1 deals generally with the installation of pipelines in land, and Part 4, which is currently under review, deals specifically with the design and construction of asbestos cement pipelines in land.

Pipes under 200mm are unlikely to fail by crushing. Since asbestos-cement pipelines are rigid, it will normally be sufficient to determine the effect of backfill and superimposed loads on sewer pipes by using the "Simplified tables of external loads on buried pipelines" published by the Building Research Establishment, or similar pipe manufacturers' tables taking account of the actual outside diameters of asbestos-cement pipes. For pressure pipes and other cases requiring more detailed analysis, the use of Transport and Road Research Laboratory's "A guide to design loadings for buried pipelines", is appropriate. A very detailed method of analysing all combinations of loads is contained in ISO 2785 "Guide to the selection of asbestos-cement pipes subject to external loads with or without internal pressure"; this standard has been under revision for a number of years.

WRc is currently reviewing the question of pipeline embedment design for this and other pipeline materials and it is intended to publish simplified guidance in due course.

For calculating the hydraulic capacity of asbestos-cement pipelines the Colebrook-White formula is commonly used for both sewers and water mains. This is conveniently presented in Hydraulics Research "Tables for the hydraulic design of pipes and sewers" (4th Edition), and "Charts for the hydraulic design of channels and pipes" (5th Edition). It should be noted that WAA "Sewers for adoption" (2nd Edition) gives roughness values of 1.5mm and 0.6mm for foul/combined sewers and surface water sewers respectively. ISO 7336 also gives guidance on hydraulic calculations for asbestos-cement pipelines.

14. HANDLING AND LAYING

Asbestos-cement pipes are generally robust, but are susceptible to hair cracks if struck on or close to the spigot end. It is therefore prudent to carry out a careful and close visual inspection of pipe ends after unloading and just before laying, but this is no substitute for careful handling at all times. Whilst the presence of hair cracks can usually be detected, their full extent may not be apparent. Therefore if it is necessary to reclaim a pipe known to be cracked, CP 2010 (BS 8010) recommends cutting back at least 50mm beyond the apparent extremity of the longest crack. A wider margin would be prudent, and the position in the pipeline of any reclaimed pipe, should be noted. (In a repair situation the whole pipe should be replaced).

The low beam strength of asbestos-cement pipes compared with iron and steel makes it the more important to ensure that a firm and uniform bed is provided. It may be found economic to over-excavate the trench and provide a compacted granular bed, rather than attempt to form a bed in the natural ground. For pipes over 150mm diameter, manufacturers recommend laying in a well prepared trench on a bed of selected backfill. Where the design of the pipeline includes a specified degree of support to the haunches, it is important to check that this is achieved in practice.

More complete information on laying is given in BS 5927 and on field testing in BS 5886.

15. HEALTH AND SAFETY

Dry abrasive discs should not be used for cutting any asbestos-cement pipes; discs should be water flushed.

Pressure pipes made in the UK from 1955-1964 and sewer pipes made in the UK from 1967-1970 contain crocidolite. Amosite was contained in both until 1979. (The use of crocidolite or amosite in new products is now prohibited in the UK.) HM Factory Inspectorate (HMFI) require 28 days notice before any work can start on materials containing crocidolite (blue asbestos). If in any doubt HMFI should be consulted. An HSE approved respirator should be worn by anyone cutting or turning, by whatever means, pipes containing crocidolite or amosite, or whilst cutting crocidolite/amosite-free pipes with a water flushed disc.

As long as the control limits are not exceeded a respirator need not be worn for lower speed operations on crocidolite/amosite-free pipes e.g. hand sawing, turning (the cutting area being kept damp), drilling under pressure, or cutting with tools designed by or approved by the pipe manufacturer (e.g. Reed or Wheeler pilot rotary cutters and field lathes). Sludge, dust, turnings and offcuts should be carefully removed whilst damp for disposal in sealed, marked bags.

At the time of publication the control limits are 0.2 fibre/mL for crocidolite or amosite and 0.5 fibre/mL for other types of asbestos.

Asbestos-cement should not be high pressure jetted without wearing respirators.

Further information is given in the Health and Safety Guidance Note EH 36, Work with asbestos cement, and EH 35 Probable asbestos dust concentration at construction processes; both of these documents should be consulted.

Information is also given in the Water Industry Forum for Health and Safety Advisory Broadsheet 7-14.

The question of the possible significance to health of asbestos fibres in drinking water has been examined and is reviewed in WRc publication TR 202. No measureable risk to health has been established but the question remains under consideration. Until it is resolved conclusively, it would be prudent to avoid the use of AC pipe for the conveyance of those potable waters which may increase the potential for fibre release, i.e. soft waters and those of relatively low pH and/or high sulphate contents.

16. SUMMARY AND CONCLUSION

There is a long service experience for asbestos-cement pipes in the UK. Used correctly, they can provide sound and durable pipelines for the conveyance of water and sewage.

17. REFERENCES

Publications referred to in this Information and Guidance Note:

BS 12	Specification for ordinary and rapid-hardening Portland cement.
BS 146	Portland-blastfurnace cement. Part 2 Metric Units.
BS 486	Specification for asbestos-cement pressure pipes and joints.
BS 2494	Specification for elastomeric joint rings for pipework and pipelines.
BS 3416	Black bitumen coating solutions for cold application.
BS 3656	Specification for asbestos-cement pipes, joints and fittings for sewerage and drainage.
BS 4027	Specification for sulphate-resisting Portland cement.
BS 5886	Methods for field pressure testing of asbestos-cement pipelines.
BS 5949	Asbestos-cement pipes and joints for thrust boring and pipe jacking.
CP 2005 (BS 8005)	Sewerage. (Revised — to be published).
CP 2010 (BS 8010)	Pipelines. Part 1 Installation of pipelines in land. (Under revision). Part 4 Design and construction of asbestos-cement pipelines in land (Under revision).
ISO 160	Asbestos-cement pressure pipes and joints.
ISO 881	Asbestos-cement pipes, joints and fittings for sewerage and drainage.
ISO 2785	Guide to the selection of asbestos-cement pipes subject to external loads with or without internal pressure.
ISO 4488	Asbestos-cement pipes and joints for thrust boring and pipe jacking.
ISO 7336	Asbestos-cement pipelines — Guidelines for hydraulic calculation.
WRc report TR 202	Asbestos in drinking water.
Health and Safety Guidance Note EH35	Probable asbestos dust concentrations at construction processes
Health and Safety Guidance Note EH 36	Work with asbestos-cement
WAA SWMC IGN No. 4-40-01	Selection, properties, storage and installation properties for elastomeric seals and sealing rings.
UK Water Fittings Byelaws Scheme IGN No. 5-01-02	Requirements for the testing of non-metallic materials for use in contact with potable water.
Building Research Establishment	Simplified tables of external loads on buried pipelines.
Transport and Road Research Laboratory	A guide to design loadings for buried rigid pipes.
Hydraulics Research	Tables for the hydraulic design of pipes and sewers.
Hydraulics Research	Charts for the hydraulic design of channels and pipes.
WAA	Sewers for adoption.
Water Industry Forum for Health and Safety Advisory Broadsheet No. 7-14	Safe handling of asbestos products.