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14 PIPES AND FITTINGS MATERIALS

14.1 GENERAL

14.1.1 Scope

- 1 This Part includes the manufacture, factory testing and supply of pipes and appurtenances of different materials for use in pipelines.
- 2 Related Sections and Parts are as follows:

This Section

Part 1 General
Part 4 Pipeline Installation
Part 5 Valves, Penstocks and Appurtenances
Part 6 Miscellaneous Metal Works
Part 7 Miscellaneous GRP Works
Part 8 Protective Coatings and Painting
Part 11 Sewer Rehabilitation
Part 12 Vacuum Sewerage System

Section 5 Concrete
Section 19 Plumbing Works
Section 20 Drainage Works to Buildings.

14.1.2 References

- 1 The following standards or revised/updated versions are referred to in this Part:

ANSI B16.3 Malleable Iron Threaded Fittings
ANSI B16.5 Steel Pipe Flanges and Flanged Fittings
ANSI B16.9 Factory-Made Wrought Steel Butt Welding Fittings
ANSI B16.11 Forged Steel Fittings, Socket Welded and Threaded
ANSI B16.28 Wrought Steel Butt Welding, Short Radius Elbows and Returns
ANSI B 36.19 Stainless Steel Pipe

ASTM A53 Standard specifications for Pipe, Steel, Black and Hot-dipped, Zinc-coated Welded and Seamless
ASTM A105 Standard specifications for Forging, Carbon Steel, for Piping Components
ASTM A182 Standard specifications for Forged or Rolled Alloy-steel Pipe Flanges, Forged Fittings, Valves and Parts for High Temperature Service
ASTM A234 Standard specifications for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A240 Standard specifications for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plated, Sheet and Strip for Pressure Vessels
ASTM A312 Standard specifications for Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A403 Standard specifications for Wrought Austenitic Stainless Steel Piping Fittings

- ASTM A774.....Standard specifications for As-Welded, Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperature
- ASTM A778.....Standard specifications for Welded Unannealed Austenitic Stainless Steel Tubular Products
- ASTM D1000.....Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
- ASTM D1004.....Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
- ASTM D2412.....Standard Test Methods for External Loading Characteristics of Plastic Pipe by Parallel Plate Loading
- ASTM D2584.....Standard Test Method for Ignition Loss of Cured Reinforced Resins
- ASTM D3681.....Standard Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe in a Deflected Condition
- AWWA C209Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- BS 65:1991Vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings
- BS 864.....Capillary and compression tube fittings of copper and copper alloy
- BS 882.....Specification for aggregates from natural sources for concrete; (EN 12620 Aggregates for concrete)
- BS 2494Elastomeric seals for joints in pipework and pipelines
- BS 2782Methods of testing plastics
- BS 3063Dimensions of gaskets for pipe flanges
- BS 3396Woven glass fibre fabrics for plastics reinforcement
- BS 3532Method of specifying unsaturated polyester resin systems
- BS 3749“E” Glass fibre woven rovings for the reinforcement of polyester and epoxy resin systems
- BS 4027Specification for Sulphate-resisting Portland cement
- BS 4346Joints and fittings for use with unplasticised PVC pressure pipe
- BS 4483Steel fabric for the reinforcement of concrete. Specification
- BS 4449Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification
- BS 5391Acrylonitrile butadiene-styrene (ABS) pressure pipe
- BS 5392Acrylonitrile butadiene-styrene (ABS) fittings for use with ABS pressure pipe.
- BS 5556General requirements for dimensions and pressure ratings for pipe of thermoplastic materials
- BS 5911Concrete pipes and ancillary concrete products
- BS 5955Code of practice for plastic pipework (thermoplastic materials)
- BS 6076Tubular Polyethylene film for use as protective sleeving or buried iron pipes and fittings

- EN 197Cement
- EN 295Vitrified clay pipes and fittings and pipe joints for drains and sewers
- EN 545Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods
- EN 598Ductile iron pipes, fittings, accessories and their joints for sewer pipelines - Requirements and test methods
- EN 639Common requirements for concrete pressure pipes including joints and fittings
- EN 642Prestressed concrete pressure pipes
- EN 1057Copper and copper alloys
- EN 1092Flanges and their joints
- EN 1401Plastic piping systems
- EN 12620Aggregates for Concrete
- EN 13244Plastic piping systems
- EN 14020Reinforcements. Specification for textile glass rovings
- EN 14118Reinforcement. Specifications for textile glass mats
- EN 14364 & EN 1796 --- Glass-reinforced thermosetting plastics (GRP)
-EN 14364: Plastics piping systems for drainage and sewerage with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Specifications for pipes, fittings and joints; EN 1796 Plastics piping systems for water supply with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP); (ISO 23856 Plastics piping systems for pressure and non-pressure water supply, drainage or sewerage - Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin)
- ISO 1456Metallic and other inorganic coatings
- DIN 30674-3Coating of ductile cast iron pipes; zinc coating with protective covering
- ISO 4179Ductile Iron Pipes for Pressure and Non-Pressure Pipelines, Centrifugal Cement Mortar Lining, General Requirements
- ISO 4633Rubber Seals - Joint Rings for Water Supply, Drainage and Sewage Pipelines - Specification for Materials.

14.1.3 System Description

- 1 Pipes and fittings, except for those used in treated sewage effluent pipelines, shall be suitable for carrying sewage at temperatures of up to 45°C with hydrogen sulphide concentrations up to 400 mg/l.
- 2 Treated sewage effluent pipelines shall be suitable for chlorine concentration up to 15 mg/l.
- 3 Pipes shall be suitable for immersion in corrosive groundwater conditions typically exhibiting the following characteristics unless otherwise specified:

SO ₃ Content	:	1.7 g/l
Cl Content	:	1.07 g/l
pH	:	8.6
Conductivity	:	4000 μ s/cm

4 The Contractor's attention is drawn to the stringent limits on infiltration detailed in Clause 4.5.2 of this section.

5 The Contractor shall be responsible for providing a jointing system as recommended by the pipe manufacturer that enables the installation and use of the designated pipeline systems.

14.1.4 Submittals

1 The Contractor shall order materials to suit the construction programme and obtain the Engineer's approval of submittals before placing orders. The Contractor shall submit two copies of the following documents for the approval of the Engineer:

(a) product data

- (i) originals of catalogues and engineering data sheets for manufactured items. Each item and option to be provided shall be clearly marked and each item not to be provided shall be deleted
- (ii) literature to show that products provided meet the requirements for material, construction, operation, and tests
- (iii) information on the following items as a minimum:
 - pipes
 - flexible couplings
 - gaskets
 - isolating joints
 - sealant systems
 - linings and protective coatings
- (iv) manufacturer's installation instructions for all items
- (v) certified reports for all tests and inspections designated herein, signed and sealed, showing full compliance with referenced standards
- (vi) maintenance requirements and procedures
- (vii) period of guarantee for products
- (viii) Manufacturer's test reports for hydrostatic proof testing, sustained pressure testing and burst strength testing.

(b) shop drawings

- (i) Piping material, class, grade and joint type, thickness or schedule, seam or seamless, coating information if applicable.
- (ii) fittings, couplings, and joints
- (iii) for concrete pipes, details of reinforcement, concrete and joints for straight
- (iv) pipes, specials and connections

(c) design data

- (i) If glass reinforced plastic (GRP) pipes with a stiffness exceeding designated values by more than 30 percent are proposed, the Contractor shall include in his submittal complete structural design calculations indicating the effect of the proposed variation in pipe stiffness of the deformation modulus of the bedding material or any other related aspect

14.1.5 Delivery, Handling and Storage

1 Each pipe, fitting and special appurtenance shall be marked with permanent identification which shall include but not necessarily limited to the following:

(a) nominal diameter

- (b) name or trade mark of manufacturer
 - (c) serial number
 - (d) class of pipe, pressure rating in compliance with referenced standards
 - (e) date of manufacture
 - (f) type of service
 - (g) details on fittings such as angle of change and taper
 - (h) circular concrete pipes with asymmetrical reinforcement shall have the letter "T" clearly marked on the inside and outside to indicate the top of the pipe when laid.
- 2 The acceptability of the pipes and fittings on delivery to the Site will be based on the results of tests carried out by one or more of the following:
- (a) the manufacturer at the place of manufacturer
 - (b) the Engineer
 - (c) a third party on behalf of the Engineer
- 3 The Engineer shall be permitted at all reasonable times to visit places of manufacture to witness tests.
- 4 The Engineer may require checking of the dimensional accuracy of GRP pipes and fittings at the place of manufacture, the cost of such verification shall be borne by the Contractor.
- 5 Transport, handling and storage of pipes and fittings shall be carried out as follows:
- (a) in accordance with the manufacturer's recommendations subject to the approval of the Engineer
 - (b) effective precautions shall be taken to prevent damage to the pipe and fittings.
- 6 During transport
- (a) pipes and fittings shall be well secured and adequately supported along their length
 - (b) bolsters and binding of approved type shall be used
 - (c) nesting of pipes (placing a smaller pipe inside a larger) may be permitted for pipes of certain materials and size provided that methods statements demonstrate that effective precautions will be taken to protect all pipe surfaces and coatings from damage
 - (d) no pipe shall overhang the end of a vehicle
 - (e) pipes and fittings of plastic materials shall be covered.
- 7 Handling shall be carried out as follows:
- (a) pipes should be lifted singly and not handled as bunches
 - (b) pipes shall be handled only by means of
 - (i) approved hooks, of the type having a plate curved to fit the curvature of the inside of the pipe, on ends of sections
 - (ii) fabric slings not less than 250 mm wide
 - (iii) other methods approved for the pipe used
 - (c) use of wire rope, chains and fork lift trucks will not be permitted
 - (d) for strings of pipe longer than the standard length precautions shall be taken to avoid curvature and longitudinal stress in excess of allowable limits
 - (e) pipes and fittings of plastic materials

- (i) smaller than 300 mm diameter may be handled manually, larger than 300 mm diameter and greater than 4 metres in length shall be lifted using fabric lifting straps or large diameter rope slings positioned at a quarter of the pipe length from each end
 - (ii) there should be enough slack in the slings to keep the hook approximately 600 mm over the pipe
 - (iii) steel chain or hooks shall not come into contact with the pipe
 - (f) VC pipes and fittings shall be transported in pallets and handled only with suitable equipment
 - (g) pipes and fittings shall not be dropped or bumped
 - (h) pipes shall not be dragged over the ground
 - (i) if rolled, pipes shall be rolled only over adequate timber bearers to prevent damage
 - (j) where necessary, chocks shall be used to prevent lateral movement of pipes.
- 8 All pipes, fittings and materials shall be stored in accordance with the manufacturer's recommendations and the following:
- (a) pipes may be stored in the open on a flat level area and raised above the ground on timber bearers so that the lowest point of any pipe or fitting is not less than 150 mm above the ground
 - (b) timber bearers not less than 200 mm wide and 75 mm thick to be provided at 4 m intervals maximum
 - (c) if on pallets or crated, on the pallets or in their crates until required
 - (d) if not on pallets or not crated, stacked one above the other as follows:
in accordance with the manufacturer's recommendations but not to a greater number of tiers than the following:

pipes \geq 900 mm diameter	2 tiers
< 900 mm \geq 600 mm diameter	3 tiers
< 600 mm diameter	4 tiers

 - (i) suitable protective packing shall be placed between tiers to the approval of the Engineer
 - (ii) wrapped pipes shall not be stacked
 - (e) if spigot and socket, stacked so that successive pipe layers have sockets protruding at opposite ends of the stack
 - (f) with pipes of different sizes and thickness stacked separately
 - (g) with maximum height of stacked pipes not exceeding 2 m, or that recommended by the supplier if less than 2 m.
- 9 Pipes and fittings of plastic materials including GRP shall be:
- (a) stored under cover and out of direct sunlight
 - (b) adequately supported along their length
 - (c) provided with a free flow of air around the pipe.
- 10 Storage of jointing materials shall be as follows:
- (a) under cover
 - (b) rubber ring gaskets shall
 - (i) be stored in their original packing

- (ii) not be exposed to sunlight
 - (iii) protected from exposure to greases and oils
- (c) gasket lubricants shall be stored so as to prevent damage to the container.
- 11 Pipes and fittings shall be protected in storage to the approval of the Engineer by means of an impermeable membrane which shall cover the pipes and fittings and separate them from the ground on which they are supported. The membrane shall be strong and durable in the prevailing climate conditions.
- 12 Pipes and fittings shall be subject to visual inspections after off-loading at site and before installation.
- 13 The following procedures shall be followed for dealing with damaged pipes and fittings:
 - (a) pipes and fittings damaged during transportation handling and storage shall be set aside and the damage brought to the attention of the Engineer
 - (b) pipes or fittings that show signs of corrosion or deterioration during storage shall immediately be treated to arrest and prevent the corrosion or deterioration or removed from Site, as the Engineer directs
 - (c) proposals for repair shall be submitted in writing for the Engineer's approval
 - (d) no attempt shall be made to repair damage without the Engineer's approval
 - (e) if in the Engineer's opinion the nature of any damage is such that the condition of a pipe has been impaired and cannot be repaired the pipe concerned shall not be incorporated in the Works
 - (f) all rejected pipes shall be immediately removed from the Site
 - (g) damaged pipe shall be replaced or repaired by the Contractor at his expense and such repairs shall be to the approval of the Engineer
 - (h) the Engineer may require that any GRP pipe or fittings found to be damaged to be subjected to a further hydraulic test which shall be carried out by the Contractor, at the Contractor's expense, in accordance with the requirements of Subpart 4.5 of this Section.

14.1.6 Pipe Materials

- 1 For the purposes of this specification the following shall apply:
- (a) Pipes of steel, glass reinforced plastic (GRP), PVC-U and polyethylene shall be deemed to be flexible pipes.
 - (b) Pipes of concrete, vitrified clay and ductile iron shall be deemed to be rigid pipes.

14.2 VITRIFIED CLAY PIPES AND FITTINGS

14.2.1 Standards

- 1 Pipes and fittings for foul sewerage and surface water applications shall be manufactured to EN 295.
- 2 Pipes and fittings for land drainage applications shall be manufactured to BS 65.
- 3 Sealing rings shall be to BS 2494 or ISO 4633.

14.2.2 Manufacture

- 1 Pipes and fittings shall comply with the following:
- (a) pipes shall have spigot and socket type joints.

- (b) pipes shall be glazed both internally and externally.
- (c) all pipes shall be free of cracks, blisters, broken ends and other imperfections.
- (d) vitrified clay pipes shall have the minimum strength requirements shown on Table 3.2

Table 3.2 – Minimum Strength Requirements

Nominal Bore (mm)	Min. Crushing Strength (FN) kN/m	
	Foul / SW (Non-Perforated)	Land Drains (Perforated)
100	28	28
150	28	28
200	40	28
300	60	34
400	64	44
500	80	60
600	96	-
800	96	-
1000	95	-

- 2 Joints shall be as follows:
- (a) Pipes and fittings shall be supplied with flexible mechanical joints of the spigot and socket type joints.
 - (b) Sealing rings shall be of elastomeric material suitable for foul sewerage and surfacewater drainage works, as the case maybe, conforming to BS 2494 or ISO 4633.
 - (c) Acceptance of VC pipes on delivery is dependent upon the Contractor demonstrating that the joints are capable of meeting the water test requirement of Clause 4.5.2 of this Section.
 - (d) Polypropylene sleeve couplings shall not be used.
- 3 Fittings shall be capable of withstanding the same load as the adjacent pipes or shall be provided with concrete surround.

14.2.3 Inspection and Testing

- 1 Barrel impermeability, straightness, crushing strength and bending moment resistance and chemical resistances tests shall be carried out in accordance with EN 295 at the frequency designated for the crushing strength test.

14.2.4 Repair Couplings for VC Pipes

- 1 Repair couplings shall be obtained from an approved manufacturer and shall consist of a moulded synthetic elastomeric sleeve which is fastened over the pipe ends by stainless steel clamping bands and be complete with a stainless steel shear ring. The repair coupling shall be suitable for use with vitrified clay pipes and shall include a bushing adapter when joining to a pipe of the same nominal bore but of a different outside diameter.
- 2 Repair couplings shall comply with the joint performance requirements of BS 65 and be capable of withstanding an external water pressure of 60 kPa without leaking.

- 3 Sleeves and bushes shall comply with the requirements of EN 681-1. Clamping bands and shear ring shall be made from 300 series austenitic stainless steel.

14.3 CONCRETE PIPES AND FITTINGS

14.3.1 Standards

- 1 Except as otherwise designated, concrete pipes and fittings shall conform to the requirements of this Subpart following standard specifications:
- (a) reinforced and unreinforced, BS 5911
 - (b) prestressed non-pressure concrete pipes, BS 5911.

- 2 The strength requirement and other features of particular application shall be as specified in this Subpart or designated in the contract specific documentation.

14.3.2 Pipe Materials

- 1 Cement used for manufacturing pipes and fittings shall be Ordinary Portland cement conforming to EN 197-1.
- 2 Aggregate shall conform to BS 882.
- 3 Reinforcement shall conform to BS 4449 or BS 4483 as appropriate.
- 4 Admixture shall be used only with the written permission of the Engineer. The methods of use and the quantities of admixtures used shall be subject to the approval of the Engineer. Admixture containing calcium chloride will not be permitted.

14.3.3 Manufacture

- 1 Pipes and Fittings:
- (a) Storage of concrete materials, mixing, curing and testing of concrete shall be in accordance with the appropriate Clauses in Section 5. Any deviation from these clauses shall be made only with the approval of the Engineer
 - (b) unless stated otherwise crushing strengths of pipes shall not be less than those designated in BS 5911 for the designated classes of pipes.
 - (c) Reinforced concrete pipes shall have a minimum effective length of 2.5 m except as otherwise designated or required for special purposes such as curves, closures or built in pipes.
 - (d) Steel reinforcement shall be accurately placed in the concrete wall. The placement of all steel shall not vary from the designated position in the pipe wall by more than ± 6 mm from the nominal position. In no case shall the cover to the reinforcement be less than 25 mm.
 - (e) The planes of the ends of the pipes shall be perpendicular to their longitudinal axis.
- 2 Joints
- (a) except as specified in other Parts of this Section, pipe joints shall be supplied with flexible mechanical joints of the spigot and socket type in accordance with BS 5911, double collar or sleeve type
 - (b) gasket stock shall
 - (i) comply with BS 2494.
 - (ii) be a synthetic rubber compound in which the elastomer is exclusively neoprene.
 - (iii) solid compound shall contain not less than 50 % by volume of neoprene and

- shall not contain reclaimed rubber or deleterious substances.
- (iv) stock shall be extruded or moulded and cured in such a manner that cross-sections are dense, homogeneous and free from porosity, blisters, pitting and other imperfections.
 - (v) stock shall be extruded or moulded with smooth surfaces to the designated size within a tolerance of $\pm 6\%$ measured on joint cross-section dimensions.
 - (c) the sealing ring shall be confined in a contained groove on the spigot face of each pipe section to properly position and confine the rubber gaskets in the annular space
 - (d) each joint shall contain a neoprene ring gasket as follows:
 - (i) the gasket shall be the sole element depended upon for watertightness of the joint.
 - (ii) the gasket shall be of circular cross-section unless otherwise approved by the Engineer.
 - (iii) the length and cross-sectional diameter of the gasket, the annular space
 - (iv) provided for the gasket, and all other joint details shall be such as to produce a watertight joint which shall not leak when pulled 13 mm over and above the initial jointing allowance.
 - (e) the initial jointing allowance is the gap between the spigot and the shoulder of the socket measured parallel to the centre of the pipeline and shall not be less than 6 mm or greater than 12 mm.
 - (f) Joints shall be capable of maintaining water tightness up to an angular deflection of 2° from true, in any direction.

14.3.4 Plastic Lining

- 1 Where designated concrete pipes shall be lined with polyvinyl chloride plastic (PVC) liner plate. The PVC liner plate material shall be as specified in Section 5 Part 14.6. The liner plate shall be securely fixed to the formwork before pouring concrete and all in-situ welding of the liner plate shall be carried out by skilled labour using the methods specified by the manufacturer. Purpose made units shall be used where required; e.g., at junctions.
- 2 The installation of liner plates in concrete pipes or structures, and the sealing and welding of joints, shall be carried out in strict compliance with all applicable specifications, instructions and recommendations of the plastic liner plate manufacturer. All welding of liner plate shall be carried out by properly trained and approved workmen.
- 3 Once cast into the pipe, the liner shall be permanently and physically attached to the concrete by the locking mechanism and shall not rely on an adhesive bond.
- 4 The lining shall withstand a 100 kPa hydrostatic back pressure applied to the under surface of the lining without losing anchorage or without rupture.
- 5 Damaged liner plate shall be repaired in accordance with the manufacturer's recommendation and to the approval of the Engineer.

14.3.5 Epoxy Coating

- 1 All exterior surfaces of concrete pipes shall be coated by the pipe manufacturer with a heavy duty, solvent free epoxy suitable for application to fresh concrete as specified in Section 5. A minimum of two coats shall be applied to attain a minimum total dry film thickness of 400 μm .

14.3.6 Inspection and Testing

- 1 Inspection procedures and tests shall be carried out at the place of manufacture. Pipes and joints shall be hydrostatically tested in accordance with BS 5911.
- 2 The performance of pipes shall be verified by the testing of random sample pipes in accordance with the type of inspection and batch size mentioned. The pipes shall be subject to rejection on account of non-compliance with the following:
 - (a) failure to pass hydrostatic test
 - (b) failure of the longitudinal concrete surfaces of joints to meet dimensional tolerances
 - (c) fractures or cracks
 - (i) passing through the shell, except that a single end crack that does not exceed the depth of the joint shall not be cause for rejection; however
 - (ii) if a single end crack that does not exceed the depth of the joint exists in more than 10 % of the pipes inspected, the defective pipes shall be rejected
 - (d) defects that indicate defective mixing and moulding
 - (e) surface defects indicating honeycomb or open texture
 - (f) spalls
 - (i) deeper than one half the depth of the joint
 - (ii) extending more than 100 mm around the circumference
 - (iii) smaller than one half the depth of the joint or less than 100 mm around the circumference exist in more than ten percent of the pipes
 - (g) insufficient cover to the reinforcement.

14.4 GLASS REINFORCED PLASTIC (GRP) PIPES AND FITTINGS

14.4.1 Standards

- 1 All activities relating to this section of the particular specification shall comply with the following or approved equal standard. The latest version of the standard indicated shall apply.

Statutory provisions shall always apply as amended from time to time.

Generally applicable standards:

EN 681Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications.

EN 14364Plastic piping systems for drainage and sewerage with or without pressure. Glass reinforced-thermosetting plastics (GRP) based on unsaturated polyester resin (UP). Specification for pipes, fittings and joints

EN 1796Plastic piping systems for water supply with or without pressure – Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP)

CEN TS 14632Plastics piping systems for drainage, sewerage and water supply, pressure and non-pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Guidance for the assessment of conformity

- ISO 25780Plastic piping systems for pressure and non-pressure water supply, irrigation, drainage or sewerage – Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin – Pipes with flexible joints intended to be installed using jacking techniques
- ISO 3126Plastic pipes. Measurement of dimensions wall thickness table.
- ISO 4633Joint rings for water supply, drainage and sewerage pipelines: Specification for materials
- ISO 1172Textile-glass-reinforced plastics, preprints, moulding compounds and laminates - Determination of the textile-glass and mineral-filler content - Calcination methods
- DIN 16 869 - Part 1 ...Centrifugally cast and filled glass fibre reinforced polyester resin pipes - dimensions.
- DIN 16 869 - Part 2 ...Glass-fibre reinforced polyester resin pipes (UP-GF) – Centrifugally cast – filled Part 2: General quality requirements, testing.
- ISO 178Plastics – Determination of flexural properties
- ISO 527-1Plastics – Determination of tensile properties – Part 1: General principles
- ISO 527-2Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics
- ISO 15306Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the resistance to cyclic internal pressure
- ISO 10952Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Determination of the resistance to chemical attack for the inside of a section in a deflected condition
- ISO 10928Plastics piping systems - Glass-reinforced thermosetting plastics (GRP) pipes and fittings - Methods for regression analysis and their use
- DIN 16966 -6.....Glass fibre reinforced polyester resin (UP-GF) pipe fittings and joint assemblies; collars, flanges, joint rings, dimensions
- DIN-16945Testing of Resins, Hardeners and Accelerators, and Catalyzed Resins
- DIN-16946 - Part 1Cured casting Resins - Testing DIN-16946- Part 2 Cured casting Resins - Types
- ISO 75Plastics – Determination of temperature of deflection under load
- ISO 527-4Plastics – Determination of tensile properties – Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites
- ISO 10468Glass-reinforced thermosetting plastics (GRP) pipes – Determination of the long-term specific ring creep stiffness under wet conditions and calculation of the wet creep factor (ISO/DIS 10468:1999)
- ISO 14828Glass-reinforced thermosetting plastics (GRP) pipes – Determination of the long-term specific ring relaxation stiffness under wet conditions and calculation of the wet relaxation factor (ISO/DIS 14828:1999)
- EN 681-1Elastomeric seals – Material requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanized rubber
- EN 1119Plastics piping systems – Joints for glass-reinforced thermosetting plastics (GRP) pipes and fittings – Test methods for leak tightness and resistance to damage of flexible and reduced articulation joints

- ISO 10466Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test method to prove the resistance to initial ring deflection
- ISO 7685Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial specific ring stiffness
- ISO 8513Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of longitudinal tensile properties
- ISO 8521Plastic piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test methods for the determination of the apparent initial circumferential tensile strength
- EN 1447Plastics piping systems – Glass-reinforced thermosetting plastics (GRP) pipes – Determination of long-term resistance to internal pressure
- ISO 7509Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes —Determination of time to failure under sustained internal pressure
- ASTM D2997Standard Specification for Centrifugally cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- ISO 2078Textile glass — Yarns — Designation (ISO 2078)
- ASTM D 3517-01Standard Specification for “Fiberglass”(Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe

14.4.2 Design

- 1 The design of GRP pipes, fittings and bedding shall be carried out by the pipe manufacturer to enable the pipe to meet the requirements of the Works. The following general requirements shall prevail for pipes and fittings:
- (a) they shall be designed to achieve a minimum working life of 60 years under all applicable standard loadings, environmental and installation conditions
 - (b) they shall have a minimum stiffness of $10,000 \text{ N/m}^2$
 - (c) Non-pressure pipes and fittings shall be designed for a nominal pressure rating of PN 01 (1 bar)
 - (d) Pressure pipes and fittings shall be designed for a normal operating pressure rating of PN16 (16 bar) to pressure ratings in ISO 25780, EN 14364 or EN 1796.
 - (e) they shall convey a liquid with a temperature up to 45°C
 - (f) they shall be designed to withstand up to 5% long term deflection in their installed conditions.
 - (g) all bends shall be long radius bends unless otherwise approved by the Engineer.
 - (h) they shall be capable of withstanding a 95% lower confidence strain of 0.85% over 60 years without failure or cracking when tested in accordance with the strain corrosion type test requirements specified herein.
 - (i) sewerage and drainage pipelines and fittings shall be designed to carry septic sewage having a maximum hydrogen sulphide concentration of 50mg/l at a temperature of 45°C
 - (j) irrigation pipelines and fittings shall conform to the water supply standards
 - (k) The manufacturer shall provide a valid Certificate of Conformity to EN 1796, EN 14364 or ISO 25780 as applicable. The certificate shall be issued by an independent certification body or authority.

- (l) For direct jack GRP pipes, the allowable jacking force shall be based on the minimum wall thickness measured at the bottom of the spigot gasket groove where the wall cross section has been reduced, and the mean longitudinal compressive strength of the pipe. A minimum factor of safety of 3.5 in accordance with ISO 25780 shall be used for the jacking force on a straight alignment. A reduced jacking force shall be used when jacking to a curvature.
- (m) Direct jack GRP pipes can be used for pressure and non-pressure applications.

14.4.3 Pipes and Fittings Manufacture

- 1 The pipes and fitting shall conform to either EN 14364 or EN 1796 for sewage or water supply pipes. Jacking pipes shall comply with ISO 25780. The referenced test standards therein have to be fulfilled.

14.4.4 General

- 1 All GRP components shall be designed and fabricated by one manufacturer.
- 2 GRP pipes and fittings shall be manufactured by an approved process utilising a mandrel or rotating mould incorporating equipment to accurately control the quantities and placement of all resins, glass and aggregates.
- 3 Use resins, reinforcement and aggregates to produce pipes and fittings, which when combined as a composite structure will satisfy the performance requirements of this section of the specification.
- 4 Internal and external surfaces shall be free from irregularities, which would impair the ability of the component to conform to the requirements of EN 14364, EN 1796 or ISO 25780.

END OF PART