

**Table 20C.E3.1A
 (Series 20C)
 Mechanical Specifications**

Series 20C

Temp (F)	Pipe Strengths (psi)					Pipe Moduli (psi)				
	Axial Tensile	Hoop Tensile	Axial Flex.	Hoop Flex.	Axial Comp.	Axial Tensile	Hoop Tensile	Axial Flex.	Hoop Flex.	Axial Comp.
Ambient	6,780	20,400	13,560	N/A	20,400	1,130,000	1,700,000	1,130,000	1,700,000	1,700,000
150	6,780	20,400	13,560	N/A	20,400	1,130,000	1,700,000	1,130,000	1,700,000	1,700,000
175	5,085	15,300	10,170	N/A	15,300	847,500	1,275,000	847,500	1,275,000	1,275,000
200										
225										
250										

ASTM D4024 / D5421 Flange Codes

2" - 6" Flanges, 150psi	RTR-111C-334; CM-B4IF-66
8" Flanges, 150psi	RTR-111C-335; CM-B4IF-66
10" - 12" Flanges, 150psi	RTR-111C-336; CM-B4IF-66
14" - 18" Flanges, 150psi	RTR-111C-337; CM-B4IF-66
20" - 24" Flanges, 100psi	RTR-111B-227; CM-B4ID-44

All materials are contact molded (closest definition to filament wound in D4024), epoxy vinyl ester resin, integrally molded flange.
 The grade epoxy is interpreted to include epoxy vinyl esters.

ASTM D2310 / D2996 Pipe Codes

2" - 3" Pipe	RTRP-11FT1-1012
4" Pipe	RTRP-11FT1-1013
6" Pipe	RTRP-11FT1-1014
8" and larger Pipe	RTRP-11FT1-1016

All materials are filament wound, epoxy vinyl ester resin, reinforced liner, HDB of > 5,000psi for joints, > 10,000psi for pipe (axial loads included).
 Short term hoop strength > 10,000psi; long. tensile strength > 6,780psi;
 Long. tensile modulus > 1,000,000psi; stiffness factor varies with pipe size.
 The grade epoxy is interpreted to include epoxy vinyl esters.
 Replace 'T' with 'Q' for the HDB rating of joints.

ASTM F1173 / ISO15840 Codes

Type I, Resin 2, Class B, Rating Method 1

Other Properties

Density (lb/cu in.)	0.06
Shear Modulus (psi)	1,150,000
Thermal Expansion Coefficient (in./in./F)	0.00001
Thermal Conductivity (BTU-in./ft ² -hr-F)	1.3
Minor Poisson's Ratio, $\nu_{min} = \nu_{ha}$	0.55
Major Poisson's Ratio, $E_a/E_h \cdot \nu_{ha} = \nu_{ah}$	0.35
Hazen Williams Coefficient	150
Specific Roughness (in.)	0.0002

ASTM D5685 Fittings Codes

2" - 18" Fittings, 150psi	RTRF 52E4D
Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 150psig rating	
20" - 24" Fittings, 100psi	RTRF 52E4C
Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 100psig rating	

Notes:

1. Axial flexural is also termed bending; hoop flexural is also termed circumferential.
2. Blank areas are Not Recommended.

**Table 20C.E3M.1A (Metric)
 (Series 20C)
 Mechanical Specifications**

Series 20C

Temp (C)	Pipe Strengths (MPa)					Pipe Moduli (GPa)				
	Axial Tensile	Hoop Tensile	Axial Flex.	Hoop Flex.	Axial Comp.	Axial Tensile	Hoop Tensile	Axial Flex.	Hoop Flex.	Axial Comp.
Ambient	46.7	140.7	93.5	N/A	140.7	7.8	11.7	7.8	11.7	11.7
65.6	46.7	140.7	93.5	N/A	140.7	7.8	11.7	7.8	11.7	11.7
79.4	35.1	105.5	70.1	N/A	105.5	5.8	8.8	5.8	8.8	8.8
93.3										
107.2										
121.1										

ASTM D4024 / D5421 Flange Codes

2" - 6" Flanges, 150psi	RTR-111C-334; CM-B4IF-66
8" Flanges, 150psi	RTR-111C-335; CM-B4IF-66
10" - 12" Flanges, 150psi	RTR-111C-336; CM-B4IF-66
14" - 18" Flanges, 150psi	RTR-111C-337; CM-B4IF-66
20" - 24" Flanges, 100psi	RTR-111B-227; CM-B4ID-44

All materials are contact molded (closest definition to filament wound in D4024), epoxy vinyl ester resin, integrally molded flange.
 The grade epoxy is interpreted to include epoxy vinyl esters.

ASTM D2310 / D2996 Pipe Codes

2" - 3" Pipe	RTRP-11FT1-1012
4" Pipe	RTRP-11FT1-1013
6" Pipe	RTRP-11FT1-1014
8" and larger Pipe	RTRP-11FT1-1016

All materials are filament wound, epoxy vinyl ester resin, reinforced liner, HDB of > 5,000psi for joints, > 10,000psi for pipe (axial loads included).
 Short term hoop strength > 10,000psi; long. tensile strength > 6,780psi;
 Long. tensile modulus > 1,000,000psi; stiffness factor varies with pipe size.
 The grade epoxy is interpreted to include epoxy vinyl esters.
 Replace 'T' with 'Q' for the HDB rating of joints.

ASTM F1173 / ISO15840 Codes

Type I, Resin 2, Class B, Rating Method 1

Other Properties

Density (g/cu cm)	1.7
Shear Modulus (GPa)	7.9
Thermal Expansion Coefficient (mm/mm/C)	0.00018
Thermal Conductivity (W-cm/cm ² -C)	0.0019
Minor Poisson's Ratio, $\nu_{min} = \nu_{ha}$	0.55
Major Poisson's Ratio, $E_a/E_h \cdot \nu_{ha} = \nu_{ah}$	0.35
Hazen Williams Coefficient	150
Specific Roughness (cm)	0.0005

ASTM D5685 Fittings Codes

2" - 18" Fittings, 150psi	RTRF 52E4D
Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 150psig rating	
20" - 24" Fittings, 100psi	RTRF 52E4C
Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 100psig rating	

Notes:
 1. Axial flexural is also termed bending; hoop flexural is also termed circumferential.
 2. Blank areas are Not Recommended.

**Table 20C.E3.5A
(Series 20C)
Stress Analysis Data**

Material Properties

C_t	0.000010 in./in./F	0.000018 mm/mm/C
$E_a = E_x$	1,400,000 psi	9.7 GPa
$\nu_{min} = \nu_{ha}$	0.55	0.55
E_h	2,200,000 psi	15.2 GPa
rho	0.060 lb/in. ³	1.7 g/cm ³
$E_a/E_h * \nu_{ha} = \nu_{ah}$	0.35	0.35

BS7159 Data

SH, $\epsilon_d * E_a$	2,520 psi (based on 0.0018 design strain)	17.38 MPa
E_h/E_a	1.57	1.57
K	Mean temperature change multiplier, 0.85 for liquids, 0.8 for gases, 1.0 for amb. temp changes.	
Kn	Fatigue factor, 1.0 for static applications	

D	tr,min
1	0.25"
1.5	0.25"
2	0.25"
3	0.25"
4	0.25"
6	0.25"
8	0.31"
10	0.31"
12	0.38"
14	0.44"
16	0.50"
18	0.56"
20	0.63"
24	0.75"

D	tr,min
25	6.4mm
40	6.4mm
50	6.4mm
80	6.4mm
100	6.4mm
150	6.4mm
200	7.9mm
250	7.9mm
300	9.5mm
350	11.1mm
400	12.7mm
450	14.3mm
500	15.9mm
600	19.1mm

**Table 20C.E3.4A
(20C)**

ISO 14692 Part 3 - Annex D Calculations

Stress Intensification Factors (SIFs), Flexibility Factors (Kappa), Pressure Stress Multipliers (PSMs)
(BS7159, Type 2 Laminate, 0.0012 design strain)

Size (in.)	Series 20C						
	Flexibility Factor	Elbows			Tees		
		Axial bending SIF		Hoop bending SIF		SIF	PSM
	In-plane	Out-of-plane	In-plane	Out-of-plane			
2	1.3	1.1	1.2	1.9	1.7	1.1	1.0
3	1.9	1.5	1.6	2.5	2.2	1.3	1.0
4	2.5	1.7	1.8	2.5	2.5	1.5	1.0
6	2.9	1.9	2.1	2.5	2.5	1.7	1.0
8	2.8	1.9	2.0	2.5	2.5	1.7	1.0
10	3.0	2.0	2.1	2.5	2.5	1.8	1.0
12	2.9	1.9	2.1	2.5	2.5	1.7	1.0
14	3.0	2.2	2.4	2.5	2.5	2.0	1.0
16	3.0	2.1	2.3	2.5	2.5	1.9	1.0
18	3.0	2.3	2.4	2.5	2.5	2.0	1.0
20	3.0	2.3	2.4	2.5	2.5	2.1	1.0
24	3.0	2.3	2.5	2.5	2.5	2.1	1.0
30	3.0	2.5	2.5	2.5	2.5	2.3	1.0
36	3.0	2.5	2.5	2.5	2.5	2.3	1.0
42	3.0	2.5	2.5	2.5	2.5	2.3	1.0
48	3.0	2.5	2.5	2.5	2.5	2.3	1.0

Note: Tees that are qualified according to ISO14692 have a PSM of 1.0. Tees that are not qualified will typically have PSMs ranging from 1.8 to 3.0. Reducing tees will have slightly different SIFs than tees; however, it is acceptable to use the same values as the same-size tees. e.g., a 6"x2" reducing tee or outlet would have the same SIF as a 6" tee.