Technical specification

Filament winding fiberglass (GRP) mortar (siliceous sand) pipes

Product code: FWC

Manufacturing process: Filament winding

Application field: Civil / Industry

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1. Scope

The present document describes the main characteristics of filament winding fiberglass (GRP) mortar pipes manufactured by Nuova Sguassero.

2. References

Standards:

- UNI 9032
- EN 1796, EN 14364
- ASTM D2996, ASTM D3262, ASTM D3517, ASTM D3754
- AWWA C950, AWWA M45
- ISO 14692

Documents:

- Technical/commercial offer (contains specific information concerning the proposed pipes as resin type, rating, length, thickness, weight and joining systems).

3. Product certifications

- FM (Factory Mutual);
- KIWA (certification for drinking water also available).

4. Application field

FWC series pipes are used in civil and industrial fields for many applications such as: thermoelectric and hydroelectric power plants, chemical and petrochemical industry, civil works (sewage systems, waterworks, drainages, irrigation plants), waters treatment, fumes treatment, fire fighting systems and desalination plants.
These piping systems convey pressure or gravity fluids and are usually installed underground; for special applications they can be installed also submerged and aboveground (properly supported).

5. Product description

5.1 Pipe wall structure

FWC pipes wall consists of three layers: inner liner, structural wall and external liner (figure 1).

- The inner liner provides chemical corrosion resistance properties and acts as an anti-diffusion barrier towards the conveyed fluid.
  This resin rich layer is manufactured with "C" glass *surfacing mat* and "E" glass *mat* as reinforcements and has a nominal thickness of 1,3 mm (higher thickness and different glass or synthetic tissues are available for specific applications).

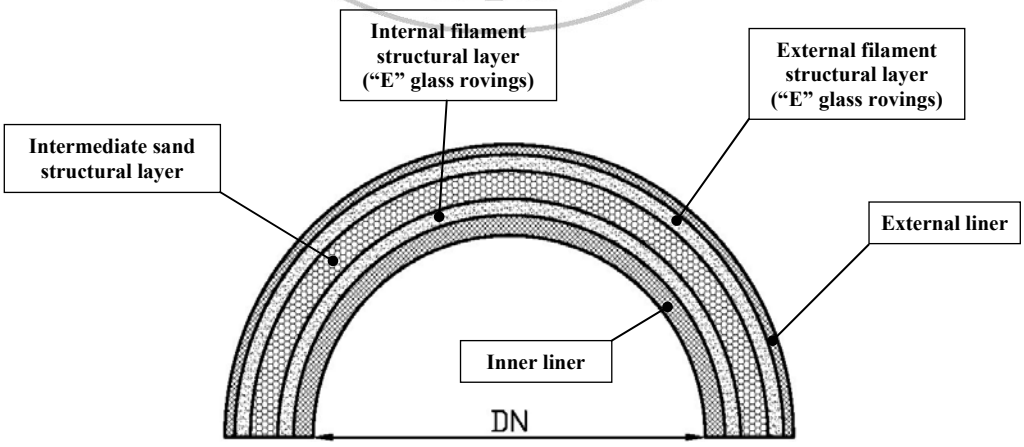

Figure 1: FWC pipes wall section.

- The structural wall provides the mechanical resistance to withstand the stresses acting on the pipe

(internal and external pressure, thermal loads, dead weight, external static and dynamics loads, etc..). The reinforcing material consists of specific weight "E" glass rovings. To increase the pipe transversal stiffness (SN) a proper thickness layer of pure siliceous sand impregnated with resin is interposed between the rovings layers, creating a "sandwich-type" wall structure. Wall thickness is function of diameter and design data.

- The standard external liner consists of a pure resin layer necessary to guarantee the perfect impregnation of the superficial glass fibers.

5.2 Manufacturing process

Pipes are manufactured with computer aided machines by the "*dual helical filament winding"* process where continuous "E" glass rovings, impregnated with resin, are wound on a rotating mandrel with a fixed angle and under controlled tension, up to reach the required thickness.
The intermediate siliceous sand layer (impregnated with resin) is stratified on the pipe trough a hopper that moves along the rotating mandrel axle.

5.3 Impregnating resin

Glass fibers impregnating resin (orthophthalic, isophthalic, bisphenolic or vinylester) depends on the composite material chemical and physical resistance required (conveyed fluid and temperature).

5.4 Raw materials

	Inner liner *(anti-corrosion)*	***Inner liner*** *(anti-diffusion)*	***Structural wall***	***External liner*** [(1)]
Impregnating resin	Orthophthalic, isophthalic, bisphenolic or vinylester			
Resin characteristics	standard, anti-abrasive, fire resistant or electrical conductive			
Pigments / Additives	--		--	note (2)
Type of reinforcing tissue	surfacing mat [(4)]	mat	rovings	note (3)
Materials	"C" glass [(4)]	"E" glass	"E" glass	note (3)
Weight	33 g/m^2	375 - 450 g/m^2	2400 tex	--
Inert structural filler	--	--	sand [(5)]	--
Nominal resin content	70%		note (6)	100%
Nominal reinforcement content	30%		note (6)	--
Filler content	--		note (6)	--
Nominal thickness	1,3 mm [(7)]		note (6)	0,2 mm [(7)]

Notes:
[(1)] the indicated data are referred to standard external liner (see also par. 5.1);
[(2)] U.V. protection if required;
[(3)] external liner can be reinforced with glass or synthetic tissues;
[(4)] inner liner can be reinforced with synthetic tissues;
[(5)] siliceous sand (ref. to standard ASTM C33);
[(6)] values are function of design data (DN, PN and SN);
[(7)] liners can be manufactured with different thickness.

5.5 Rating and dimensions

Pipes are identified by a set of parameters (rating) such as nominal diameter (DN), nominal pressure (PN) and if applicable (usually for underground installation) the transversal stiffness class (SN).
Standard products range available is indicated in table 1. For intermediate values of the indicated parameters reference can be made to the applicable product standards. Different or greater diameters, pressure and stiffness classes are available on demand.

Pipes thickness is calculated on the basis of the design data using the main dimensioning criteria stated in the applicable standards (UNI, EN, ASTM, AWWA, ISO, etc..).
Pipes standard length is 12 m.

Parameter	*Symbol [Unit]*	*Value*
Nominal (inner) diameter	DN [mm]	DN300 ÷ DN2400
Nominal pressure	PN [bar]	PN4 ÷ PN12,5
Stiffness class	SN [Pa]	SN500 ÷ SN10000

Table 1: FWC pipes standard product range.

5.6 Joining systems

The proposed joining systems for FWC pipes can be divided in two categories:

- Axial restrained joint: bell & spigot with double O-ring gasket and key-lock, flanged and butt & strap welding;
- Non axial restrained joint: bell & spigot with double O-ring gasket and sleeve with double lip gasket.

Pipes can be joined also with mechanical coupling such as Helden, Reka, Straub, Teekay, Gibault, etc…
Joint type selection depends on design data, technical specifications, installation requirements and customer requests.

5.7 Physical and mechanical properties

GRP laminate has exceptional chemical resistance, mechanical strength values similar to steel but with a specific weight about 4 times lower, low electrical conductivity, low thermal conductivity, optimal abrasion resistance and low surface roughness that reduces pressure losses.
Table 2 reports values of some physical and mechanical properties.

Characteristics	*Mean nominal value*
Superficial roughness	30 μm / 150 HW
Winding (roving) angle	55° or 63°
Tensile axial (E_a) / hoop (E_h) elastic modulus	note (8)
Allowable axial / hoop tensile stress	note (8)
Poisson coefficient due to stress in hoop direction (υ_{hl})	0,5 ÷ 0,6
Poisson coefficient due to stress in axial direction (υ_{lh})	$\upsilon_{lh} = \upsilon_{hl} \times (E_a/E_c)$
Thermal expansion coefficient	18 ÷ 20 x 10^{-6} 1/°C
Thermal conductivity(9)	0,26 W/mK
Specific heat(9)	1,26 J/gK
Electrical resistivity(9)	1000 MΩ/m
Specific weight	1,7 ÷ 1,8 kg/dm^3
Note: (8) values are function of design data (DN, PN and SN); (9) approximate values function of pipe wall structure.	

Table 2: FWC pipes physical and mechanical properties.