KERAMO
STEINZEUG

Glazed Vitrified Clay Pipes

A Natural Solution

Presented by:

KERAMO STEINZEUG N.V.
Paalsteenstraat 36
B-3500 Hasselt
Telephone +32 / 11 / 21 02 32
Telefax +32 / 11 / 21 09 44
www.keramo-steinzeug.com

The Standard EN 295

Keramo Steinzeug pipes and fittings are manufactured to a harmonised European standard EN 295, which specifies requirements for vitrified clay pipes and fittings with flexible mechanical joints for drains and sewers. National reference can still be recognised by two letters indicating the country. (e.g. BS EN 295 stands for British Standard EN 295; whereas DIN EN 295 is the translation of EN 295 into the German language). EN 295 consists today of 7 parts :

EN 295-1 = Requirements
EN 295-2 = Quality control & sampling
EN 295-3 = Test methods
EN 295-4 = Special fittings, adapters, accessories
EN 295-5 = Perforated pipes & fittings
EN 295-6 = Manholes
EN 295-7 = Jacking pipes

The material vitrified clay

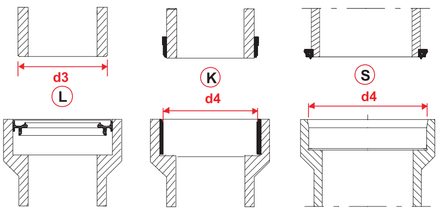
Vitrified clay pipes and fittings are produced from the raw materials clay, grogg (Chamotte) and water. The glaze applied to the products before firing consists of mainly the same basic components plus metallic oxides for colour. During drying at a temperature of approx. 80°C most of the water necessary for shaping is extracted. The subsequent firing at temperatures rising up to 1250°C creates a completely new material by sintering.
This vitrified clay has exceptional properties in respect to chemical resistance, mechanical strength, impermeability and hardness. Highly developed manufacturing and preparation techniques have made it possible to upgrade an already proven product, the consistency is guaranteed by quality control. Vitrified clay pipes are designed for sewers operating on gravity in municipal and industrial applications.

The joints

It is imperative that tight flexible joints are formed when individual pipes and fittings are assembled to form sewers. The pipe and joint are part of a unique system that together ensures easy assembly, reliability and long service life. For this reason sealing elements are factory installed.

- Joint "L" to jointing system "F "(EN 295)
- Joint "KD" to jointing system "F" (EN 295)
- Joint "K" to jointing system "C" (EN 295)
- Joint "S" to jointing system "C" (EN 295)

Jointing systems "C" & "F" to EN 295



Quality control

Pipes and fittings meet the requirements of the relevant clauses of EN 295 in all respects. Compliance with the requirements is monitored and recorded by the internal quality management system to ISO 9002 of each manufacturing plant. Third party inspections and audits, carried out by independent assessors complying with the requirements of EN 45011 and EN 45012, are more frequent than that required by EN 295.
Quality supervision may also be carried out by national certification bodies, such as MA 30; BSI; AFNOR; BENOR from the E.C.; MOE from Singapore.
Batch test certificates for specific product supplies are provided upon request.

Chemical resistance

Vitrified clay pipes and fittings to the specification of EN 295 are resistant to chemical attack. For special circumstances or application, the chemical resistance may be determined by the use of the test in clause 10 of EN 295-3.

Physical properties

The most important properties which might be required for calculation purposes are listed in the following table:

Specific weight	KN/m³	22
Bending tensile strength	N/mm²	15 - 40
Compression strength	N/mm²	100 -200
Tensile strength	N/mm²	10 - 20
Mohs hardness		≈ 7
Modulus of elasticity	N/mm²	≈ 50.000
Coefficient of thermal expansion	1 / K	≈ 5*10-6
Thermal conductivity	W/m*K	≈ 1,2

Joint assemblies

These shall remain watertight when tested at internal or external pressures of 5kPa (0,05 bar) and 50 kPa (0,5 bar).
The joint under such internal or external pressure must not show any visible leakage when further be subjected to:

Angular deflection: (after 5 mm draw)

Nominal size (DN)	Deflection per metre of deflected pipe length
100 - 200	80 mm
225 - 500	30 mm
600 - 800	20 mm
> 800	10 mm

Pipes and fittings of the same jointing system, of the same nominal size and the same pipe class are directly interchangeable.
Uniformity of pipe class during installation is a prerequisite.
For all applications it must be observed, that joint assemblies are guaranteed to withstand

- cyclic temperature changes of -10°C to +70°C and chemical attacks from normal sewage and other harmful effluents in concentrations from pH 0 (sulphuric acid) to pH 14 (caustic soda).
- Resistance to discharges from industries can be calculated using the index CR.

Products

DN	Spigot / socket pipes								Jacking pipes			
	Normal load series (N)				High load series (H)						Permissible jacking load	
	FN KN/m	Jointing system	Standard length(m)	Weight Kg/m	FN KN/m	Jointing system	Standard Length(m)	Weight Kg/m	Standard length	Weight Kg/m F_1 (kN)	Manual recording F_2 (kN)	Automatic recording F_2 (kN)
100	34	F	1,25	15	---	---	---	---	---	---	---	---
125	34	F	1,25	19	---	---	---	---	---	---	---	---
150	34	F	1,50	24	---	---	---	---	0,50/1,00	36	170	210
200	32	F/C	2,00/2,50*	37	48	C/F	2,00/2,50	43	1,00	60	280	350
225	45	C	2,00	47	---	---	---	---	---	---	---	---
250	40	C	2,50	53	60	C	2,50	75	1,00/2,00	105	704	880
300	48	C	2,50	72	72	C	2,50	100	1,00/2,00	125	800	1000
350	56	C	2,00	101	70	C	2,00	116	---	---	---	---
400	64	C	2,50	136	80	C	2,50	152	1,00/2,00	240	1760	2200
450	---	---	---	---	72	C	2,00	196	---	---	---	---
500	60	C	2,50	174	80	C	2,50	230	1,00/2,00	295	2080	2600
600	57	C	2,50	230	96	C	2,50	326	2,00	350	2400	3000
700					112	C	2,50	405	2,00	380	2400	3000
800					96	C	2,50	473	2,00	460	2400	3000
900	60	C	2,00	431	---	---	---	---	---	---	---	---
1000	60	C	2,00	555	---	---	---	---	2,00	584	2400	3000
1200	60	C	2,00	699	---	---	---	---			---	---
1400	60	C	2,00	800	---	---	---	---			---	---

* lenght 2.5 m : only F

Standard Fittings

	Short length for connections to manholes	Bends (N + H)				Junctions (N + H)		Stop-pers	Enlargers (Tapers)	Saddles/ Branches	Accessories			
											Rings			„M“-seals
		15°	30°	45°	90°	45°	90			45° / 90°	„P“	„B“	„U“	
100		x	x	x	x	/100		x	/125-150				x	x
125		x	x	x	x	/100-125		x	/150				x	x
150	GZ; GE; GA	x	x	x	x	/100-150	/150	x	/200 (N)	x		x	x	x
200	GZ; GE; GA	x	x	x	x	/100-200	/150-200	x	/250 (N)	x	x	x	x	x
225	GZ; GE; GA	x	x	x	x	/150-225	/150-225	x			x			x
250	GZ; GE; GA	x	x	x	x (N)	/150-200	/150-200	x	/300 (N)		x			x
300	GZ; GE; GA		x (N)	x		/150-200	/150-200	x			x			x
350	GZ; GE; GA					/150-200	/150-200	x			x(H)			x
400	GZ; GE; GA						/150-200	x (N)			x			x
450	GZ; GE; GA					/150-200	/150-200				x			x
500	GZ; GE; GA						/150-200				x			x
600	GZ; GE; GA						/150-200				x			x
700	GZ; GE; GA						/150-200							x
800	GZ; GE; GA						/150-200							x
900	GZ; GE; GA						/150-200							x
1000	GZ; GE; GA						/150-200							x

Other sizes for fittings or accessories on request and to special order

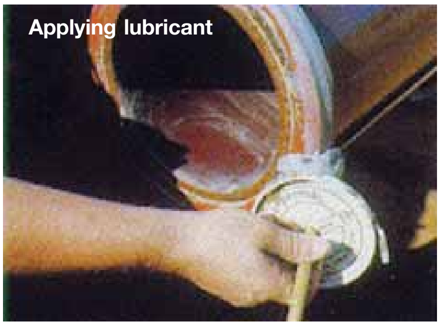
Other accessories see “Range of products”

Site work

Pipe control

On delivery to site, the pipes and fittings should be checked for any damage incurred during transport . A simple wipe of internal surfaces of the pipes socket and spigot end with fine powder such as talcum can identify even the finest crack.
Another method to test the soundness of a pipe with an experienced ear is to make the pipe ring by knocking the pipe with a suitable piece of metal.
Both these methods can be used at any time including on site.

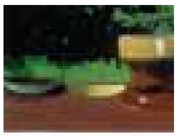

Applying talcum

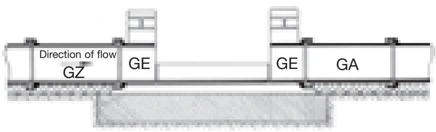

Applying lubricant


Jacking pipes testing device

Laying / Bedding

Laying commences at the lowest point of the line. Make sure that socket and spigots are clean, apply the recommended lubricant to the sealing element(s) and push the spigot fully home into the socket manually with the aid of a crowbar or mechanically with the aid of an approved assembly device.
The type of bedding required is determined by a structural analysis. On supplying the necessary details (e.g. type of soil; trench design; loads; life loads; additional loads) we can perform such structural analysis with our recommendations for pipe bedding and pipe strength class free of charge.
It is important to ensure that the soil around the base of the pipe is firm. Loose soil should be well compacted mechanically. Soft soil should be removed and replaced by non-cohesive soil. The bed at the base of the trench should be prepared in such a way that the pipe, when laid, is supported along the length of its barrel. Recesses should be formed to accommodate the sockets. In order to avoid point or linear loading vitrified clay pipes should not be laid on stony soil or directly on rock.





Flexible manhole connections

Testing

Water test to EN 295
When pipes or pipe sections are tested with water at ambient temperature, the water addition W_{15} to maintain the pressure of 0,5 bar shall not exceed 0,07 l/m2 of internal surface without leakage.
Air Test to EN 1610
The air test is a convenient alternative to the usual water test. Pipelines can only be deemed faulty after the unsuccessful completion of a water test.
For performing an air test on a line made from Keramo-Steinzeug products, we recommend the following procedure:

- Apply a pressure equivalent to 100 mbar (ensure adequate safety measures are implemented)
- Observe the period for the air to settle 5 min. for ≤ DN 500; DN/100 in min. for > DN 500
- During the following test periods the air pressure must not drop more than 15 mbar

DN	Test period	DN	Test period
100	3,0 min.	350	5,0 min.
125	3,0 min.	400	5,5 min.
150	3,0 min.	450	6,0 min.
200	3,0 min.	500	7,0 min.
225	3,0 min.	600	8,0 min.
250	3,5 min.	700	10,0 min.
300	4,0 min.	800	11,0 min.

Water test to EN 1610
The following table contains the values for the permissible water addition (l / m) at an allowance of 0,15 l/m² during the test period of 30 minutes.

DN 100 = 0,05	DN 350 = 0,17
DN 125 = 0,06	DN 400 = 0,19
DN 150 = 0,07	DN 450 = 0,21
DN 200 = 0,09	DN 500 = 0,24
DN 225 = 0,11	DN 600 = 0,28
DN 250 = 0,12	DN 700 = 0,33
DN 300 = 0,14	DN 800 = 0,38


Testing device for air tests on pipelines

Biological induced H_2S-corrosion

The formation of **H_2S** in sewage is a consequence of the natural biological decomposition of sulphur containing organic and inorganic matter (proteins, sulphates). H_2S mainly forms under anaerobic conditions by sulphate reducing bacteria (desulfovibrio desulfuricans) in the slime of a matured sewer and to a lesser extent by bacteriological processes in the sewage. In gravity sewers the formation of H_2S commences after the oxygen originally present in the sewage has been consumed by manifold biological processes. This is followed by the anaerobic decomposition with an ever increasing formation of H_2S, which slowly escapes into the sewer atmosphere. Turbulence in the sewage stream increases the escape of the gaseous H_2S. The formation of H_2S is supported by long sewage flows, low flow velocities and high sewage temperatures. To estimate the possibility of H_2S evolution in sewage the Z-formula, developed by Richard D. Pomeroy, is used world-wide.

$$Z = \frac{3\,(EBOD)}{S^{1/2} \times Q^{1/3}} \times \frac{P}{B}$$

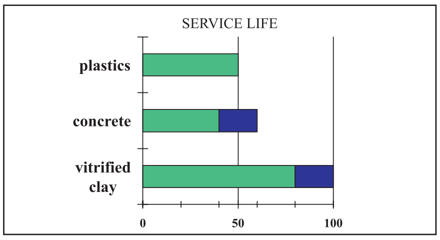
It is not necessary to value its numerical result to be accurate, but it is worthy of consideration and is of particular interest when selecting the pipe material.
The formation of H_2S and the oxidation into **H_2SO** by bacteria (e.g. thiobacillus thiooxydans) living on the moist surface of the sewer occurs not only in gravity sewers, but also and more severely in pressure pipe lines, where, due to the absence of an atmosphere, continuously ideal conditions for the sulphate reducing bacteria prevail. The biological induced H_2S-corrosion has its effects only above the surface level of the sewage stream, where the sulphuric acid reacts with the lime content of cement-bound pipe materials. On concrete pipes which contain limestone as the aggregate the effects of biological H_2S-corrosion show later than on those having quartzistic aggregate. In general a progression in corrosion of concrete sewers having a constant presence of hydrogen sulphide in the sewer atmosphere can be expected with 3 - 6 mm/a. **Vitrified clay pipes are immune to sulphuric acid attack.**

Economic considerations

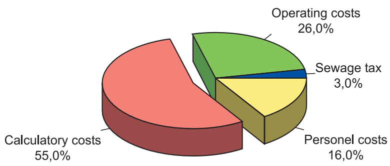
The management of domestic and industrial waste water transport, infrastructure and treatment is most often a local government issue.. The authority is obliged to pay particular attention to the economic aspects. These include the one-off cost for construction of the sewer line and the operation and maintenance cost (subsequent cost).
The **cost for construction** of a sewer line is determined largely by the location and the type of construction. A line laid through a green field will cost less than a sewer along a major street. In both cases, however, the cost of the pipe material is only a fraction of the entire cost of the project.
The **operating and maintenance cost** are the basis of the charges levied for use of the sewer. These costs represent a constant expense. The calculation of the anticipated magnitude of these expenses is therefore even more important than that of the construction cost. These running cost include:

- ***Capital expenditure*** - ***Depreciation***
- ***Maintenance*** - ***Administration***

It can be assumed that the estimated cost for maintenance and administration will be the same for all sewers. With regard to the capital expenditure (interest and amortisation) and the rate of depreciation, a different cost must be anticipated, depending on the pipe material. Features such as resistance to corrosion and chemical attack, abrasion, temperature, as well as their impermeability, sewers constructed from vitrified clay have an above-average life-span. The higher cost for interest on the capital required to the purchase of vitrified clay pipes as the chosen material as opposed ti cheaper less permanent materials is therefore more than compensated.



Composition of the municipal sewage charges



Source: DUDEY. J., PECHER R., ATV - Survey: Sewage Charges

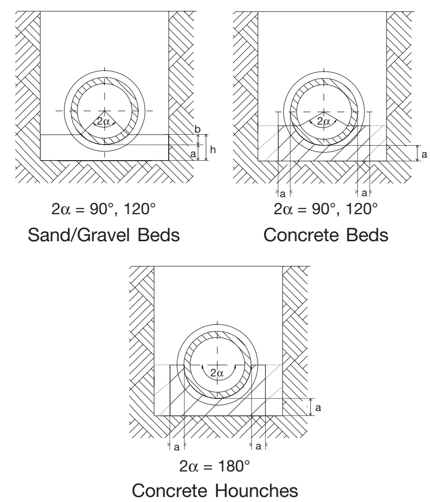
Structural design

Buried pipe lines can be stressed by backfill and traffic loads. In special applications additional risk may result from temperature influences and internal pressures.
Instructions for the calculation of the load bearing capacity of sewers have been published by the Abwassertechnische Vereinigung (ATV) - German Sewage Engineering Society) in ATV-A 127 (Worksheet 127) When carrying out the calculation, a basic distinction must be made between the two available types of pipes. Flexible pipes permit close inter-actions between load, deformation of the cross-section and load distribution. The computation of the likely deformation risk is decisive in the choice of material suitability..
Rigid pipes do not deform under load and interaction between deformation and stress distribution do not occur. The stress computation set against the permissible rupture stress is decisive for the suitability.
Vitrified clay pipes are rigid pipes.
Calculating the reserves for stress bearing the identification of the following details is essential:

- Type of soil, specific weight, angle of internal friction
- Traffic loads
- Superimposed loads (e.g. buildings)
- Designed slope of trench walls
- Type of trench shoring
- Trench width at pipe crown
- Depth of cover
- Pipe diameter, strength, etc.

The result of the computation gives the factor of safety. In general applications a safety factor of 2,2 is required for vitrified clay pipes.

TYPES OF BEDDING



The organisation

STEINZEUG
Abwassersysteme Gmbh

D - 50858 Cologne / Germany
Phone: (+49) 02234 507-0
Fax: (+49) 02234 507207
e-mail: info@steinzeug.de
Internet: www.steinzeug.com

KERAMO STEINZEUG N.V.

B - 3500 Hasselt / Belgien
Phone: (+32) 011 210232
Fax: (+32) 011 210944
e-mail: keramo@keramo-steinzeug.be
Internet: www.keramo-steinzeug.com