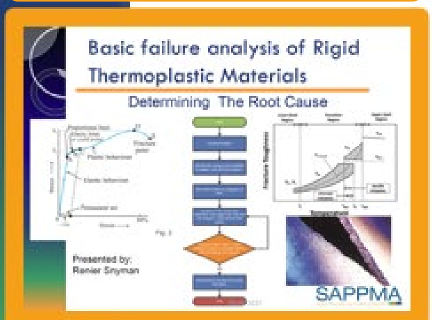
SAPPMA

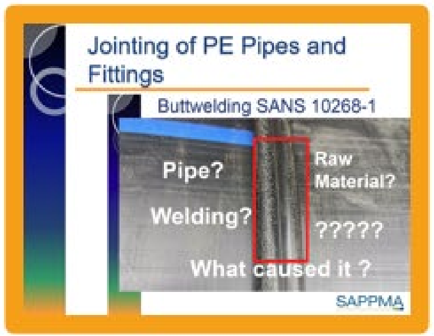
southern african plastic pipe manufacturers association

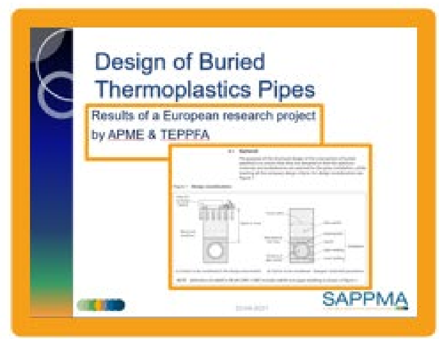
WEBINAR VII

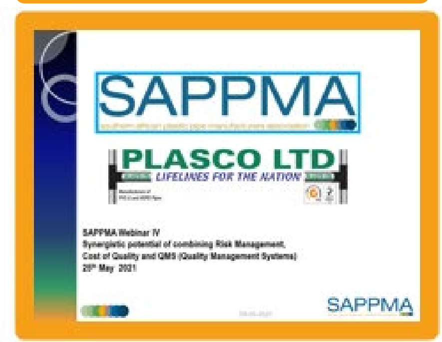
August 2021

SAPPMA Webinar I to VI on SAPPMA Web site

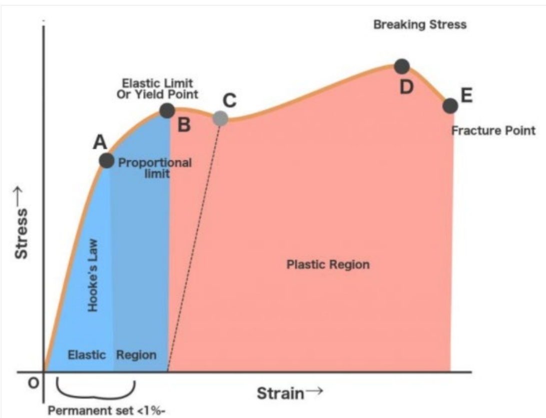




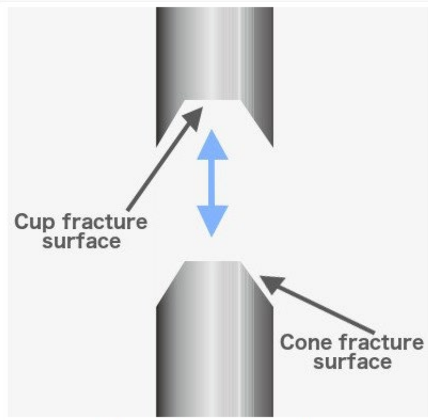




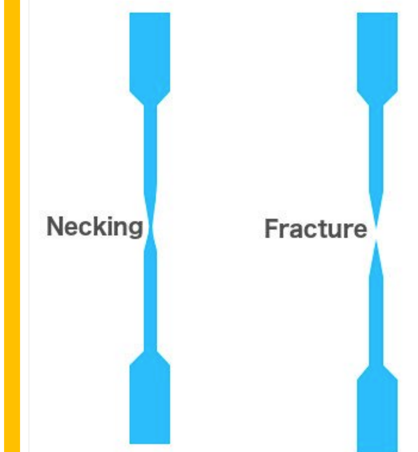
Form Gives Structure



Stress-strain curve of a ductile material



Cup and cone geometry



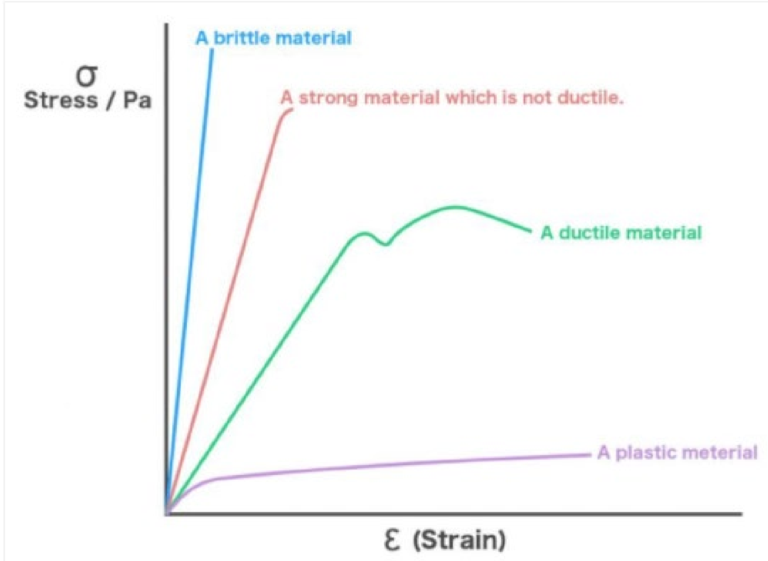
Necking exhibits point 'D' of the stress-strain curve, whereas Fracture represents point 'E'.

Structure determines Behavior

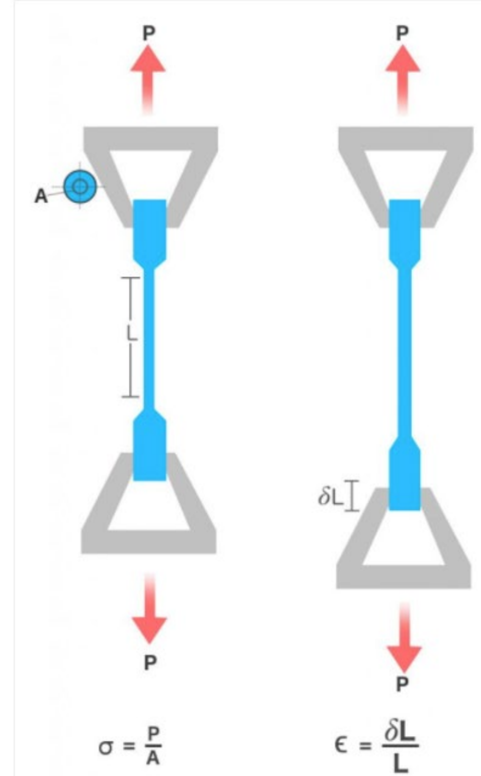
25-08-2021

SAPPMA
southern african plastic pipe manufacturers association

How do you know?



Stress-strain curve of different materials



Stress-strain demonstration

Will it work on its own?

Will it work together?

How does it compare to what we know?

Does it compliment or complicate?

SAPPMA
southern african plastic pipe manufacturers association

Are you able to make the connection?

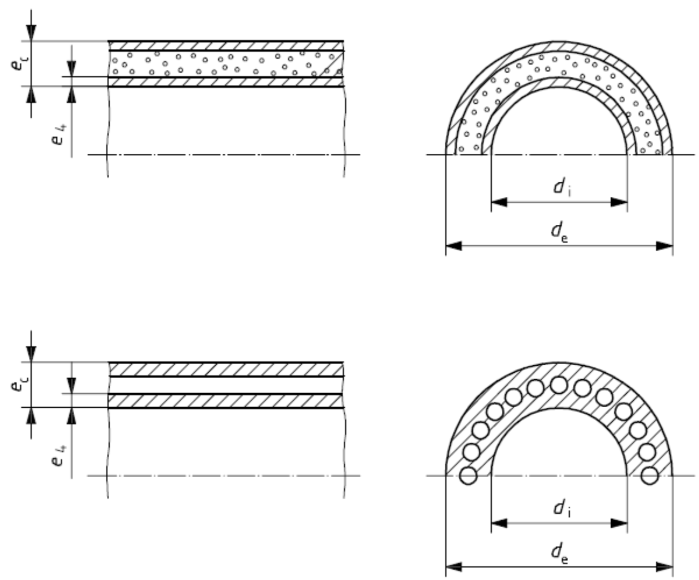
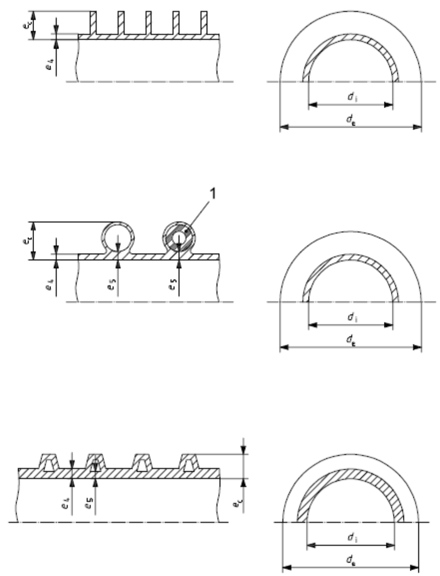
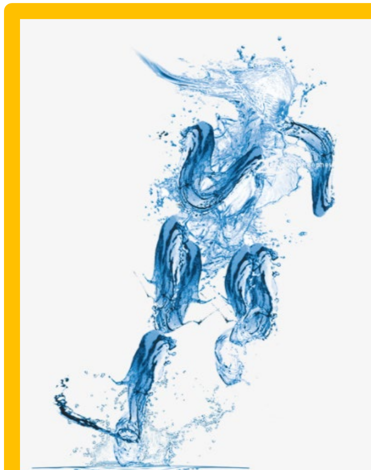


Figure 1 — Typical examples of wall construction Type A1



Key
1 supporting profile

Figure 1 — Typical examples of Type B wall construction



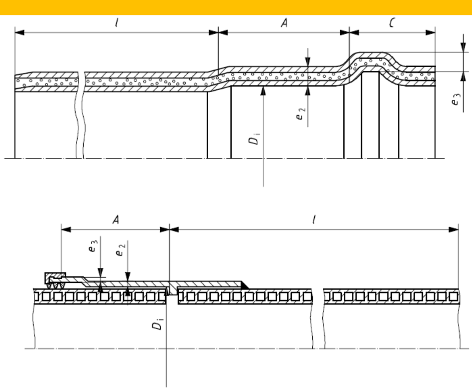


Figure 3 — Typical examples of joints for Type A constructions

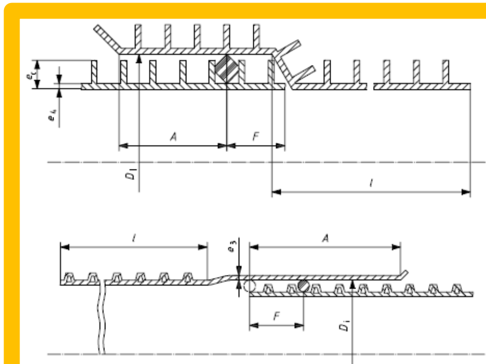
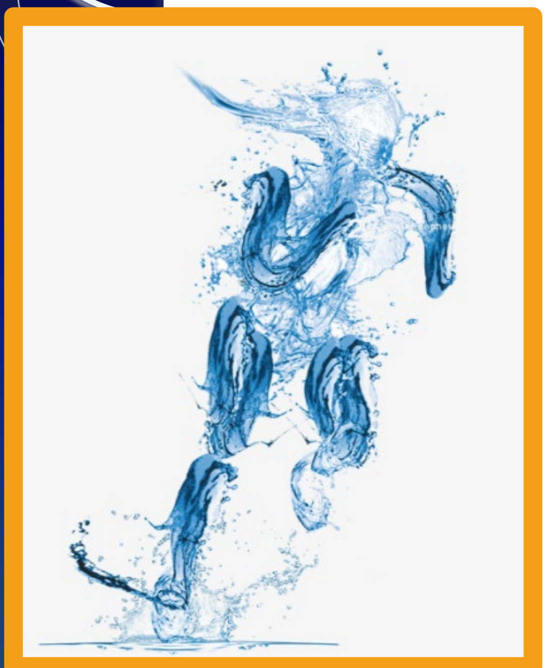
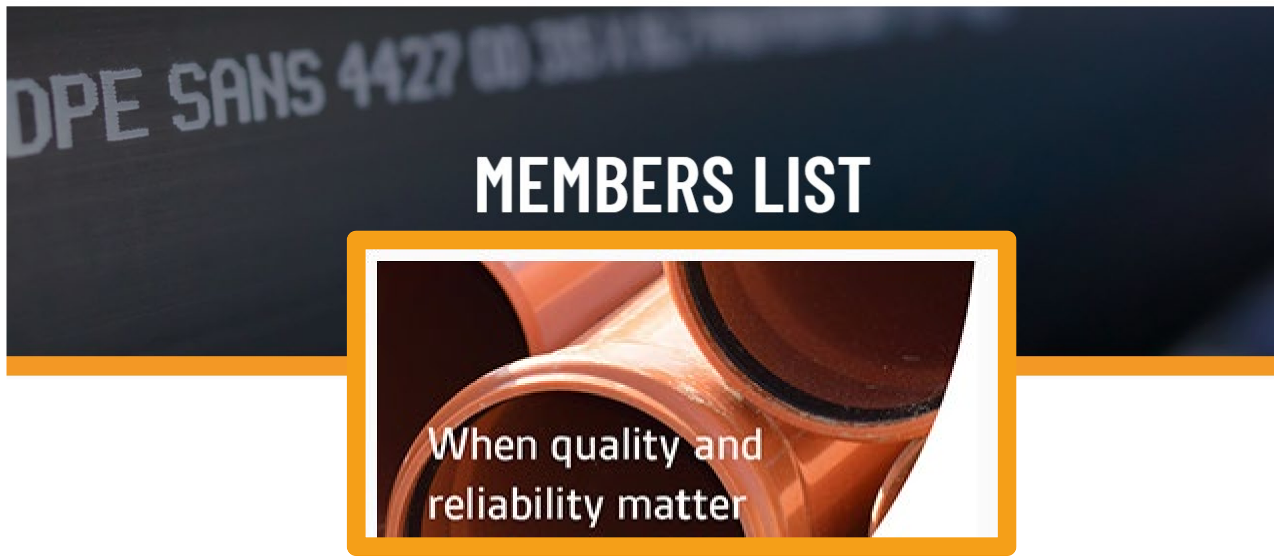


Figure 2 — Typical examples of elastomeric sealing ring joints with the sealing ring located on the spigot, Type B

Allow our Members to share their know-how

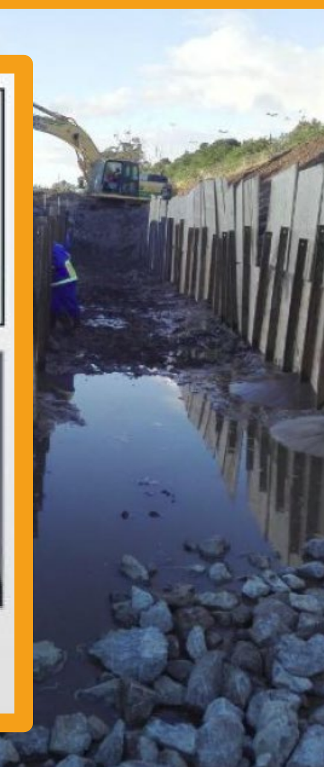
SAPPMA
southern african plastic pipe manufacturers association





PIPE MANUFACTURERS	POLYMER MANUFACTURERS	SUPPLIERS
CERTIFICATION BODIES	SPECIALISED MANUFACTURERS	INDIVIDUAL MEMBERS

SAPPMA Webinar VII



Design and Construction of Thermoplastic Structured Wall Pipeline Systems

Schalk van der Merwe and Stephan Kleynhans, both professional engineers, mechanical and civil, will be looking at aspects to consider that are of importance in the design and construction of Thermoplastic Structured Wall Pipeline Systems.

Their involvement and experience as a duo with a great number of large diameter outfall sewers in South Africa make them ideal candidates to share their experiences and views on this very important topic.

Presenters

SAPPMA Webinar VII

25 August 2021

ZUTARI
IMPACT. ENGINEERED.

Schalk Van Der Merwe

ZUTARI
IMPACT. ENGINEERED.

Stephan Kleynhans

SAPPMA
southern african plastic pipe manufacturers association

DESIGN AND CONSTRUCTION OF THERMOPLASTIC STRUCTURED WALL PIPELINE SYSTEMS

ZUTARI

IMPACT. ENGINEERED.

SAPPMA

southern african plastic pipe manufacturers association

Presentation content

- Pipeline design principles – theory
- Practical considerations – design & construction

Before we start:

- Focus not only on (SWP) Structured Wall Pipe systems
- Design principles & practical considerations are applicable to all materials
- Only highlighting a few design and practical considerations – there are numerous other important aspects to be considered not mentioned here

Design & construction considerations

- Pipe materials
- Design (Schalk's presentation)
- Specifications
- Material testing
- Installation
- Repairs
- Concluding remarks

Pipe materials

- Any material can fail – problems do happen (often unintentionally)
- Horses for courses

ZUTARI

SAPPMA
southern african plastic pipe manufacturers association

PIPE CLASS/STRENGTH SELECTION

ZUTARI

SAPPMA
southern african plastic pipe manufacturers association

Specifications

- Pipes preferably to be manufactured under license

- Ring stiffness

Ring stiffness is calculated in ISO 9969 according to:

$$R_{s,ISO} = \frac{E_0 I}{d_m^3}$$

Ring stiffness is calculated in DIN 16961 according to:

$$R_{s,DIN} = \frac{E_{24} I}{r_m^3}$$

$$\frac{R_{s,DIN}}{R_{s,ISO}} = \frac{E_{24} \cdot d_m^3}{r_m^3 \cdot E_0} \approx \frac{380 \cdot 8}{1 \cdot 800} \approx 3.8$$

Specifications (cont)

- Maximum short-term and long-term deflection must be specified
  - Confirm the material properties used in calculations

		Short-term: All loads	Long-term: Soil loads, Traffic loads	Long-term: other loads	
Characteristic values of pipe material and ring stiffness:					
Pipe material elastic modulus:	E_P	800,0	488,8	160,0	N/mm²
Ultimate flexural tensile stress:	σ_{BT}	21,0	17,6	14,0	N/mm²
Ultimate flexural compressive stress:	σ_{BC}	21,0	17,6	14,0	N/mm²
Pipe ring stiffness:	S_0	6,647	4,061	1,329	kN/m²

SAPPMA
southern african plastic pipe manufacturers association

Specifications (cont.)

- Raw material specification
  - What is permissible in terms of “foreign” material?
  - Carbon black limits?
  - Use of recycled material permissible? Percentage of recycled material that can be used or are used?
  - Even international specifications differ!!!

Pipes shall be made from polyethylene (PE), stabilized using suitable antioxidants and usually coloured throughout with carbon black or other pigments. The choice of stabilizers and other additives shall be left to the pipe manufacturer. Moulding materials of unknown composition shall not be used.

4.1 Compound

The compound from which the products are produced shall be made by adding to the polyethylene base polymer only those additives necessary for the manufacture and end use of the products, in accordance with the applicable parts of ISO 4427.

All additives shall be uniformly dispersed.

NOTE Components manufactured from PE 32 materials are not covered by ISO 4427.

Specifications (cont.)

4.3 Use of reprocessable and recyclable material

Clean, reprocessable material generated from a manufacturer's own production and works testing of products according to ISO 4427 may be used if it is derived from the same compound as used for the relevant production. Reprocessable material obtained from external sources and recyclable material shall not be used.

Specifications (cont.)

- Pipe tolerance, e.g. roundness, pipe ends, wall thickness, etc.

Sample	Thickness	Nominal stiffening tube spacing
	mm	mm
A	18-24	112
B	17-18	105
C	18.5- 23	100

Specifications (cont.)

ZUTARI

Specifications

- Quality control and testing
  - Parameters tested
  - Frequency of testing
  - Third party testing

Characteristic	Requirement [a]	Test parameters		Test method
		Parameter	Value	
Compound density	⩾ 930 kg/m^3	Test temperature	23 °C	ISO 1183-2
		Number of samples	According to ISO 1183-2	
Carbon black content (black compound only)	(2 to 2,5) % by mass	In accordance with ISO 6964		ISO 6964
Carbon black dispersion (black compound only)	⩽ grade 3	In accordance with ISO 18553 [c]		ISO 18553
Pigment dispersion (blue compound only)	⩽ grade 3	In accordance with ISO 18553 [c]		ISO 18553
Water content [d]	⩽ 300 mg/kg	Number of test pieces [b]	1	ISO 15512
Volatile content	⩽ 350 mg/kg	Number of test pieces [b]	1	EN 12099
Oxidation induction time	⩾ 20 min	Test temperature	200 °C [e]	ISO 11357-6
		Number of test pieces [b]	3	
Melt mass-flow rate (MFR) for PE 40	0,2 to 1,4 g/10 min Maximum deviation of ± 20 % of the nominated value [f]	Load	2,16 kg	ISO 1133:2005, Condition D
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces [b]	According to ISO 1133	
Melt mass-flow rate (MFR) for PE 63, PE 80 and PE 100	0,2 to 1,4 g/10 min Maximum deviation of ± 20 % of the nominated value [f]	Load	5 kg	ISO 1133:2005, Condition T
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces [b]	According to ISO 1133	

SAPPMA
southern african plastic pipe manufacturers association

ZUTARI

Specifications

Table 5 — Scope and frequency of internal control

Item no.	Material	Articles to be checked: Pipes	Articles to be checked: Fittings	Property	Frequency	Requirement as in Subclause	Testing as in Subclause
1	PE	×	×	MFR	At each raw material change	4.7	5.5
	PVC-U	–	–			–	–
	PP	×	×			4.7	5.5
2	PE	×	×	Design	Continuously	4.2	5.1
	PVC-U	×	×			4.2	5.1
	PP	×	×			4.2	5.1
3	PE	×	×	Surface finish	Every two hours or each pipe/fitting[a]	4.8	5.6
	PVC-U	×	×			4.8	5.6
	PP	×	×			4.8	5.6
4	PE	×	×	Colour	Continuously	4.9	5.7
	PVC-U	×	×			4.9	5.7
	PP	×	×			4.9	5.7
5	PE	×	×	Dimensions	Every two hours or each pipe[a]	4.10	5.8
	PVC-U	×	×			4.10	5.8
	PP	×	×			4.10	5.8
6	PE	×	×	Weldability	When material-related parameters change	4.4	5.9
	PVC-U	–	–			–	–
	PP	×	×			4.4	5.9
7	PE	×	–	Ring stiffness[b] S_{R24} or S	Monthly, and when material-related parameters change	4.3.1	5.2.1
	PVC-U	×	–			4.3.1	5.2.1
	PP	×	–			4.3.1	5.2.1

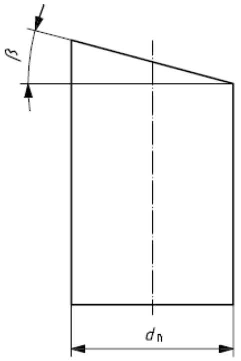
[a] Every two hours for continuous production processes and injection moulding production; for discontinuous production: every component.

[b] If not otherwise specified, testing shall be carried out on pipes, fittings and joints at the earliest 15 hours after their production.

SAPPMA
southern african plastic pipe manufacturers association

Specifications (cont.)

- Pipe specials
  - Know your specifications and applicable de-rating factors!



β shall not be greater than 15°.

Key

d_n nominal outside diameter

β cut angle

Figure B.2 — Segment design

Table B.3 — Derating factors for segmented bends

Cut angle β	Derating factor f_B
$\leqslant$ 7,5°	1,0
7,5° < β $\leqslant$ 15°	0,8

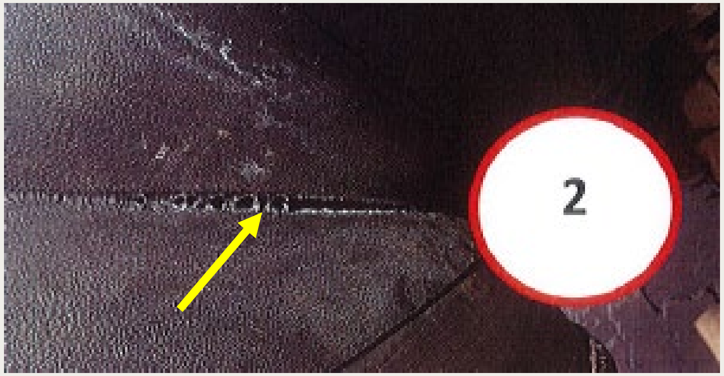
Material testing

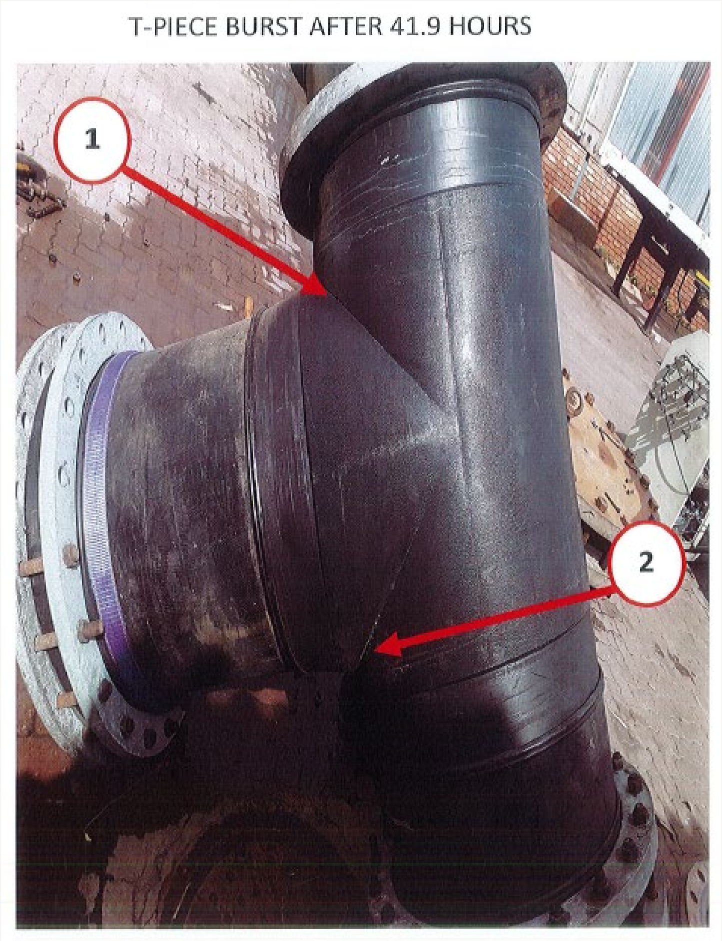
Item No.	Test Type	Unit	Results	Requirements	Conclusion [1]
1.	Weld Factor Determination	f_z	1.0	≥ 0.9	C
2.	Bend test *(weld)*	°	< 160	>160	NC

1: C= Conformance, NC = Non-conformance, TBA = to be announced, N.A = Not available/applicable

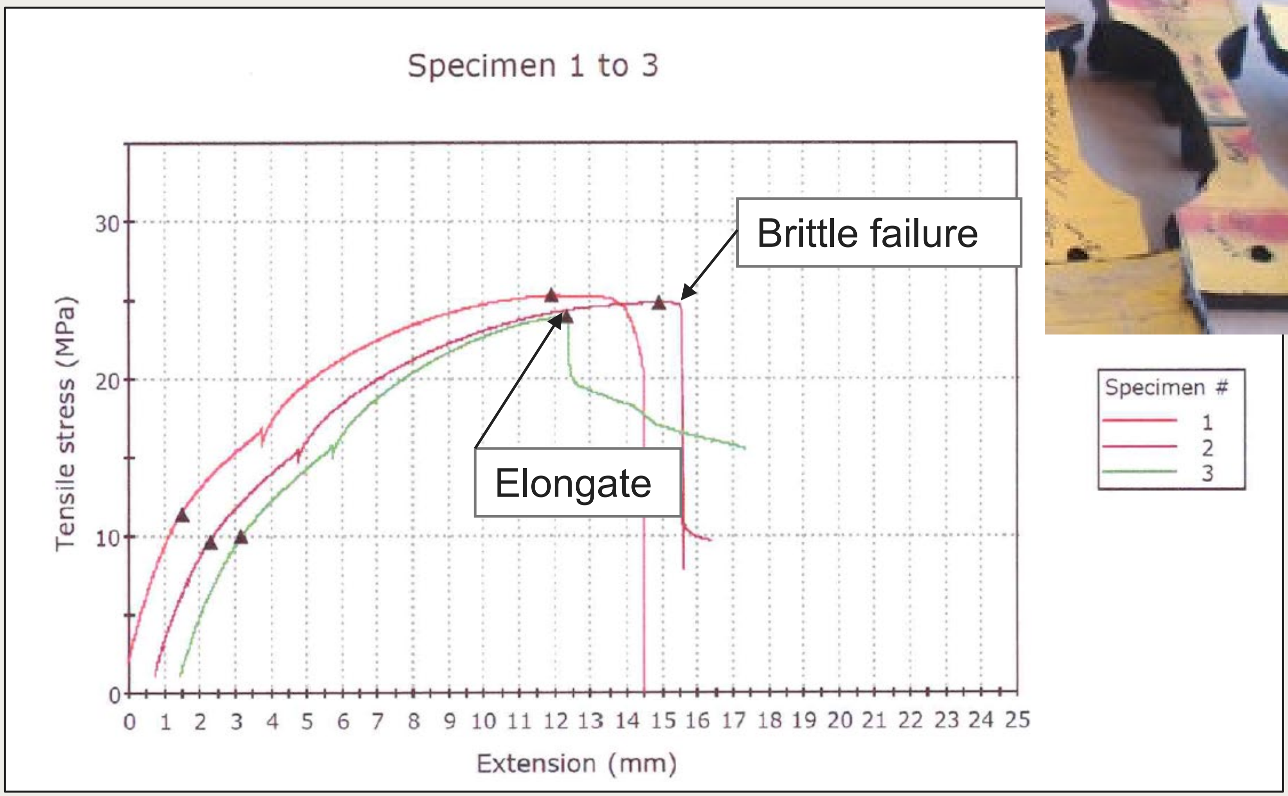
Material testing (cont)

- Imported moulded T-Piece bursting





Material testing (cont.)



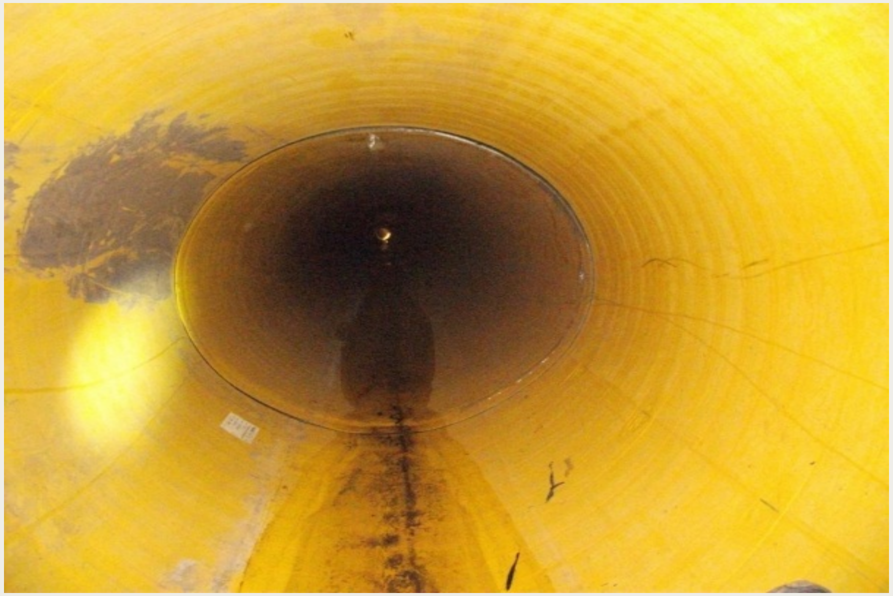
Material testing (cont)

Summary

Sample	Polymer (%)	Polymer type	Carbon black content (%) 2 – 2.5%	Residue (%)	OIT (min) ≥ 20 min
L MH 43-15	98.48	High Density Polyethylene	1.52	0.00	24.07
MH 43-12	98.33	High Density Polyethylene	1.76	0.00	>60 45.23
9 Pipe 4	97.29	High Density Polyethylene + 3.8% Polypropylene	1.18	1.53	18.49
L MH 42-1	95.84	High Density Polyethylene + 4.3% Polypropylene	1.38	2.78	6.91 15.43
MH 43-12 (redone)		High Density Polyethylene with Polypropylene master batch			
Ring Stiffness A	98.35	High Density Polyethylene with Polypropylene master batch	1.37	0.28	35.8
Ring Stiffness B	97.82	High Density Polyethylene + 3.4% Polypropylene	1.23	0.95	27.5
Ring Stiffness C	98.55	High Density Polyethylene	1.59	0	11.2

Installation

Excessive deflection



Failure – external loading

Installation – pipes will float

IMPACT. ENGINEERED.

Installations – Thermal expansion and contraction

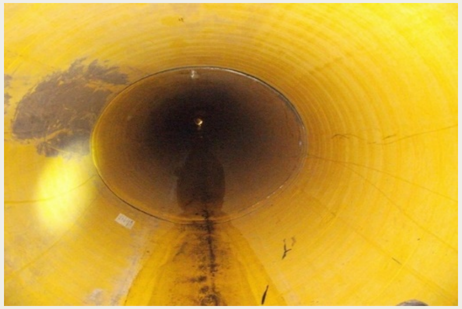
- Coefficient of linear expansion (HDPE) = 0.2 mm/m ºC

- MH spacing of 90 m @ 25 degree change = 450 mm change in pipeline length

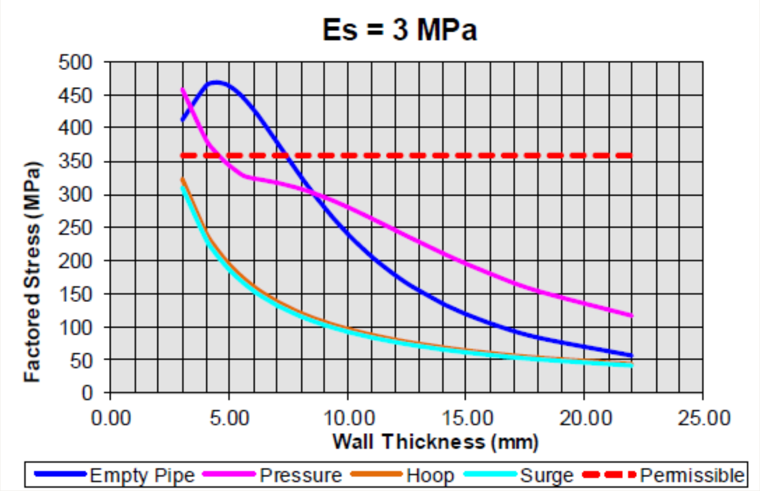
Installation - Thermal expansion and contraction (cont)

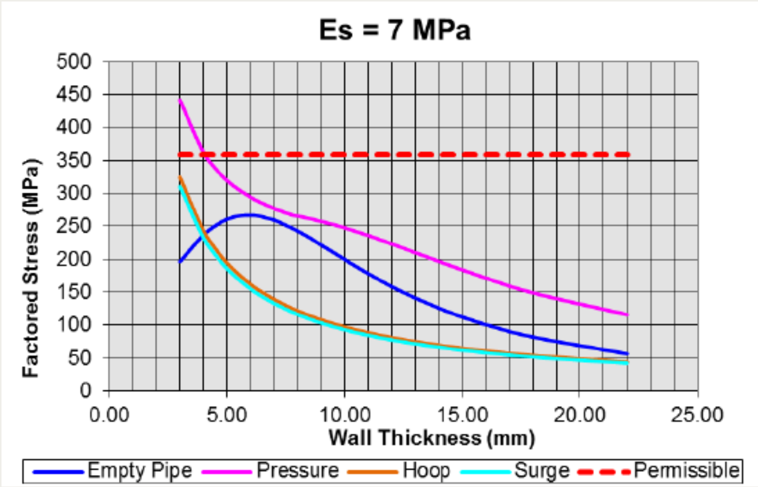
- Pipes become curved when strung next to trench on uneven soil and being warmer on the top
- When installed in trench, pipe not completely horizontal and vertical – problematic at flat slopes (1:1000 or flatter)
- Curved pipes could cause mis-alignment at electrofusion couplings

Repairs



- Tested ring stiffness (3rd party) showed ring stiffness to be lower than stated by manufacturer
- Pipe already installed, but excessive deflection
- Most economical option likely is to improve bedding conditions





SAPPMA
southern african plastic pipe manufacturers association

Conclusions

- Numerous projects have been **successfully implemented** using structured wall HDPE, solid wall HDPE, PVC, GRP, concrete, steel, ductile iron, etc.

- We are designing **pipe systems**
  - Know the applications of pipe materials
  - Understand the loads, especially external loads on larger diameters or poor soil conditions
  - Understand pipe/soil interaction

- Not all international specifications are the same – **confirm which specifications** are used by the manufacturer

Conclusions (cont.)

- Ensure that critical aspects are address in **project specifications** where not addressed in the standard specification, e.g. use of recycled material, tolerances, frequency of testing, etc.

- Allow for **3rd party testing** of materials prior to commencement of construction

- Proper **supervision** is required during construction

- Whenever you are uncertain – **seek advice** from organisations like SAPPMA

THANK YOU

Questions and Answers

ZUTARI
IMPACT. ENGINEERED.

Schalk Van Der Merwe

SAPPMA
southern african plastic pipe manufacturers association

Questions and Answers

ZUTARI

IMPACT. ENGINEERED.

Stephan Kleynhans

25-08-2021

SAPPMA

Together it brings to Life

Polymer Engineering


Mechanical Engineering

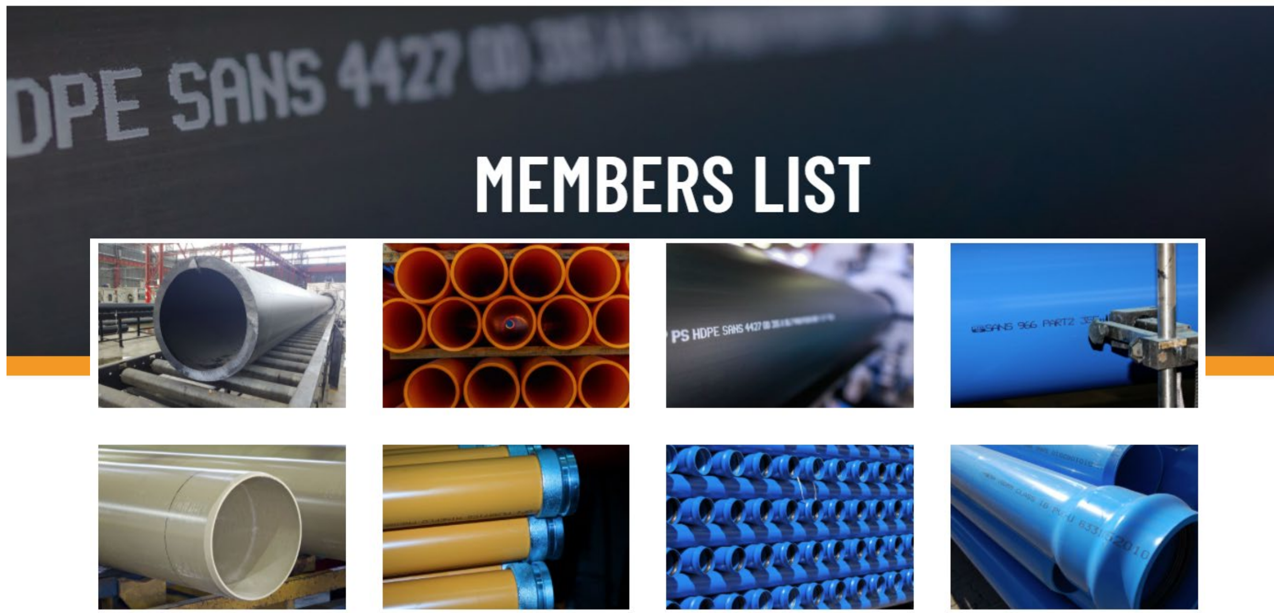
Civil Engineering

SAPPMA
southern african plastic pipe manufacturers association

Call on our members to make Life easier

SAPPMA

southern african plastic pipe manufacturers association



PIPE MANUFACTURERS

POLYMER MANUFACTURERS

SUPPLIERS

CERTIFICATION BODIES

SPECIALISED MANUFACTURERS

INDIVIDUAL MEMBERS

Participants
Audience
& Organizers

SAPPMA
southern african plastic pipe manufacturers association

Questions and Answers

ian@sappma.co.za

admin@sappma.co.za

SAPPMA
southern african plastic pipe manufacturers association