Technical Data 9

Longitudinal Flexural Strength in Drain Pipes

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Definition of longitudinal flexural strength

The longitudinal flexural strength

- is defined as the product of the E-modulus (E in kN/m²) and the moment of inertia (I in m^4)
- has the unit of measure force x area, e.g. kN×m², and
- determines, among other things, the deflexion of a freely suspended pipe.

Why is the longitudinal flexural strength of a buried pipe important?

Prevention of pipe damage and sag-bends

In the static calculation of flexible pipes in accordance with the German standard ATV-A 127 "Guidelines for Static Calculations on Drainage Conduits and Pipelines," the ring stiffness of the pipe is of primary importance. The flexural strength of the pipe lengthwise is not even taken into account. It is assumed that the bedding of the pipe remains consistent along its length. Some pipelines are constructed to comply with the high ring stiffness requirements in accordance with ISO 9969. The longitudinal flexural strength is in part entirely ignored. However, differences in the bedding and support of pipes longitudinally cannot be completely ruled out. Possible causes are, for example, washouts at a later date or irregular settling of the soil. Also, errors in the construction of the lower bedding cannot always be entirely avoided. Flexible pipes having insufficient longitudinal flexural strength usually incur sag-bends, while concrete or stoneware pipes with flexural rigidity incur radial cracks or fragmentation under excessive loads. Axial strain occurs, for instance, as a result of the progressive drawing of the trench lining and also when free-flowing filler materials are used.

Freely suspended pipeline

In the case of freely suspended pipes, the loads arising from the intrinsic weight and any water contained inside have to be compensated for by sufficient longitudinal flexural strength.

Use of liquid soils

The use of liquid soils is becoming more and more popular. The pipeline is laid on supports, such as sand banks or the like, which are spaced as far apart as possible and weighted down, depending on the buoyant forces expected. Afterwards, if possible in a single operation, the entire area around the pipeline (upper and lower bedding layer) is filled up over the soffit with liquid soil having a specific weight of 18-20 kN/m³. This subjects the pipeline to high buoyant forces which, in the sections between the weights, have to be compensated for solely by the longitudinal flexural strength.

How is the longitudinal flexural strength measured?

In smooth, solid-walled pipes, in which the material properties are known and identical throughout, the minimum value of the longitudinal flexural strength can be determined both experimentally and by way of calculation.

In profiled pipes or multi-layer pipes with different E-moduli in the individual layers, the longitudinal flexural strength is usually determined empirically.

In order to determine the actual longitudinal flexural strength of the HS and CONNEX pipes, extensive testing was done for the nominal diameters DN/OD 250-500. The longitudinal flexural strength B is determined on the basis of the deflexion measured in the 3-point bending trial. Furthermore, a few other pipelines were tested for the nominal diameter DN/OD 315. The findings are summarized in Table 1.

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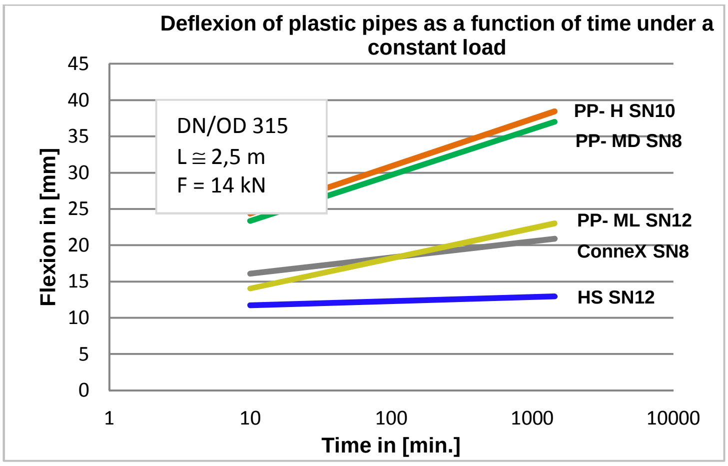
Testing to measure the longitudinal flexural strength, DN/OD 315 shown here, duration of trial 10min./24h/1000 h

Tabelle 1: Zusammenfassung der experimentell ermittelten Werte für die Längsbiegesteifigkeit DN/OD 315

Rohr-System	DN/OD	Min. Wand-Dicke [mm]	Längsbiegesteifigkeit [kNm²]	
			Kurzzeit (10min.)	Langzeit (50 a)
HS (SN12)	315	10,0	395	198
Connex (SN 8)	315	9,2	245	123
PP-H (SN10)	315	12,7	186	59
PP-MD (SN 8)	315	11,4	194	49
PP-ML (SN12)	315	12,2	323	81



For the nominal diameters < DN/OD 250 and > DN/OD 500, longitudinal flexural strength values can be calculated for both the HS and CONNEX pipes on the basis of the experimental results.

Sample calculation

- Soil cover h = 3 m
- Assumption: Pipe support critically weakened at a length of 1.8 m
- Pipe surface loading approx. pE = 0.75 x 3 x 20 kN/m³ = 45 kN/m²
- Pipeline load DN/OD 315 approx. pE*= 0.315 x 45 = 14.18 kN/m
- Solid-walled pipe in accordance with DIN EN 1401 / 1852 / 12666
- Static assumption: Beams on two supports without fixation
- Intrinsic weight of pipe (0.1-0.15 kN/m) and water content (0.5 kN/m) are not accounted for

Table 2: Effect of the longitudinal flexural strength using DN/OD 315 as an example (intrinsically)

Material	Ring stiffness	Wall thickness	E-Modula	Longitudinal flexural strength	Flexion
	SN (short term)	s	E (short/ long term)	E x I (Long term)	w (Long term)
	kN/m²	mm	N/mm²	kNm²	**mm**
PVC-U	12 (HS)	10.0	3.000 / 1.500	198	**10**
PVC-U	8	9.2	3.000 / 1.500	123	**16**
PP-ML	12	12.2	2400/600	81	**24**
PP-H	10	12.7	1.700 / 400	59	**33**
PP-MD	8	11.4	1500 / 375	49	**40**
PE-HD	8	15.0	800 / 160	25	**78**
PP-H Profile	8	3.7 +Ribs	1250 / 312	13	**149**

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