RIB program DWA A127 18.0 Analysis of Buried Pipes Seite/Page 1

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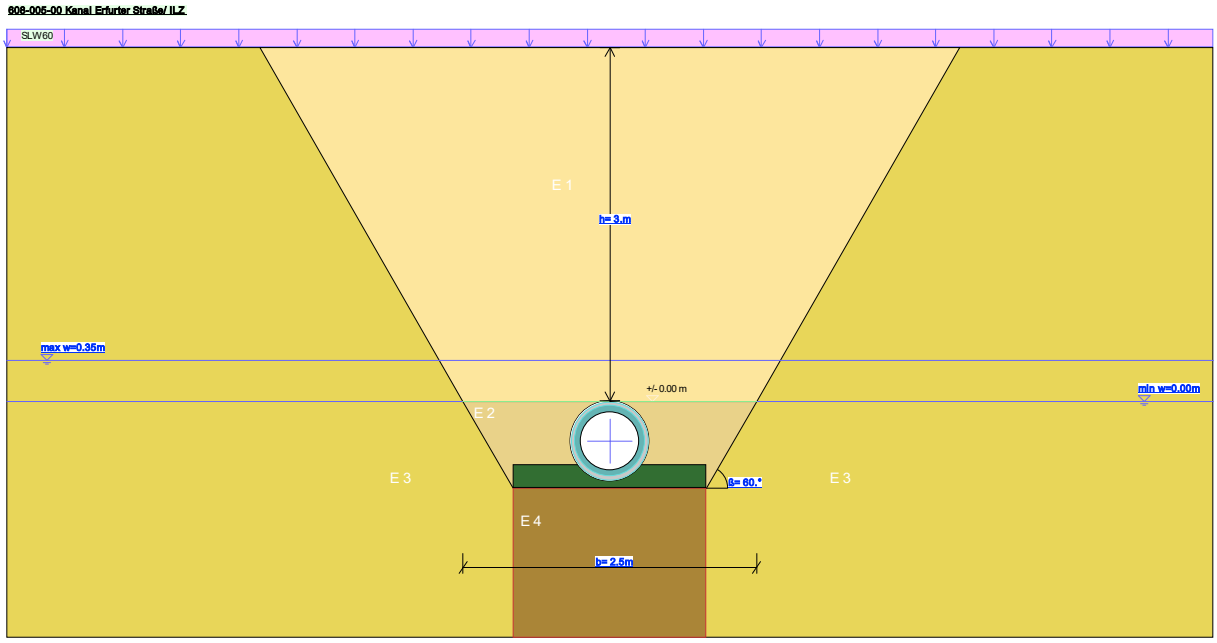
Input file: DN500_Stahlbeton_DIN_1045_mini.ror
Datum/Date : 26.10.2018



S T R U C T U R A L A N A L Y S I S O F B U R I E D P I P E S

according to DWA worksheet A127: Code for the structural analysis of drainage ducts and drainage tubes (RIB program *A127*)
Calculation acc. to DWA-A 127

Reinforced concrete tube, Typ 2 to DIN V 1201 / DIN EN 1916

Printout of the input:

Dimensions and material data:

Nominal diameter	DN	500
Outer diameter	da =	670 mm
Inner diameter	di =	500 mm
Wall thickness	t =	85 mm

Reinforcement two layers:

Circumf. reinforcement:			BSt 500
int.As,Ring =	6.7	Diameter	8.0 mm/m (3.4 cm2/m)
ext.As,Ring =	6.7	Diameter	8.0 mm/m (3.4 cm2/m)
Longit. reinforcement:			
int.As,Long. =	12	Diameter	8.0 mm/Circumference
ext.As,Long. =	12	Diameter	8.0 mm/Circumference

Concrete cover: int.c-nom/ext.c-nom = 25/25 mm

Material properties:

Concrete (Strength quality of concrete):	C 40/50	
Specific weight of pipe material	SpeWgt.R =	25.000 kN/m3
Youngs modulus of the pipe	E.R =	30000 N/mm2
Admissible equivalent stress	sigma.VR,Rd =	6.0 N/mm2
Fatigue strength of the RC-steel		
delta.sigma,Rsk/gamma.s,fat (0.20E+07 LoadCyk) =		64 N/mm2

Installation:
The pipes are designed for an installation according to DIN EN 1610 and ATV-DVWK-A 139:
- foundation type 1 on concrete, minimum dimensions acc. to A 139, Fig. 6a

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  Angle of foundation 2*Alpha =     90 degrees
- Embedment condition B3:
  Vertical trench support within the pipe zone using trench sheets or
  sheet boards and compaction against trench construction.
 (The trench sheets are not driven below the bottom level of the pipe)
- Backfill condition A3:
  Vertical trench construction using heavy interlocking sheet piles,
  timber boards, trench plates or other shoring equipment, which is
  removed after backfilling.
- Trench width used                  b  =    2.5 m
  Angle of repose                 Beta =     60 Deg.
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Design load assumptions:

Backfill height	h =	3.00 m
Relative projection	a =	1.14
Live load:	SLW 60	
Maximum ground water level max	hw =	0.35 m above pipe crown
Minimum ground water level min	hw =	0.00 m above pipe crown
Pipe empty		

Partial safety factors (TS) and other factors:

Design value for permanent action	= gamma.G = 1.35
Design value for variable action	= gamma.Q = 1.50
TS-Factor for concrete	= gamma.c = 1.50
TS-Factor for RC-steel	= gamma.s = 1.15
Factor for reduced strength of concrete	= alpha.D = 0.85
TS-Factor for material properties used to determine the bearing capacity	= gamma.R = 1.35
Proof of fatigue resistance with:	
TS-Factor for actions	= gamma.F,fat = 1.00
TS-Factor for model uncertainties	= gamma.Ed,fat = 1.00
TS-Factor for RC-steel	= gamma.s,fat = 1.15

Soil characteristics:

Soil zones:	Zone 1 Main filling	Zone 2 Pipe zone	Zone 3 Natural soil	Zone 4 below pipe
Installation cond.	A3	B3		
Soil classes	G1	G1	G1	
Proctor density	Dpr = 0 %	Dpr =100 %	Dpr =100 %	
Mod. of deform.	E1 = 6.0	E2 = 6.0	E3 = 23.0	E4 = 60.0
Angle of frict.	Phi' = 25.0		Phi'= 32.5	
Specific weight	Gamma = 20.0			
under buoyancy	Gamma'= 11.0			

Definition of the soil groups (see section 3.1):
Group G1: Non cohesive sand and gravel, to be compacted to Dpr 95%
Group G2: Weakly cohesive sand and gravel,to be compacted to Dpr 95%
Group G3: Cohesive soil mixtures and silt,to be compacted to Dpr 92%
Group G4: Cohesive soils (clay and loam), to be compacted to Dpr 92%

Remark: In the case Dpr = 00.0 % the deformation stiffnesses are taken from a soil certificate taking into account Arbeitsblatt A127,table 1
(Secant modulus within stress limits 0 and approximately 0.1 N/mm2).
Remark: The modulus of deformation E2 (embedment) for the relevant range of stress is obtained from a geological certificate.

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Computed results:

Soil zones:	Zone 1	Zone 2	Zone 3	Zone 4
Earth press. rel.	K1 = 0.500	K2 = 0.500		
Limit E2		E2 = 6.0		
Creep factor f1		f1 = 1.0		
Factor f2		f2 = 1.000		
Factor Alpha.B		alp.B= 0.910		
effective E	E1 = 6.0	E2 = 5.5	E3 = 23.0	E4 = 60.0
effective Phi'	phi'= 25.0			
effective Delta	del = 0.0			

Effective relative projection a' = a*E1/E2 = 1.252
Reduction factor trench load kappa = 1.000
Reduction factor surface load kappa.0 = 1.000

Pipe stiffness SR = 61.351 N/mm2
zeta = 1.189
Horizontal foundation stiffness SBh = 3.90 N/mm2
Vertical foundation stiffness SBv = 4.79 N/mm2
System stiffness Pipe/Soil VRB = 15.741
K* = 0.000
cv* = -0.097
Stiffness proportion VS = 132.54

Concentration factors max.lambda = 1.753
lambda.R = 1.743
lambda.RG = 1.676
lambda.B = 0.752

External loads:
Earth loads:
- within soil above pipe pE = 60.0 kN/m2
- vertical lambda.RG * pE = ev = 100.6 kN/m2
- horizontal qh = eh = 25.9 kN/m2
- found. reaction pressure (ev - eh) * K* = eh* = 0.0 kN/m2

Live loads:
- Traffic load p = 17.4 kN/m2
- Impact coefficient phi = 1.20
- structurally effective pV = 20.8 kN/m2
- structurally effective pH = 0.0 kN/m2
- found. reaction pressure (pV-pH) * K* = ph* = 0.0 kN/m2

Maximum total loads qv = 121.4 kN/m2
qh = 25.9 kN/m2
qh* = 0.0 kN/m2

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Sections:	Springline	Pipe crown	Pipe base
Cross-section values:			
Area (cm2/m):	951.034	951.034	951.034
Moment of resistance (cm3/m):	1216.854	1241.434	1241.434
Internal forces acc. to chapter 9.1 (associated values acc. to table T3)			
Bending moments M (kNm/m):			
M.g (Dead load) =	-0.084	0.072	0.095
M.w (Water fill/ground water) =	0.058	-0.050	-0.066
M.ev (Earth load vertical) =	-2.332	2.289	2.384
M.eh (Earth load horizontal) =	0.541	-0.543	-0.497
M.pV (Live load vertical) =	-0.483	0.474	0.494
M.pH (traffic horizontal):	0.000	0.000	0.000
Sum of M (total load) =	-2.300	2.242	2.410
M.Gk (Sum of permanent loads) =	-1.817	1.768	1.917
M.Qk (Sum of variable loads) =	-0.483	0.474	0.494
M.Gd = gamma.G*M.Gk = 1.35*M.Gk =	-2.453	2.387	2.587
M.Qd = gamma.Q*M.Qk = 1.50*M.Qk =	-0.725	0.711	0.741
M.Ed = M.Gd + M.Qd =	-3.177	3.098	3.328
Normal forces N (kN/m):			
N.g (Dead load) =	-0.976	0.177	-0.986
N.w (Water fill/ground water) =	-0.184	-0.550	-0.605
N.ev (Earth load vertical) =	-29.420	1.118	-13.298
N.eh (Earth load horizontal) =	0.000	-7.500	-5.445
N.pV (Live load vertical) =	-6.094	0.232	-2.754
N.pH (traffic horizontal):	0.000	0.000	0.000
Sum of N (total load) =	-36.674	-6.524	-23.088
N.Gk (Sum of permanent loads) =	-30.580	-6.755	-20.334
N.Qk (Sum of variable loads) =	-6.094	0.232	-2.754
N.Gd = gamma.G*N.Gk = 1.35*N.Gk =	-41.284	-9.119	-27.451
N.Qd = gamma.Q*N.Qk = 1.50*N.Qk =	-9.141	0.347	-4.132
N.Ed = N.Gd + N.Qd =	-50.424	-8.772	-31.583

Design for cracked state according to DIN V 1201 (DIN 1045-1)
with gamma.c = 1.50, gamma.s = 1.15, alpha.D = 0.85, gamma.R = 1.35
and fcd = 22.67

Sections:	Springline	Pipe crown	Pipe base
Wall thickness t / eff. height d =	85/ 48	85/ 56	85/ 56
Design results:			
Steel strain eps.s (0/00) =	9.80	10.00	10.00
Concr.compr.strain eps.1 (0/00) =	-3.50	-1.60	-2.18
Inner lever arm (cm) =	4.30	5.40	5.30
required As,ring (cm2/m) =	2.0	1.7	1.7
existing As,ring (cm2/m) =	3.4	3.4	3.4

Pipe effective stress (sigma.VR) for state I acc.to DIN V 1201 in N/mm2
with gamma.G = 1.0, gamma.Q = 1.0, gamma.R = 1.0

Sections:		Springline	Pipe crown	Pipe base
sigma.M	=	1.890	1.806	1.942
sigma.N	=	-0.386	-0.069	-0.243
sigma.N/sigma.M	=	-0.204	-0.038	-0.125
Coefficien fR (DIN V 1201)	=	0.900	0.933	0.900
existing sigma.VR,Ed	=	1.354	1.620	1.529
admissible sigma.VR,Rd	=	6.000	6.000	6.000

The pipe has sufficient bending stiffness.
Deformation analysis and proof of stability are not required.

Weight of steel without additions for socket or offcut:

Circumferential reinforcement	=	10.4 kg/m
Longitudinal reinforcement	=	9.5 kg/m
Total reinforcement	=	19.8 kg/m

Program RTpipe: End of calculation DN500_Stahlbeton_DIN_1045_mini.ror

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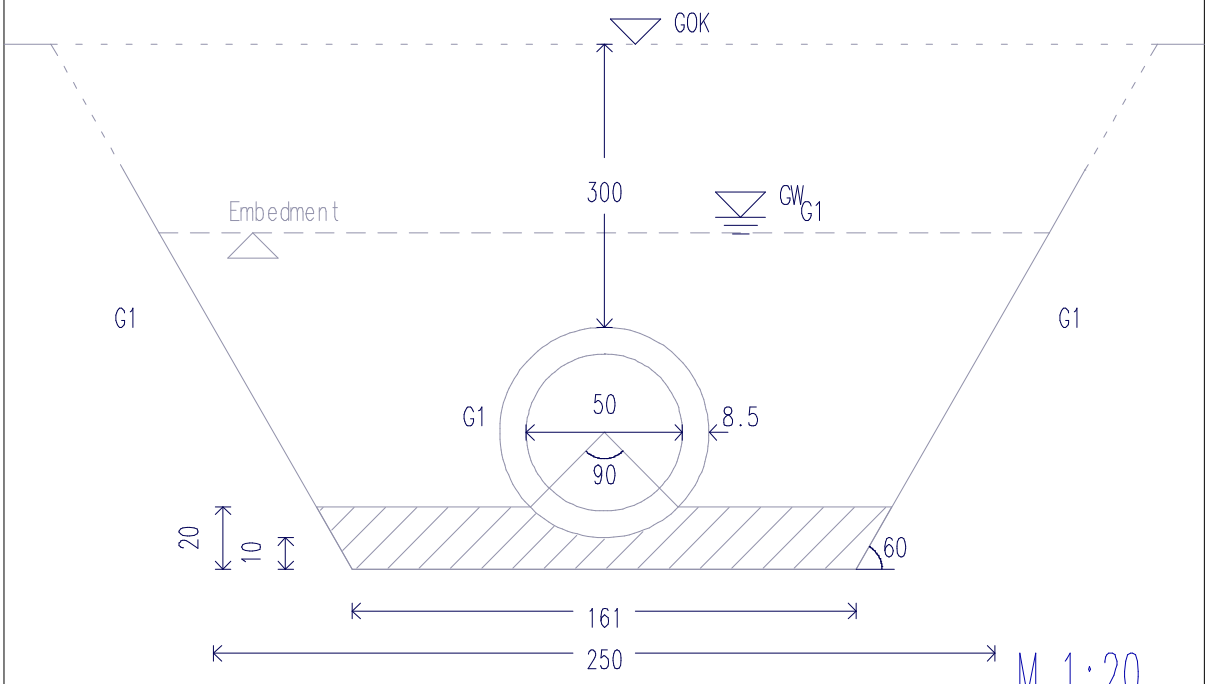
Reinforced concrete or reinforced concrete pressure pipe

DN500

Traffic load SLW 60



Support acc. to EN 1610/ATV-A139

The soil groups mean:
Group G1: Non-cohesive sand and gravel
Group G2: Slightly cohesive sand and gravel
Group G3: Cohesive mixed soils and silt
Group G4: Cohesive soils (clay and loam)

Concrete
support90

Backfilling layered
placing + compacting
to Proctor density in %:
Earth covering = 0
Bedding = 100

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