PRILOGA 1B

NASLOVNA STRAN NAČRTA

OSNOVNI PODATKI O GRADNJI		
naziv gradnje		**PRENOVA HIŠE OBRTI IN ROKODELSTVA**
kratek opis gradnje		**Objekt "HIŠA OBRTI IN ROKODELSTVA" je obstoječ spomeniško varovan objekt med Glavno in Spodnjo ulico v Lendavi, na parcelah št. 4173/1, 4173/2, 4173/3 k.o. 166 LENDAVA. Evidenčna številka spomenika v Registru kulturne dediščine je 8362 (Lendava - Hiša Glavna ulica 41). Objekt se prenovi in rekonstruira v poslovni objekt, s posameznimi poslovnimi prostori / obrtnimi delavnicami / prodajalnami.**
Seznam objektov, ureditev površin in komunalnih naprav z navedbo vrste gradnje.		
vrste gradnje	☐	**novogradnja - novozgrajen objekt**
Označiti vse ustrezne vrste gradnje	☐	**novogradnja - prizidava**
	☑	**rekonstrukcija**
	☐	**sprememba namembnosti**
	☐	**odstranitev**
DOKUMENTACIJA		
vrsta dokumentacije		**PZI**
(IZP, DGD, PZI, PID)		
številka projekta		**D-31/2021**
	☐	**sprememba dokumentacije**
PODATKI O NAČRTU		
strokovno področje načrta		**GRADBENE KONSTRUKCIJE**
številka načrta		**D-31/2021-GK**
datum izdelave		**1.2.2022**
PODATKI O IZDELOVALCU NAČRTA		
ime in priimek pooblaščenega arhitekta, pooblaščenega inženirja		**ALEKSANDER PLEJ, dipl. inž. grad.**
identifikacijska številka		**G-3439**
podpis pooblaščenega arhitekta, pooblaščenega inženirja		ALEKSANDER PLEJ dipl.inž.grad. IZS G-3439
PODATKI O PROJEKTANTU		
projektant (naziv družbe)		**ASPA-ING D.O.O.**
naslov		**Ulica Prekmurske čete 71, 9232 Črenšovci**
vodja projekta		**Aleksander Plej, dipl.inž.gradb.**
identifikacijska številka		**IZS G-3439**
podpis vodje projekta		ALEKSANDER PLEJ dipl.inž.grad. IZS G-3439
odgovorna oseba projektanta		**Aleksander Plej**
podpis odgovorne osebe projektanta		ASPA-ING

2.2 KAZALO VSEBINE NAČRTA

2.1	Naslovna stran načrta
2.2	Kazalo vsebine načrta
2.3	Tehnično poročilo
2.4	Risbe, pozicijski načrti in izračuni
2.5	Statični izračuni
2.6	Opažno armaturni načrti

2.3 TEHNIČNO POROČILO

2.3.1 SPLOŠNI PODATKI

Projekt obravnava izdelavo načrta gradbenih konstrukcij za prenovo hiše obrti in rokodelstva v Lendavi, ki ga je izdelalo podjetje ASPA-ING d.o.o., Ul. Prekmurske čete 71, 9232 Črenšovci.

STANDARDI Gradbene konstrukcije so izdelane skladno z 8. členom Pravilnika o mehanski odpornosti in stabilnosti objektov, po pravilih standardov EVROCOD.

ANALIZA OBTEŽBE Vsi statični elementi v obravnavanem projektu so primerno dimenzionirani po veljavnih standardih in predpisih za tovrstne konstrukcije. Objekt je lociran na območju mesta Lendava. Glede na poznan podatek lahko določim obtežbo vetra, snega in potresa na predviden objekt. Ostale obtežbe so podane pri izračunu elementov konstrukcije.

2.3.2 TEHNIČNO POROČILO OBJEKTA

Projekt obravnava izdelavo načrta gradbenih konstrukcij za prenovo hiše obrti in rokodelstva v Lendavi, ki ga je izdelalo podjetje ASPA-ING d.o.o., Ul. Prekmurske čete 71, 9232 Črenšovci.

- OPORNI ZID, AB STENA in STOPNICE

  V sklopu prenove hiše obrti in rokodelstva v Lendavi je potrebno izvesti oporni zid, pasovni temelj z armirano-betonsko steno in stopnice.
  Oporni zid poteka vzporedno s Spodnjo ulico (Lendava) in je nadeljevanje obstoječega objekta. Oporni zid je dimenzioniran kot konzolni zid v obliki črke L, razvitih dimenzij 1234/250/410cm. Debelina pete je 50cm, debelina zidu je 40cm. Vse je razvidno v opažno-armaturnih načrtih.
  Na južni parcelni meji se izvede pasovni temelj z armirano-betonsko steno. Pasovni temelj je dimenzij 504/60/50cm, AB stena pa dimenzij 504/360/30 cm. Vse je razvidno v opažno-armaturnih načrtih.
  Med oporni zid in AB steno se izvedejo stopnice, po katerih se s Spodnje ulice pride na notranjo ploščad hiše. Stopnice se izvedejo na utrjeno gramozno nasutje.
  Geometrija, lokacija in dimenzije navedenih nosilnih elementov so razvidne iz opažno-armaturnih načrtov.
  Predhodno ni bila na terenu izvedena geološko - geomehanska raziskava temeljnih tal. Za planum temeljnih tal se naj upošteva modul stisljivosti Ms = 5 - 10 MN/m^2. Pri izračunu pete in pasovnega temelja je bila upoštevana nosilnost temeljnih tal Sigma tal dop.= 200 kN/m^2, ter modul reakcije tal K_{min}= 20 kN/m^3. Pod navedene nosilne elemente se mora izvesti gramozni tampon, pri čemer se naj upošteva nosilnost planuma tampona E_{vd2} = 100 MN/m^2, zgoščenost planuma 98 % po Proctorju po SIST EN 13286. Pred izdelavo temeljenja nosilnih elementov, se mora izvesti geomehanska meritev nosilnosti dinamičnega deformacijskega modula E_{vd}, katera mora dosegati vrednost min. E_{vd} = 50 MN/m^2, da se potrdi predvidena nosilnost gramozirane podlage, oz. se izvede ponovni preračun temeljenja. Oporni zid, pasovni temelj z AB steno in stopnice se izvedejo iz cementnega betona C 30/37, XC2, Dmax 16, PV-II, ter armirajo z armaturo kvalitete S500 (B) v skladu z opažno-armaturnimi načrti v PZI, ter projektom betona, katerega izdela izvajalec.
  Notranjo stran opornega zidu ter AB stene, peto opornega zidu in pasovni temelj je potrebno zaščititi pred vlago in meteornimi vodami. To se izvede s pomočjo hidroizolacije in drenažnega sistema, s katerim odvajamo meteorno vodo preko peskolovov v meteorni odvodnik.
  Oporni zid se zasipa z gramozom in se komprimira po slojih debeline 30 cm, do višine določene v arhitekturi. Utrjeno gramozno nasutje za stopnice se navaža in komprimira po slojih debeline 30 cm, do določene višine.

- NOSILNA KONSTRUKCIJA GANGA

  V sklopu prenove hiše obrti in rokodelstva v Lendavi je potrebno izvesti rekonstrukcijo severno-vzhodnega dela ganga. Obstoječa nosilna konstrukcija ganga se odstrani in se nadomesti z jeklenimi konzolami in lesenimi tramovi, tako, da tvorijo nosilno konstrukcijo ganga.
  Jekleni nosilci so prečnega prereza IPE 200 in so razporejeni kot je prikazano v načrtu arhitekture. Nosilci so členkasto vpeti v nosilne zidove objekta. Nosilce je potrebno antikorozijsko zaščititi in pobarvati v barvo po želji investitorja.

- POŽARNE STOPNICE

  V sklopu prenove hiše obrti in rokodelstva v Lendavi je potrebno izvesti požarne stopnice ob jugo-zahodnem delu ganga.
  Pasovna temelja se izvedeta iz cementnega betona C 30/37, XC2, Dmax 16, PV-II, ter armirajo z armaturo kvalitete S500 (B) v skladu z opažno-armaturnimi načrti v PZI, ter projektom betona, katerega izdela izvajalec.
  Jekleno konstrukcijo je potrebno antikorozijsko zaščititi.

SPLOŠNO

Pri izvedbi je izvajalec dolžan izvajati gradnjo po veljavnih tehničnih predpisih in standardih, ter voditi dokumentacijo s katero dokazuje kvaliteto vgrajenih materialov in tehnoloških postopkov. Odstopanja od statičnega izračuna in projekta je dovoljeno samo s soglasjem odgovornega projektanta.
Pri gradnji je potrebno upoštevati pogoje gradbišča in pozicije, ter nosilnost nosilnih elementov konstrukcije objekta, ki jih lahko med gradnjo začasno obremenimo.
Za vsako spremembo namembnosti projektiranih prostorov se je potrebno pogovoriti z odgovornim projektantom, ki poda mnenje o vplivu novih obtežnih pogojev na nosilno konstrukcijo.

OBTEŽBE, MATERIALI

Obtežbe upoštevane pri izdelavi načrta projektne dokumentacije so usklajene z zahtevami projektne naloge.
Vplivi in obtežbe so privzeti iz standardov:

SIST EN 1991, SIST EN 1992, SIST EN 1996, SIST EN 1997, SIST EN 1998

Osnovni so:

Določitev gostote teže:	EN 1991-1-1:2004 z nacionalnim dodatkom SIST EN 1991-1-1:2004 /A101
Obtežbe s snegom:	EN 1991-1-3:2004
Vpliv vetra:	EN 1991-1- 4:2005
Potresni vpliv:	SIST EN 1998-1:2005/A101:2006

Velikost obtežb, katere so bile merodajne za izračun objekta so razvidne iz statike projekta.

Pri izdelavi statičnega izračuna so bile upoštevane samo zakonsko določene obtežbe. V primeru morebitnih drugih obtežb se morajo obravnavati tako, da nimajo vpliva na objekt. O morebitnih drugih – dodatnih obtežbah mora biti obveščen projektant konstrukcije.

V primeru druge zasnove objekta od predvidenega v statičnemu izračunu, oz. pri spremembi koristnih obtežb na konstrukciji se mora izvesti ponovna statična presoja!

2.3.3 UPORABLJENI MATERIALI IN ZAŠČITNI SLOJI

BETON

Podložni beton:		C12/15, X0, Cl-1.0, Dmax32, S1
AB temeljenje:		C30/37, XC2, Cl-0.2, Dmax16, S2, PVII
Zaščitni sloj betona:		
- temeljenje	..... 5,0 cm	

ARMATURA

Rebrasta armatura:	S 500 B
Mrežna armatura:	S 500 B
- trdnost na meji tečenja armature	fy,k = 50,0 MPa.

JEKLENE KONSTRUKCIJE

Osnovni material:	jeklo kvalitete S 235 JRG1

2.3.4 ZAHTEVE

Pri izvedbi vseh elementov je potrebno upoštevati vse statične karakteristike in zagotoviti:

- ateste, izjave o skladnosti in izjave o lastnostih za vse vgrajene materiale
- s strani geomehanika oz. geologa ob izkopu gradbene jame pregled, ter preveritev dejanske nosilnosti temeljnih tal
- pred izvedbo del je potrebno imeti (na gradbišču za fazo, katera se izvaja) PZI – projekt za izvedbo (gradbene konstrukcije)
- kvalitetno zaščito, ter izvedbo hidroizolacije na konstrukcijskih elementih

Pri izvedbi in montaži vseh konstrukcijskih elementov zagotoviti prisotnost nadzorne osebe na gradbišču in s strani nadzorne osebe prevzem izvedenih konstrukcijskih elementov (UR.L.RS št. 110/2002, Zakon o graditvi objektov). Konstrukcijske elemente in statične zasnove NI dovoljeno spreminjati brez pisne odobritve odgovornega projektanta gradbenih konstrukcij!
Nosilnost temeljnih tal mora ob izkopu gradbene jame pregledati geomehanik in podati pisno mnenje. V kolikor je dejanska nosilnost temeljnih tal manjša od predpisane oz. je modul reakcije temeljnih tal manjši od predpisanega v statičnem izračunu se s strani geomehanika pisno poda predlog temeljenja.

Brez predhodnega obvestila odgovornega projektanta gradbenih konstrukcij in njegovega vpisa v gradbeni dnevnik izvajalca del se konstrukcijskih elementov v nobenem primeru ne sme spreminjati!

Projektiranje vseh klasično izvedenih nosilnih elementov objekta je izvedeno po evropskih standardih:

EN 1990 EUROCODE 0	Osnove projektiranja konstrukcij
EN 1991 EUROCODE 1	Osnove obtežb na konstrukcije
EN 1992 EUROCODE 2	Osnove projektiranja betonskih konstrukcij
EN 1993 EUROCODE 3	Osnove projektiranja jeklenih konstrukcij
EN 1995 EUROCODE 5	Osnove projektiranja lesenih konstrukcij
EN 1996 EUROCODE 6	Osnove projektiranja zidanih konstrukcij
EN 1997 EUROCODE 7	Osnove projektiranja geotehničnih konstrukcij
EN 1998 EUROCODE 8	Osnove projektiranja potresno odpornih konstrukcij

Obvezno predhodno vse mere preveriti na samem objektu!

Statična analiza objekta je narejena s pomočjo programskega orodja Frilo statik!

2.4 RISBE, POZICIJSKI NAČRT IN IZRAČUNI

Osnovni parametri objekta in konstrukcije:

Kategorija priporočene življenske dobe:	4. - življenska doba 50 let
Kategorija temeljnih tal (po EC8) :	E
Nadmorska višina lokacije objekta:	A ≈ 160 m
Snežna cona (po SIST EN 1991-1-3):	A1
Vetrna cona (po SIST EN 1991-1-4):	I
Kategorija pomembnosti (po SIST EN 1998-1, 4.2.5):	II
Izbran razred duktilnosti (po SIST EN 1998-1):	I
Projektni pospešek a_g	0,100

2.4.1 STALNA OBTEŽBA

Stalna obtežba, ki vpliva na konstrukcijske elemente je podana v statičnih izpisih.

Zasip opornega zidu je predviden z gramozom. Geomehanske karakteristike gramoza, katere so upoštevane za izračun aktivnega pritiska na oporni zid, so (gama) $\gamma = 19$ kN/m^3, (kohezija) $c = 0$ kPa in (strižni kot) $\varphi = 30^\circ$.

2.4.2 KORISTNA OBTEŽBA

Koristna obtežba, ki vpliva na konstrukcijske elemente je podana v statičnih izpisih.

2.4.3 ANALIZA OBTEŽBE SNEGA

Obtežba snega ni merodajna.

2.4.4 ANALIZA OBTEŽBE VETRA

Obtežba vetra ni merodajna.

2.4.5 ANALIZA OBTEŽBE POTRESA

Obtežba potresa ni merodajna.

2.4.6 ARMIRANO BETONSKI PREREZI

Dimenzioniranje armirano betonskih prerezov po EVROPSKIH STANDARDIH:

~ MEJNO STANJE NOSILNOSTI **(ULS)**

~ MEJNO STANJE UPORABNOSTI **(SLS)**

MATERIALNE KARAKTERISTIKE

BETON C30/37

fck = 30 Mpa

fcd = fck/γ_c =30/1,5 Mpa

γc …….faktor varnosti betona

f cd = α × fcd = 0,85 × 30/1,5 = 17 MPa

Ecm = 30,5 KN/cm2…….povprečni modul elastični

Trdnostni razredi in lastnosti betonov:

trdnostni razred	f_{ck} (MPa) karakteristična tlačna trdnost valja	f_{ctm} (MPa) srednja vrednost natezne trdnosti	$f_{ctk\ 0.05}$ (MPa) spodnja karkteristična natezna trdnost (5% fraktila)	$f_{ctk\ 0.95}$ (MPa) zgornja karkteristična natezna trdnost (95% fraktila)	modu elastičnosti E (GPa)	Poissonov količnik	Spec. toplotni raztezek ($°C^{-1}$)
C 12/15	12	1,6	1,1	2,0	26	0,2	10^{-5}
C 16/20	16	1,9	1,3	2,5	27,5		
C 20/25	20	2,2	1,5	2,9	29		
C 25/30	25	2,6	1,8	3,3	30,5		
C 30/37	30	2,9	2,0	3,8	32		
C 35/45	35	3,2	2,2	4,2	33,5		
C 40/50	40	3,5	2,5	4,6	35		
C 45/55	45	3,8	2,7	4,9	36		
C 50/60	50	4,1	2,9	5,3	37		

ARMATURA: S 500 (B)

fyk = 500 Mpa…….karakteristična meja plastičnosti

fyd = fyk/γs = 500/1,15 = 434,78 Mpa

γ_s = 1,15……..faktor varnosti armature

Pred izvedbo temeljenja je potrebno s strani geomehanika izmeriti dejansko nosilnost tal. Ob morebitnem odstopanju dejanske nosilnosti temeljnih tal od predvidenih parametrov iz geomehanskega poročila pri statičnem izračunu je potrebno na novo dimenzionirati temeljenje na dejanske podatke o nosilnosti tal!

2.5 STATIČNI IZRAČUNI

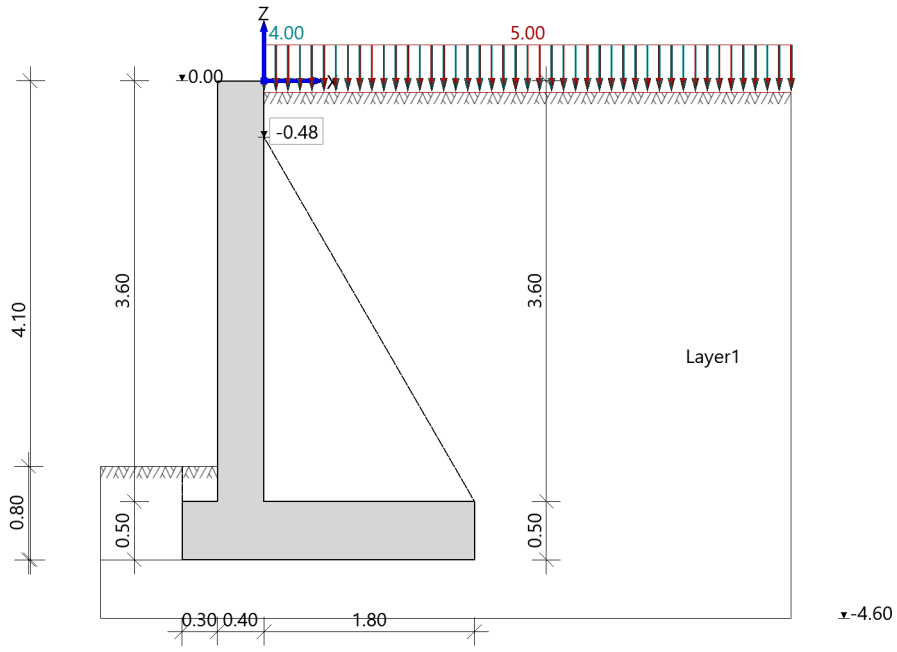
- OPORNI ZID
- AB STENA
- PASOVNI TEMELJ
- JEKLENI NOSILEC
- POŽARNE STOPNICE

Item: Oporni zid

Cantilevered Retaining Wall WSM+ 01/22 (FRILO R-2022-1/P05)

System

Graphics



Characteristic values

Design Codes

Design byDIN EN 1992-1-1/NA/A1:2015-12 and DIN EN 1997-1/NA:2010-12

Cantilever wall

	Total height	=	4.10	m	Soil inclination	=	0.0	°	Soil depths difference	=	0.00 m
Wall:	Width top	=	0.40	m	Haunch uphill	=	0.00	m	Haunch downhill side	=	0.00 m
Toe:	Length	=	0.30	m	Height	=	0.50	m			
Heel uphill:	Length	=	1.80	m	Height rear	=	0.50	m	Haunch uphill side	=	0.00 m

Properties

Concrete density	γb	=	25.00	kN/m³
Soil friction angle	$\delta S,k$	=	30.0	°
Active angle of wall friction	δ	=	2/3 φ'	
Passive wall friction angle	δp	=	0 φ'	

Soil

Soil layers uphill

Nr.	γ [kN/m³]	γ' [kN/m³]	φ' [°]	c' [kN/m²]	d [m]	E* [kN/m²]	Description
1	19.00	19.00	30.0	0.00	4.50	90000.00	

Soil layer before downhill heel

γ [kN/m³]	γ' [kN/m³]	φ' [°]	c' [kN/m²]	d [m]
19.00	19.00	30.0	0.00	0.80

Terrain

Ground begin Δz = 0.10 m
continuous
Inclination β = 0.0 °

Loads

Soil loads

Loads on the soil

Nr.	load type	pi		a [m]	b [m]	L [m]	z [m]	Earth pressure distribution	Action	Sim	Alt
1	Surface load	4.00	kN/m²	0.00	-	-	-	-	Permanent loads	0	-
2	Surface load	5.00	kN/m²	0.00	-	-	-	-	Cat. C: congregation areas	0	0

Design

Earth Resistance

Earth resistance not applied.

Earth pressure

Inner stability (reinforced concrete design)

Earth pressure type = Active earth pressure
Any tensile forces from cohesion are not applied.
Minimum earth pressure not taken into account.

Outer stability (geotechnical verifications)

Earth pressure is applied to the inclined sliding surface

Earth pressure type = Active earth pressure
Any tensile forces from cohesion are not applied.
Minimum earth pressure not taken into account.

Geotechnical design

The detailed proof of base failure including sliding is maintained

Reinforced concrete analysis

Settings of wall design

Requirements durability:

attack on concrete		XF1/WF	
attack on reinforc.		XC2/XD1	
min. concrete class		C 30/37	
long. reinforcement	$\varphi_{,m}$	= 12	mm
allowance in design	ΔC_{dev}	= 15	mm
longitudinal bars	$C_{min,m}$	= 40	mm
concrete coverage	$C_{nom,m}$	= 55	mm
laying dist. link	$C_{,l}$	= 55	mm
all. crack width	w_{max}	= 0.30	mm

Concrete strength class		=	C30/37			
Steel		=	B500B			
Steel diameter inside	OS,1	=	12 mm	Steel diameter outside	OS,2	= 12 mm
Diameter stirrup	OB	=	-			
Measurement inside	cv,l1	=	5.5 cm	Measurement outside	cv,l2	= 5.5 cm
Distance reinforcement layer inside	d1	=	6.1 cm			
Distance reinforcement layer outside	d2	=	6.1 cm			

Foundation dimension settings

As the wall
Reduction of the transverse force with a variable cross-section height is carried out

Results

Result overview

Geotechnical verifications

Proof	Superposition	Utilization ratio μ
Toppling proof	1	0.00
Bearing Resistance Failure	2	0.79
Sliding proof	2	0.75
Slope stability	3	0.70
Gapping joint 1st core width	4	0.68
Gaping joint 2nd core width	5	0.38

average settlement s_m = 0.2 cm Decisive combination : 4
Tilt a = 0.025 ° Decisive combination : 4

Required reinforcement

Location	Flexural reinforcement $a_{sl,req}$ top/outer [cm²/m]	LCc. [-]	$a_{sl,req}$, bottom/inner [cm²/m]	LCc. [-]	Shear reinforcement $a_{sw,req}$ [cm²/m]	LCc. [-]
Constrained wall	3.00	6	5.06	7	0.00	7
Cut part heel	6.42	7	0.00	6	0.00	2
Cut part toe	3.75	6	6.11	8	0.00	2

Overview of superposition and load cases

Actions

Name	ψ_0	ψ_1	ψ_2
Permanent loads	1.00	1.00	1.00
Cat. C: congregation areas	0.70	0.70	0.60

Load cases

No.	Name	Action
1	Soil and wall weight	Permanent loads
2	Earth pressure from dead load	Permanent loads
3	Soil load Nr. 1 (incl. earth pressure)	Permanent loads
4	Soil load Nr. 2 (incl. earth pressure)	Cat. C: congregation areas

Decisive combinations (permanent design situation)

No.	Limit state	decisive combination
1	EQU	0.90×(1) + 0.90×(2) + 0.90×(3)
2	STR/GEO-2	1.35×(1) + 1.35×(2) + 1.35×(3) + 1.50×(4)
3	GEO-3	1.00×(1) + 1.00×(3) + 1.30×(4)
4	SLS	1.00×(1) + 1.00×(2) + 1.00×(3)
5	SLS	1.00×(1) + 1.00×(2) + 1.00×(3) + 1.00×(4)
6	STR/GEO-2	1.00×(1) + 1.00×(2) + 1.00×(3)
7	STR/GEO-2	1.00×(1) + 1.35×(2) + 1.35×(3) + 1.50×(4)
8	STR/GEO-2	1.35×(1) + 1.00×(2) + 1.00×(3)

The load numbers are in brackets

Geotechnical verifications

Earth pressure

Active earth pressure factors

from z = [m]	to z = [m]	α [°]	φ' [°]	δ [°]	$\theta_{\alpha max}$ [°]	k_{agh} [-]	k_{ach} [-]	k_{aph} [-]
-0.10	-0.48	0.0	30.0	20.0	60.0	0.279[1]	0.922[1]	0.279[1]
-0.48	-3.60	30.0	30.0	30.0	60.0	0.333[1]	0.433[1]	0.333[1]
-3.60	-4.10	0.0	30.0	20.0	60.0	0.279[1]	0.922[1]	0.279[1]

1 : β = 0 °

Sliding surface information

Earth pressure is applied to the inclined sliding surface

Point of intersection top edge terrain and sliding surface, relative to top edge wall (above positive) hang-clos
corner (in the direction of slope positive)

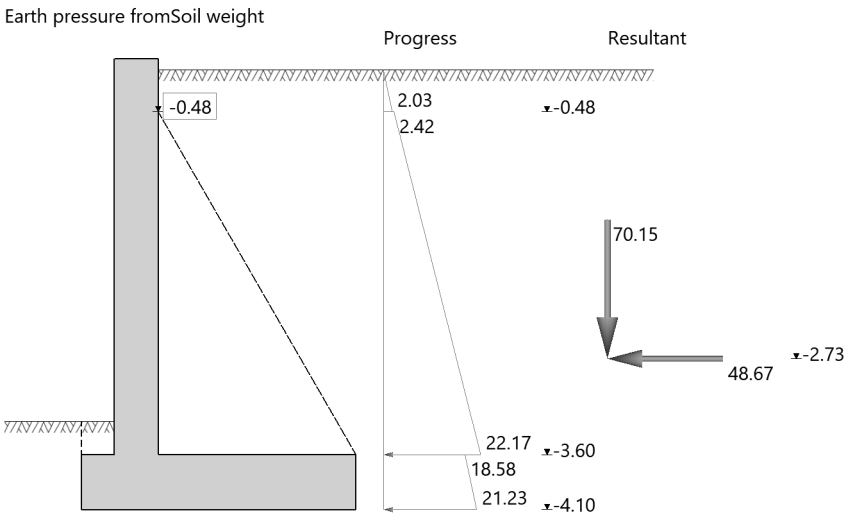
- in x-direction s_x = 0.00 m - in z-direction s_z = -0.48 m

Earth pressure curve from dead load

z [m]	e_{ah} [kN/m²]
-0.10	0.00
-0.48	2.03
-0.48	2.42
-3.60	22.17
-3.60	18.58
-4.10	21.23

Resultant

Horizontal resultant E_{ah} = 48.67 kN/m Action point from the top of the wall z_a = -2.73 m
Vertical resultant E_{av} = 70.15 kN/m



Earth pressure from loads

Load number 1

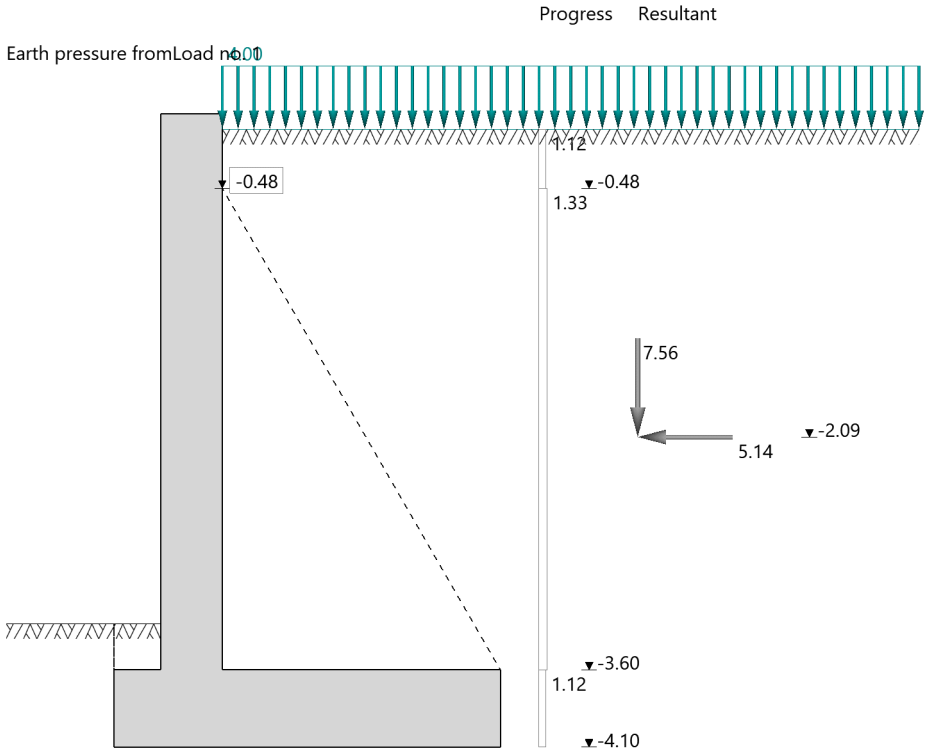
load type = Surface load Load value pi = 4.00 kN/m²
Depth of effect z = 0.00 m

Progress

z [m]	e_{aph} [kN/m²]
-0.10	1.12
-0.48	1.12
-0.48	1.33
-3.60	1.33
-3.60	1.12
-4.10	1.12

Resultant

Horizontal resultant E_{aph} = 5.14 kN/m Action point from the top of the wall z_{ap} = -2.09 m
Vertical resultant E_{apv} = 7.56 kN/m



Load number 2

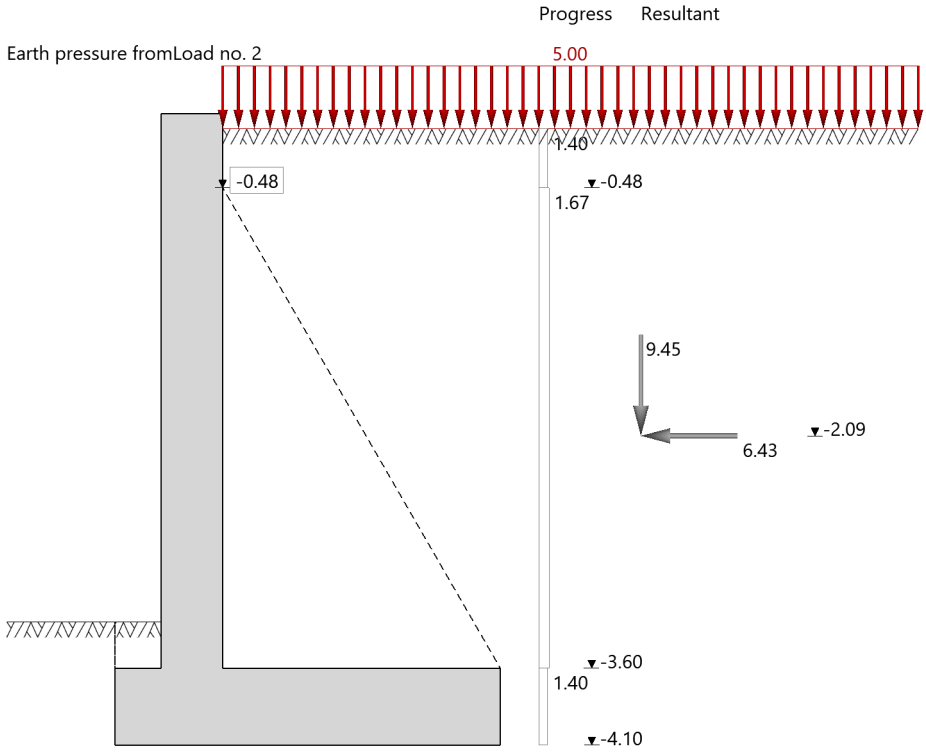
load type = Surface load Load value pi = 5.00 kN/m^2
Depth of effect z = 0.00 m

Progress

z [m]	e_{aph} [kN/m^2]
-0.10	1.40
-0.48	1.40
-0.48	1.67
-3.60	1.67
-3.60	1.40
-4.10	1.40

Resultant

Horizontal resultant E_{aph} = 6.43 kN/m Action point from the top of the wall z_{ap} = -2.09 m
Vertical resultant E_{apv} = 9.45 kN/m



Water pressure

Resultant

R_h = 0.00 kN/m R_v = 0.00 kN/m

Internal forces

Shear forces table

Load case	t [kN/m]	n [kN/m]	m [kNm/m] Center of the base	m [kNm/m] Toppling edge
Soil and wall weight	0.00	122.27	26.22	-126.63
Earth pressure from dead load	-48.67	70.15	23.13	-64.56
Soil load Nr. 1 (incl. earth pressure)	-5.14	7.56	7.64	-1.81
Soil load Nr. 2 (incl. earth pressure)	-6.43	9.45	9.55	-2.26
Earth Resistance	0.00	0.00	0.00	0.00

Resistance check (ULS)

Proof of toppling about valley side edge.

Design situation Persistent
Ultimate state EQU

No earth resistance set/available

Stabilizing moment:

m_{stb} = (-126.63 ·0.90) + (-64.56 ·0.90) + (-1.81 ·0.90) + (-2.26 ·0.00) = -173.70 kNm/m

Destabilizing moment:

m_{dst} = = 0.00 kNm/m

Check

m_{dst} = 0.00 < | m_{stb} = -173.70 |
Degree of utilization μ = 0.00

The toppling check is fulfilled

Bearing Resistance Failure

Design situation Persistent
Ultimate state STR

No earth resistance set/available

Actions

t_{rep} = (-48.67 · 1.00) + (-5.14 · 1.00) + (-6.43 · 1.00) = -60.24 kN/m

n_{rep} = (122.27 · 1.00) + (70.15 · 1.00) + (7.56 · 1.00) + (9.45 · 1.00) = 209.43 kN/m

m_{rep} = (26.22 · 1.00) + (23.13 · 1.00) + (7.64 · 1.00) + (9.55 · 1.00) = 66.52 kNm/m

Design value of bearing pressure stress

Design value of actions:

n_d = (122.27 · 1.35) + (70.15 · 1.35) + (7.56 · 1.35) + (9.45 · 1.50) = 284.15 kN/m

Resulting inclination of bearing pressure

tan δ = - t_{rep} / n_{rep} = 60.24 / 209.43 = 0.29

Reduced foundation area

According to DIN 4017 Fig. 4, only the horizontal part of the foundation width is used
and the load eccentricity for the calculation of the reduced foundation area is taken into account

Eccentricity e_b = m_{rep} / n_{rep} · cos(a) = 66.52 / 209.43 ·cos(0.0) = 0.32 m

Reduced foundation area b' = b - 2 · e_b = 1.86 m

DIN 4017:2006 - Bearing Resistance Failure

d' m	N_{Ek} kN/m	T_{Ek} kN/m	δ °	ω °	N_{Ed} kN/m	T_{Edx} kN/m	T_{Edy} kN/m	R_{nk} °	R_{nd} kN/m	η
0.80	209.4 kN	0.0 kN	16.0	90.0	284.1 kN	0.0 kN	82.3 kN	504.6 kN	360.4 kN	0.79

Layers

	z m	d m	ls m	φ' °	ls ·φ' °m	c' kN/m²	ls ·c' kN/m	A m²	γ kN/m³	A ·γ kN/m
1	1.61	1.61	5.10	30.0	153.1	0.00	0.0	12.79	19.00	243.04
2	2.29	0.67	2.08	30.0	62.4	0.00	0.0	3.51	19.00	66.64
3	2.50	0.21	0.84	30.0	25.2	0.00	0.0	0.84	19.00	15.88
4	2.93	0.43	3.69	30.0	110.8	0.00	0.0	1.03	19.00	19.56
			11.72	**30.0**	351.5	**0.00**	0.0	18.16	**19.00**	345.11

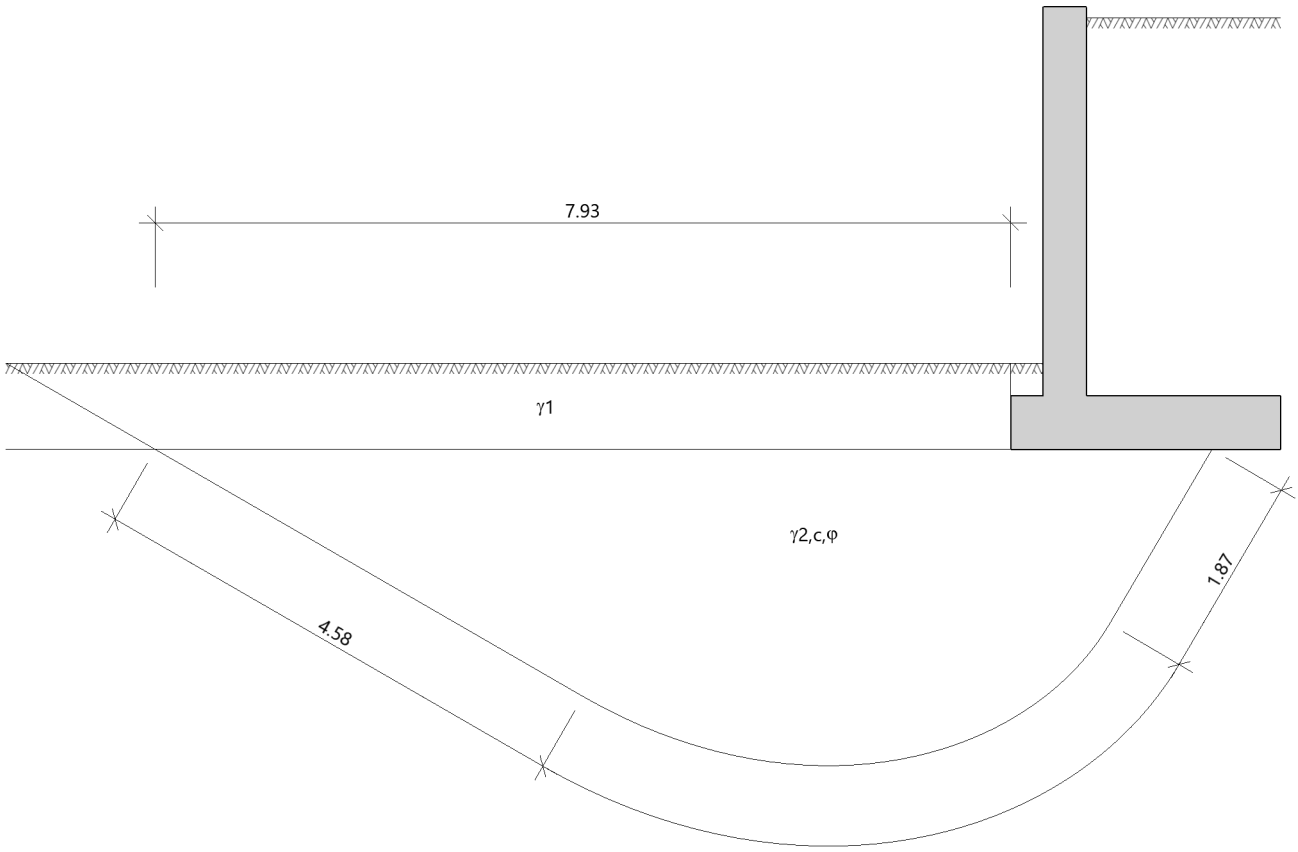
Coefficients

	N	N0	v	i	λ	ζ
N_b	3.632	10.047	1.000	0.361	1.000	1.000
N_d	9.338	18.401	1.000	0.507	1.000	1.000
N_c	14.441	30.140	1.000	0.479	1.000	1.000

m_a = 1.000 m_b = 2.000 m = 2.000

Average values

b' m	d m	s m	β °	γ_1 kN/m³	γ_2 kN/m³	c' kN/m²	φ' °	a °	pv kN/m²
1.86	0.80	0.00	0.0	19.00	19.00	0.00	30.0	0.0	0.00



Sliding proof

Design situation Persistent
Ultimate state GEO-2

Sliding downhill

Angle of rotation set δ_{Sk} = 30.0 °
No earth resistance set/available

Design value of actions

Design actions:

t_d = (-48.67 · 1.35) + (-5.14 · 1.35) + (-6.43 · 1.50) = -82.29 kN/m

Design resistance

Representative action:

n_{rep}' = (122.27 · 1.00) + (70.15 · 1.00) + (7.56 · 1.00) + (9.45 · 1.00) = 209.43 kN/m

Perpendicular part earth resistance	n_{epk} =		0.00 kN/m
Bearing friction resistance	r_d =	$(n_{rep}' + n_{epvk}) \cdot \tan(\delta_{sk}) / \gamma_{Rh}$	
	=	(209.43 + 0.00) · tan(30.0) / 1.10 =	109.92 kN/m
Earth resistance	r_{pd} =	E_{ph} / γ_{Ep} = 0.00 / 1.40 =	0.00 kN/m
Design resistance total	=	$r_d + r_{pd}$ =	109.92 kN/m

Check

	|td	= -82.29 kN/m	| <	$r_d + r_{pd}$ =	109.92 kN/m
Degree of utilization	μ =	0.75			

Slide stability is fulfilled.

Proof of stability / Ground failure

Terrain fracture after the lamella process of Bishop / DIN 4084
Design situation Persistent
Ultimate state GEO-3
Loads are only considered for the slats, they have an unfavorable effect for.

Input

Center points
x_{Start} = -2.50 m z_{Start} = 0.00 m
Width = 2.50 m Height = 1.10 m
Number of center points in X = 6 Number of center points in Z = 6
Radii
Max. slip circle depth = -9.10 m Number of radii per center point = 5
The smallest radius results from the distance from the center to the EB (edge bottom) foundation
A total of 180 lamellae circle geometries were proved

Iteration

Max. number of iterations = 100 Precision = 0.03
Supposed degree of utilization μ = 1.0

Relevant slip circle

Center M_x = -0.63 m Center M_z = 0.46 m
Radius r = 5.16 m Number of slices = 17
Number of iterations = 2

Calculation of area

i [-]	$Alpha_{ij}$ [m^2]	γ/γ'_j [kN/m^3]	G_{ij} [kN/m]	G_i [kN/m]
1	0.39	19.00	7.49	8.56
	0.06	19.00	1.07	
2	0.39	19.00	7.49	10.43
	0.16	19.00	2.95	
3	0.32	19.00	6.15	9.99
	0.18	19.00	3.46	
	0.02	19.00	0.38	
4	0.33	19.00	6.31	11.31
	0.21	19.00	3.94	
	0.06	19.00	1.05	
5	0.33	19.00	6.31	11.71
	0.21	19.00	3.94	
	0.08	19.00	1.45	
6	0.14	25.00	3.56	12.69
	0.19	19.00	3.60	
	0.21	19.00	3.94	
	0.08	19.00	1.58	
7	1.65	25.00	41.19	46.67
	0.005	19.00	0.09	
	0.21	19.00	3.94	
	0.08	19.00	1.45	
8	0.21	25.00	5.13	37.37
	1.44	19.00	27.30	
	0.21	19.00	3.90	
	0.05	19.00	1.04	
9	0.20	25.00	5.06	35.81
	1.42	19.00	26.91	
	0.18	19.00	3.46	
	0.02	19.00	0.38	
10	0.25	25.00	6.16	41.85
	1.72	19.00	32.75	
	0.16	19.00	2.95	
11	0.25	25.00	6.16	39.98
	1.72	19.00	32.75	
	0.06	19.00	1.07	
12	1.74	19.00	33.14	33.14
13	1.61	19.00	30.52	30.52
14	1.43	19.00	27.22	27.22
15	1.21	19.00	22.99	22.99
16	0.91	19.00	17.24	17.24
17	0.37	19.00	6.94	6.94

Geometry and inner actions

i [-]	b_i [m]	θ_i [°]	φ_{id} [°]	c_{id} [kN/m^2]	G_{id} [kN/m]	P_{id} [kN/m]
1	0.49	-25.0	24.8	0.00	8.56	0.00
2	0.49	-19.1	24.8	0.00	10.43	0.00
3	0.40	-13.9	24.8	0.00	9.99	0.00
4	0.42	-9.2	24.8	0.00	11.31	0.00
5	0.42	-4.6	24.8	0.00	11.71	0.00
6	0.42	0.03	24.8	0.00	12.69	0.00
7	0.42	4.6	24.8	0.00	46.67	0.00
8	0.41	9.3	24.8	0.00	37.37	1.64
9	0.40	13.9	24.8	0.00	35.81	1.62
10	0.49	19.1	24.8	0.00	41.85	1.97
11	0.49	25.0	24.8	0.00	39.98	5.17
12	0.45	30.9	24.8	0.00	33.14	4.74
13	0.45	37.0	24.8	0.00	30.52	4.74
14	0.45	43.6	24.8	0.00	27.22	4.74
15	0.45	51.0	24.8	0.00	22.99	4.74
16	0.45	60.0	24.8	0.00	17.24	4.74
17	0.45	74.4	24.8	0.00	6.94	4.74

Calculation of action and resistance

i [-]	$(G_{id} + P_{id}) \cdot \sin(\theta_i)$ [kN/m]	$(G_{id} + P_{id}) \cdot \tan(\varphi_{id}) + c_{id} \cdot b_i$ [kN/m]	μ [-]	$\cos(\theta_i) + \mu \cdot \sin(\theta_i) \cdot \tan(\varphi_{id})$ [-]	$E_{md,i}$ [kNm/m]	$R_{md,i}$ [kNm/m]
1	-3.62	3.95	0.72	0.766	-18.67	26.66
2	-3.41	4.82	0.72	0.836	-17.61	29.75
3	-2.40	4.62	0.72	0.891	-12.38	26.75
4	-1.81	5.22	0.72	0.934	-9.37	28.89
5	-0.94	5.41	0.72	0.970	-4.84	28.78
6	0.01	5.86	0.72	1.000	0.03	30.26
7	3.78	21.56	0.72	1.024	19.50	108.72
8	6.28	18.02	0.72	1.041	32.42	89.41
9	8.98	17.29	0.72	1.051	46.36	84.95
10	14.33	20.24	0.72	1.054	73.99	99.15
11	19.08	20.85	0.72	1.047	98.50	102.83
12	19.47	17.50	0.72	1.029	100.54	87.80
13	21.22	16.29	0.72	0.999	109.55	84.17
14	22.04	14.76	0.72	0.954	113.78	79.91
15	21.56	12.81	0.72	0.888	111.31	74.49
16	19.04	10.15	0.72	0.788	98.32	66.53
17	11.25	5.40	0.72	0.589	58.10	47.28
					Σ = 799.52	Σ = 1096.35

Resisting moment from earth resistance

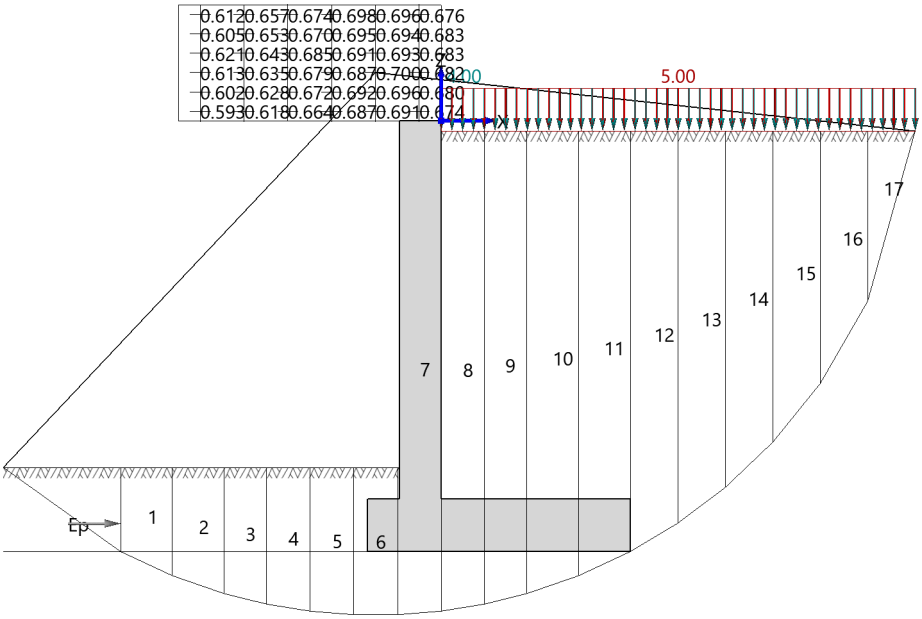
Left from x = -3.05 m, the sliding line is more inclined than the ground resistance slide resulting for β=δ=a=0.0° Therefore, instead of the effects and resistances of the lamellas to the left of x = -3.05 m, the ground resistance for β= δ= a= 0.0° and φ=φd is set at the position x. The moment generated by the earth resistance around the center of the circuit is multiplied by μ and added to the resistors.

Earth resistance $E_{ph,d}$ = 14.86 kN/m
Moment $\mu \cdot R_{mp,d}$ = 45.97 kNm/m

Check

E_{md} = 799.52 kNm/m
R_{md} = 1096.35 + 45.97 = 1142.32 kNm/m
Degree of utilization μ = 0.70 < 1.0

The terrain sliding check is fulfilled



Serviceability check (SLS)

Proof of the limitation of a gaping joint

Design situation Persistent
Ultimate state SLS

No earth resistance set/available

Check of eccentricity as a result of effective permanent action (1st core range)

Perpendicular action:

n_{gk} = (122.27 · 1.00) + (70.15 · 1.00) + (7.56 · 1.00) = 199.98 kN/m

Moments actions:

m_{gk} = (26.22 · 1.00) + (23.13 · 1.00) + (7.64 · 1.00) = 56.98 kNm/m

Eccentricity as a result of permanent actions $e_{bg} = |M_{gk} / N_{gk}| = 0.28$ m

Check

$e_{bg} = 0.28$ m $< b / 6 = 0.42$ m

Degree of utilization $\mu = 0.68$

The bearing pressure results from characteristic permanent stress is within the 1st core range.

No earth resistance set/available

Check of the eccentricity due to all representative effects (2nd core range)

Perpendicular action

$n_{g+q,rep}$ = (122.27 · 1.00) + (70.15 · 1.00) + (7.56 · 1.00) + (9.45 · 1.00) = 209.43 kN/m

Moments actions

$m_{g+q,rep}$ = (26.22 · 1.00) + (23.13 · 1.00) + (7.64 · 1.00) + (9.55 · 1.00) = 66.52 kNm/m

Eccentricity as a result of all effects $e_{bg+q} = |m_{g+q,rep} / n_{g+q,rep}| = 0.32$ m

Check

$e_{bg+q} = 0.32$ m $< b / 3 = 0.83$ m

Degree of utilization $\mu = 0.38$

The bearing pressure resultant from the total stress is within the 2nd core range.

Settlement calculation

The settlement calculation is performed for a rigid foundation at the marked point.
Excavation discharge $\sigma_v = 0.00$ kN/m^2

Settlement

m_{rep} = 1.00×(26.22) + 1.00×(23.13) + 1.00×(7.64) = 56.98 kNm/m

v_{rep} = 1.00×(122.27) + 1.00×(70.15) + 1.00×(7.56) = 199.98 kN/m

Soil pressure allocation

Eccentricity	e_x	= 0.28	m
Uniform portion of the soil pressure (excavation considered)	σ_m	= 79.99	kN/m²
Overpressed sole length	l_p	= 2.50	m
Limit depth (from lower edge base)	t_s	= 4.98	m
Settlement from a uniform portion of the soil pressure (medium settlement)	s_m	= 0.218	cm

Tilt

m_{rep} = 1.00×(26.22) + 1.00×(23.13) + 1.00×(7.64) = 56.98 kNm/m

v_{rep} = 1.00×(122.27) + 1.00×(70.15) + 1.00×(7.56) = 199.98 kN/m

Soil pressure allocation

Eccentricity	e_x	= 0.28	m
Nonuniform portion of soil pressure	$\Delta\sigma$	= 54.70	kN/m²
Overpressed sole length	l_p	= 2.50	m
Limit depth (from lower edge base)	t_s	= 4.98	m
Rotation of the non uniform portion of soil pressure	a	= 0.025	°

Proof against unacceptable twisting of the retaining wall

The eccentricity of the bearing pressure resultant with permanent and variable effects is met. With the assumption of a non-binding, at least rigid, cohesive soil, and at least of medium-density,there can be assume that no unacceptable distortions are in the cantilever wall .

Proof of unacceptable displacements in the base surface

The earth resistance was not used when the slide stability was proven. The check against unacceptable displacements of the bottom joint of the supporting wall can be regarded as provided.

Reinforced Concrete Design

Earth pressure

Active earth pressure factors

from z = [m]	to z = [m]	a [°]	φ' [°]	δ [°]	k_{agh} [-]	k_{ach} [-]	k_{aph} [-]
-0.10	-3.60	0.0	30.0	20.0	0.279[1]	0.922[1]	0.279[1]

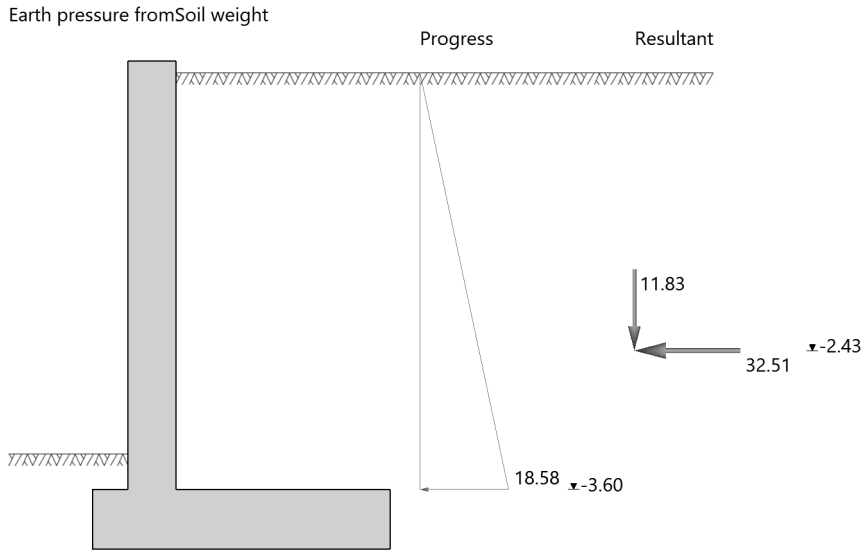
1 : β = 0 °

Earth pressure curve from dead load

z [m]	e_{ah} [kN/m²]
-0.10	0.00
-3.60	18.58

Resultant

Horizontal resultant E_{ah} = 32.51 kN/m Action point from the top of the wall z_a = -2.43 m
Vertical resultant E_{av} = 11.83 kN/m



Earth pressure from loads

Load number 1

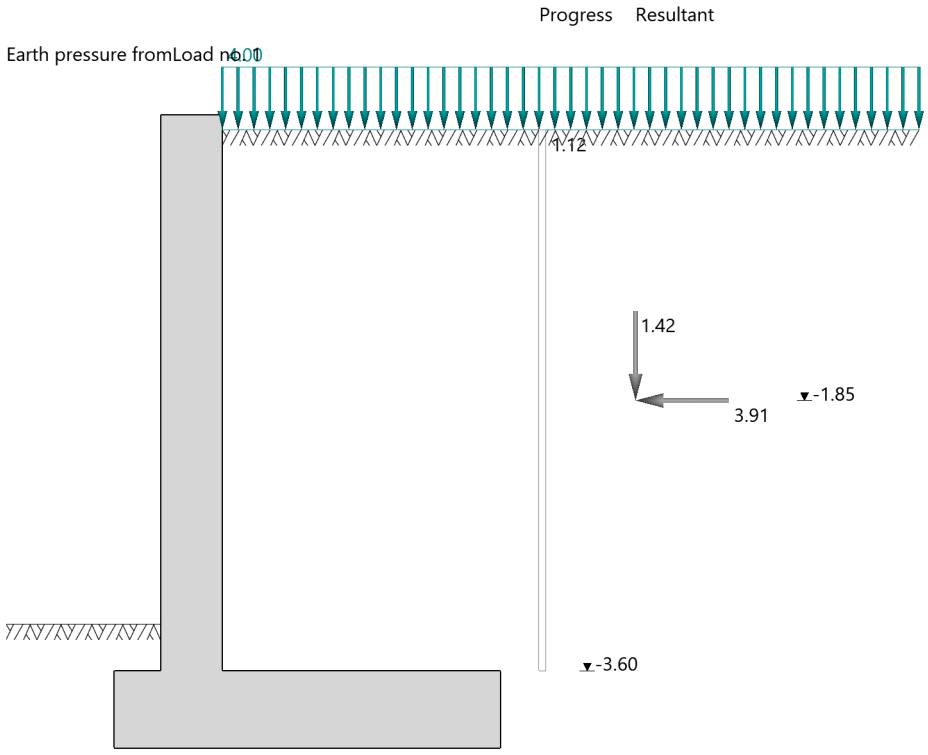
load type = Surface load Load value pi = 4.00 kN/m^2
Depth of effect z = 0.00 m

Progress

z [m]	e_{aph} [kN/m^2]
-0.10	1.12
-3.60	1.12

Resultant

Horizontal resultant E_{aph} = 3.91 kN/m Action point from the top of the wall z_{ap} = -1.85 m
Vertical resultant E_{apv} = 1.42 kN/m



Load number 2

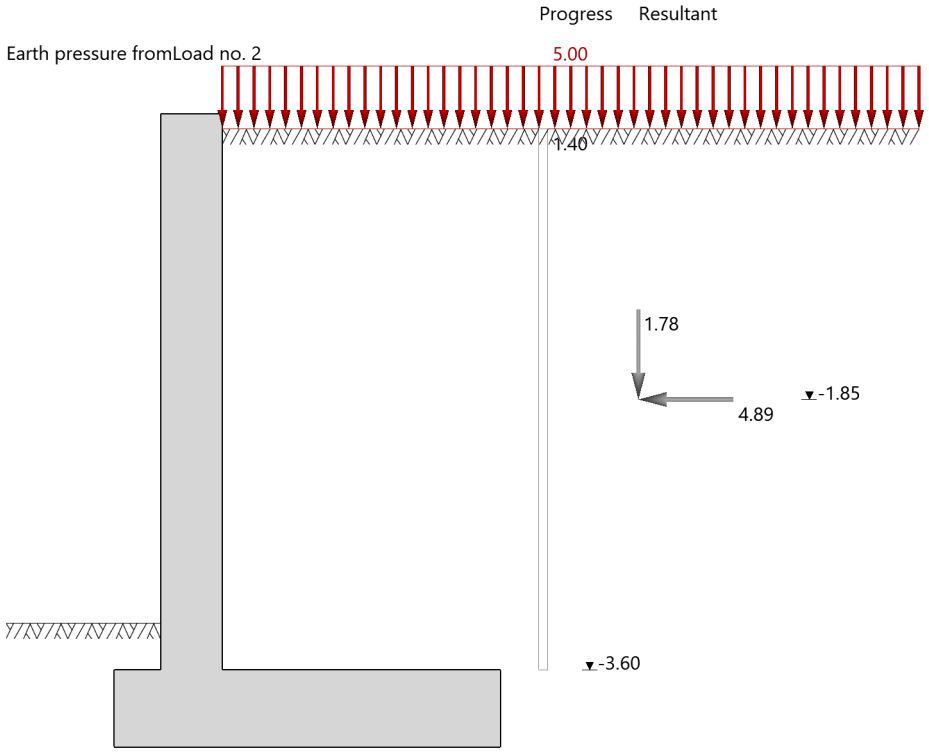
load type = Surface load Load value pi = 5.00 kN/m^2
Depth of effect z = 0.00 m

Progress

z [m]	e_{aph} [kN/m^2]
-0.10	1.40
-3.60	1.40

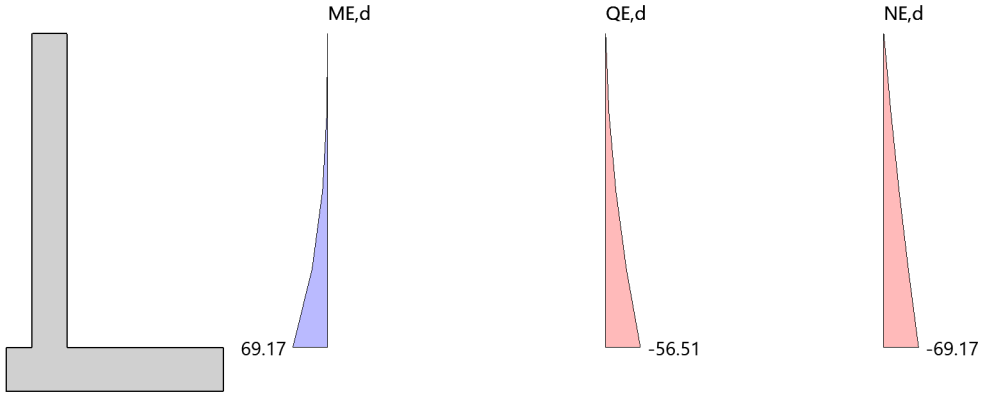
Resultant

Horizontal resultant E_{aph} = 4.89 kN/m Action point from the top of the wall z_{ap} = -1.85 m
Vertical resultant E_{apv} = 1.78 kN/m



Wall design

Design values of inner forces



z = -3.60 m

Action from:	n [kN/m]	v [kN/m]	m [kNm/m]
Wall weight	-36.00	0.00	0.00
Earth pressure from dead load	-11.83	-32.51	35.57
Soil load Nr. 1 (incl. earth pressure)	-1.42	-3.91	6.56
Soil load Nr. 2 (incl. earth pressure)	-1.78	-4.89	8.20

Bending design in point z = -3.60 m

m_{Ed} [kNm/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sl,req\ inner}$ [cm²/m]	m_{Ed} [kNm/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sl,req\ outer}$ [cm²/m]
69.17	-56.57	40.0	33.9	5.06[1]	42.13	-49.26	40.0	33.9	3.00[1]

Min. ductility reinforcement is considered
Min. compressive reinforcement is considered

1 : Minimum ductility reinforcement decisive

Decisive load combination bending

$m_{Ed,As1}$ = (35.57 · 1.00) + (6.56 · 1.00) + (8.20 · 0.00) = 42.13 kNm/m

$n_{Ed,As1}$ = (-36.00 · 1.00) + (-11.83 · 1.00) + (-1.42 · 1.00) + (-1.78 · 0.00) = -49.26 kN/m

$m_{Ed,As2}$ = (35.57 · 1.35) + (6.56 · 1.35) + (8.20 · 1.50) = 69.17 kNm/m

$n_{Ed,As2}$ = (-36.00 · 1.00) + (-11.83 · 1.35) + (-1.42 · 1.35) + (-1.78 · 1.50) = -56.57 kN/m

Shear design in point z = -3.60 m

v_{Ed} [kN/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sz,exist}$ [cm²/m]	z [cm]	$v_{rd,c}$ [kN/m]	$v_{rdc,min}$ [kN/m]	v_{rdcc} [kN/m]	cot θ [-]	v_{rdMax} [kN/m]	$a_{sw,req}$ [cm²/m]	$a_{sw,min}$ [cm²/m]
-56.51	-56.57	40.0	33.9	5.06	19.2	104.57	158.54	141.98	3.00	735.60	0.00	0.00

Consider min. lateral reinforcement

Decisive load combination shearing

v_{Ed} = (-32.51 · 1.35) + (-3.91 · 1.35) + (-4.89 · 1.50) = -56.51 kN/m

n_{Ed} = (-36.00 · 1.00) + (-11.83 · 1.35) + (-1.42 · 1.35) + (-1.78 · 1.50) = -56.57 kN/m

Foundation design

Characteristic internal forces for the base pressure calculation in the center of the foundation with reference to

Action from:	t [kN/m]	n [kN/m]	m [kNm/m]
Soil and wall weight	0.00	122.27	26.22
Earth pressure from dead load	-48.67	70.15	23.13
Soil load Nr. 1 (incl. earth pressure)	-5.14	7.56	7.64
Soil load Nr. 2 (incl. earth pressure)	-6.43	9.45	9.55

Heel uphill

Bearing pressure calculation bending

The design effect of the tangential of soil area :

t_{Ed} = (-48.67 · 1.35) + (-5.14 · 1.35) + (-6.43 · 1.50) = -82.29 kN/m

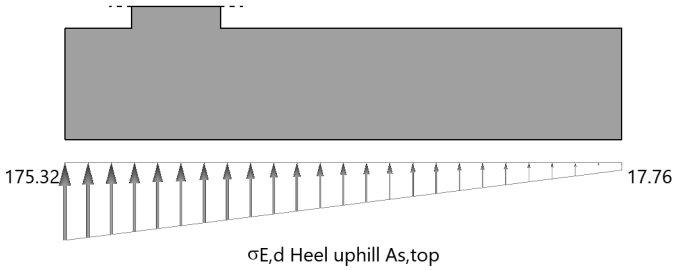
The design effect of the normal of soil area :

n_{Ed} = (122.27 · 1.00) + (70.15 · 1.35) + (7.56 · 1.35) + (9.45 · 1.50) = 241.35 kN/m

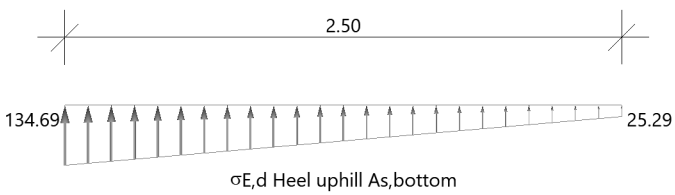
Moment design effects:

m_{Ed} = (26.22 · 1.00) + (23.13 · 1.35) + (7.64 · 1.35) + (9.55 · 1.50) = 82.06 kNm/m

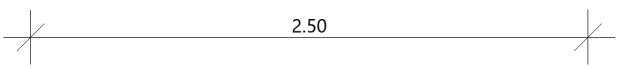
Eccentricity in SLS	e	=	0.34 m
Sole pressure toe	σ_{1d}	=	175.32 kN/m²
Bearing pressure heel	σ_{2d}	=	17.76 kN/m²
Overpressed sole length	l_p	=	2.50 m



σE,d Heel uphill As,top



σE,d Heel uphill As,bottom



Design internal forces from soil pressure of the the superposition of bending relative to the coordinate system

n,As,top [kN/m]	v,As,top [kN/m]	m,As,top [kNm/m]	n,As,bottom [kN/m]	v,As,bottom [kN/m]	m,As,bottom [kNm/m]
45.71	-134.07	101.46	31.33	-116.42	91.34

Bearing pressure calculation shearing

The design effect of the tangential of soil area :

t_{Ed} = (-48.67 · 1.35) + (-5.14 · 1.35) + (-6.43 · 1.50) = -82.29 kN/m

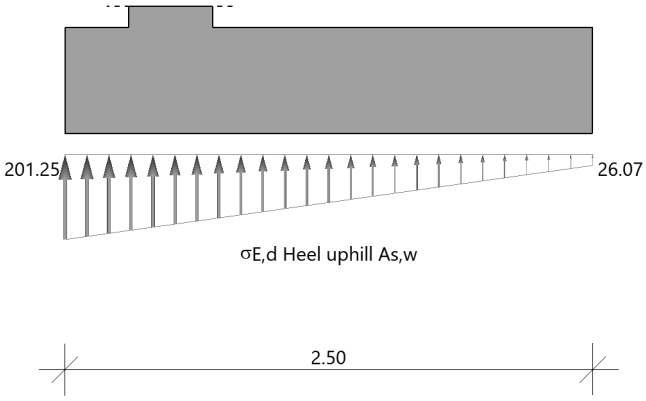
The design effect of the normal of soil area :

n_{Ed} = (122.27 · 1.35) + (70.15 · 1.35) + (7.56 · 1.35) + (9.45 · 1.50) = 284.15 kN/m

Moment design effects:

m_{Ed} = (26.22 · 1.35) + (23.13 · 1.35) + (7.64 · 1.35) + (9.55 · 1.50) = 91.24 kNm/m

Eccentricity in SLS	e	=	0.32 m
Sole pressure toe	σ_{1d}	=	201.25 kN/m^2
Bearing pressure heel	σ_{2d}	=	26.07 kN/m^2
Overpressed sole length	l_p	=	2.50 m



Design internal forces from soil pressure of the the superposition of lateral force bending relative to the coordir

n [kN/m]	v [kN/m]	m [kNm/m]
46.46	-160.44	121.96

Characteristic shear force on uphill heel related to coordinate system

Action from:	n [kN/m]	v [kN/m]	m [kNm/m]
Soil weight	0.00	53.31	-31.99
Wall weight	0.00	22.50	-20.25
Earth pressure on the sliding surface from dead weight	-48.67	70.15	-27.63
Earth pressure at real wall from dead load	32.51	-11.83	-46.06
Resultant from soil loads no. 1(without earth pressure)	0.00	0.00	0.00
Resultant from soil loads no. 2(without earth pressure)	0.00	0.00	0.00
Earth pressure on actual wall from soil load no. 1	3.91	-1.42	-7.82
Earth pressure on actual wall from soil load no. 2	4.89	-1.78	-9.78
Earth pressure on the sliding surface from soil load no.1	-5.14	7.56	2.19
Earth pressure on the sliding surface from soil load no.2	-6.43	9.45	2.74

Bending design in point x = 0.00 m

m_{Ed} [kNm/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sl,req.\ btm}$ [cm^2/m]	m_{Ed} [kNm/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sl,req\ top}$ [cm^2/m]
-40.21	13.94	50.0	43.9	0.00	-68.41	19.93	50.0	43.9	6.42[1]

Min. ductility reinforcement is considered
Min. compressive reinforcement is considered

1 : Minimum ductility reinforcement decisive

Decisive load combination bending

$m_{Ed,Astop}$ = (-31.99 ·1.00) + (-20.25 ·1.00) + (-27.63 ·1.35) + (-46.06 ·1.35) + (-7.82 ·1.35) + (-9.78 ·1.50) + (2.19 ·1.35) + (2.74 ·1.50) + (101.46) = -68.41 kNm/m

$n_{Ed,Astop}$ = (-48.67 ·1.35) + (32.51 ·1.35) + (3.91 ·1.35) + (4.89 ·1.50) + (-5.14 ·1.35) + (-6.43 ·1.50) + (45.71) = 19.93 kN/m

$m_{Ed,Asbottom}$ = (-31.99 ·1.00) + (-20.25 ·1.00) + (-27.63 ·1.00) + (-46.06 ·1.00) + (-7.82 ·1.00) + (-9.78 ·0.00) + (2.19 1.00) + (2.74 ·0.00) + (91.34) = -40.21 kNm/m

$n_{Ed,Asbottom}$ = (-48.67 ·1.00) + (32.51 ·1.00) + (3.91 ·1.00) + (4.89 ·0.00) + (-5.14 ·1.00) + (-6.43 ·0.00) + (31.33) = 13.94 kN/m

Shear design in point x = 0.00 m

v_{Ed} [kN/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sz,exist}$ [cm²/m]	z [cm]	$v_{rd,c}$ [kN/m]	$v_{rdc,min}$ [kN/m]	v_{rdcc} [kN/m]	cot θ [-]	v_{rdMax} [kN/m]	$a_{sw,req}$ [cm²/m]	$a_{sw,min}$ [cm²/m]
40.42	20.68	50.0	43.9	6.42	35.4	118.22	180.25	264.76	1.00	2256.75	0.00	0.00

Consider min. lateral reinforcement

Decisive load combination shearing

v_{Ed} = (53.31 ·1.35) + (22.50 ·1.35) + (70.15 ·1.35) + (-11.83 ·1.35) + (-1.42 ·1.35) + (-1.78 ·1.50) + (7.56 ·1.35) + (9.45 ·1.50) + (-160.44) = 40.42 kN/m)

n_{Ed} = (-48.67 ·1.35) + (32.51 ·1.35) + (3.91 ·1.35) + (4.89 ·1.50) + (-5.14 ·1.35) + (-6.43 ·1.50) + (46.46) = 20.68 kN/m)

Toe

Bearing pressure calculation bending

The design effect of the tangential of soil area :

t_{Ed} = (-48.67 ·1.00) + (-5.14 ·1.00) + (-6.43 ·0.00) = -53.81 kN/m

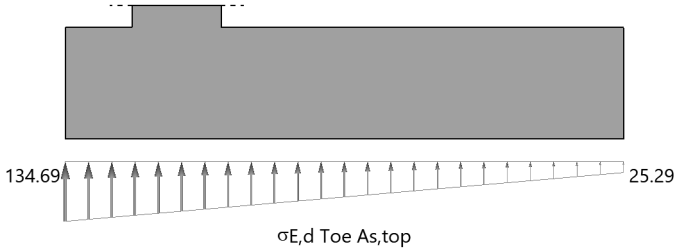
The design effect of the normal of soil area :

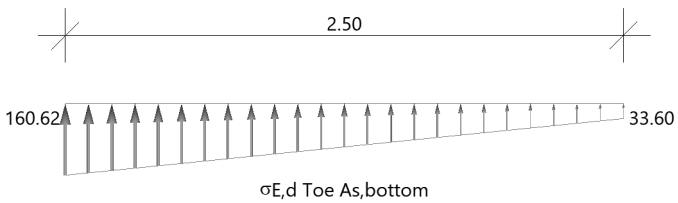
n_{Ed} = (122.27 ·1.00) + (70.15 ·1.00) + (7.56 ·1.00) + (9.45 ·0.00) = 199.98 kN/m

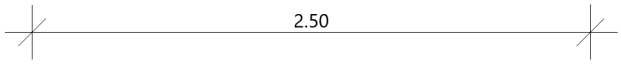
Moment design effects:

m_{Ed} = (26.22 ·1.00) + (23.13 ·1.00) + (7.64 ·1.00) + (9.55 ·0.00) = 56.98 kNm/m

Eccentricity in SLS	e =	0.28	m
Sole pressure toe	σ_{1d} =	134.69	kN/m²
Bearing pressure heel	σ_{2d} =	25.29	kN/m²
Overpressed sole length	l_p =	2.50	m







Design internal forces from soil pressure of the the superposition of bending relative to the coordinate system

n,As,top [kN/m]	v,As,top [kN/m]	m,As,top [kNm/m]	n,As,bottom [kN/m]	v,As,bottom [kN/m]	m,As,bottom [kNm/m]
-10.34	38.44	3.28	-10.17	45.90	4.46

Bearing pressure calculation shearing

The design effect of the tangential of soil area :

t_{Ed} = (-48.67 · 1.35) + (-5.14 · 1.35) + (-6.43 · 1.50) = -82.29 kN/m

The design effect of the normal of soil area :

n_{Ed} = (122.27 · 1.35) + (70.15 · 1.35) + (7.56 · 1.35) + (9.45 · 1.50) = 284.15 kN/m

Moment design effects:

m_{Ed} = (26.22 · 1.35) + (23.13 · 1.35) + (7.64 · 1.35) + (9.55 · 1.50) = 91.24 kNm/m

Eccentricity in SLS	e	=	0.32 m
Sole pressure toe	σ_{1d}	=	201.25 kN/m^2
Bearing pressure heel	σ_{2d}	=	26.07 kN/m^2
Overpressed sole length	l_p	=	2.50 m



Design internal forces from soil pressure of the the superposition of lateral force bending relative to the coordir

n [kN/m]	v [kN/m]	m [kNm/m]
-16.57	57.22	4.60

Characteristic inner forces at the cut part the toe in relation to the coordinate system

Action from:	n [kN/m]	v [kN/m]	m [kNm/m]
Soil weight	0.00	-1.71	-0.26
Wall weight	0.00	-3.75	-0.56

Bending design in point x = -0.40 m

m_{Ed} [kNm/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sl,req.\ btm}$ [cm^2/m]	m_{Ed} [kNm/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sl,req\ top}$ [cm^2/m]
3.35	-10.17	50.0	43.9	6.11[1]	2.46	-10.34	50.0	43.9	3.75[1]

Min. ductility reinforcement is considered
Min. compressive reinforcement is considered

1 : Minimum ductility reinforcement decisive

Decisive load combination beshearing

$m_{Ed,Astop}$ = (-0.26 · 1.00) + (-0.56 · 1.00) + (3.28) = 2.46 kNm/m

$n_{Ed,Astop}$ = (-10.34) = -10.34 kN/m

$m_{Ed,Asbottom}$ = (-0.26 · 1.35) + (-0.56 · 1.35) + (4.46) = 3.35 kNm/m

$n_{Ed,Asbottom}$ = (-10.17) = -10.17 kN/m

Shear design in point x = -0.40 m

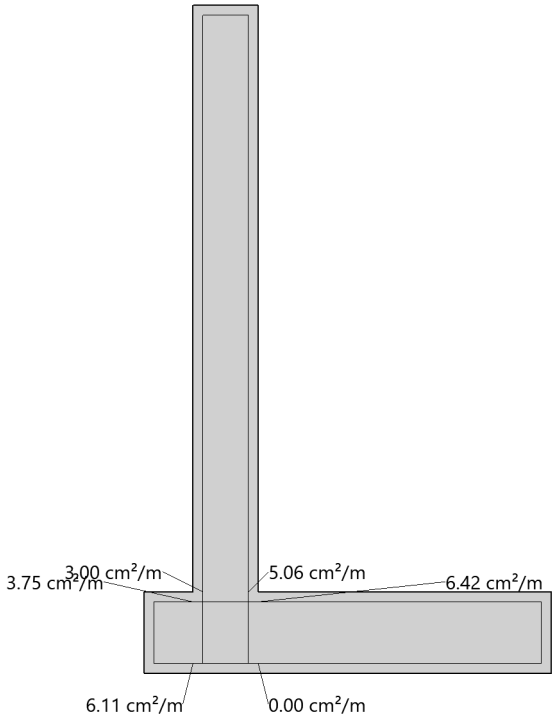
v_{Ed} [kN/m]	n_{Ed} [kN/m]	h [cm]	d [cm]	$a_{sz,\,exist}$ [cm²/m]	z [cm]	$v_{rd,c}$ [kN/m]	$v_{rdc,min}$ [kN/m]	v_{rdcc} [kN/m]	cot θ [-]	v_{rdMax} [kN/m]	$a_{sw,req}$ [cm²/m]	$a_{sw,\,min}$ [cm²/m]
49.85	-16.57	50.0	43.9	6.11	25.0	120.15	184.18	186.00	3.00	956.25	0.00	0.00
Consider min. lateral reinforcement												

Decisive load combination shearing

v_{Ed} = (-1.71 · 1.35) + (-3.75 · 1.35) + (57.22) = 49.85 kN/m

n_{Ed} = (-16.57) = -16.57 kN/m

Schematic reinforcement graphic

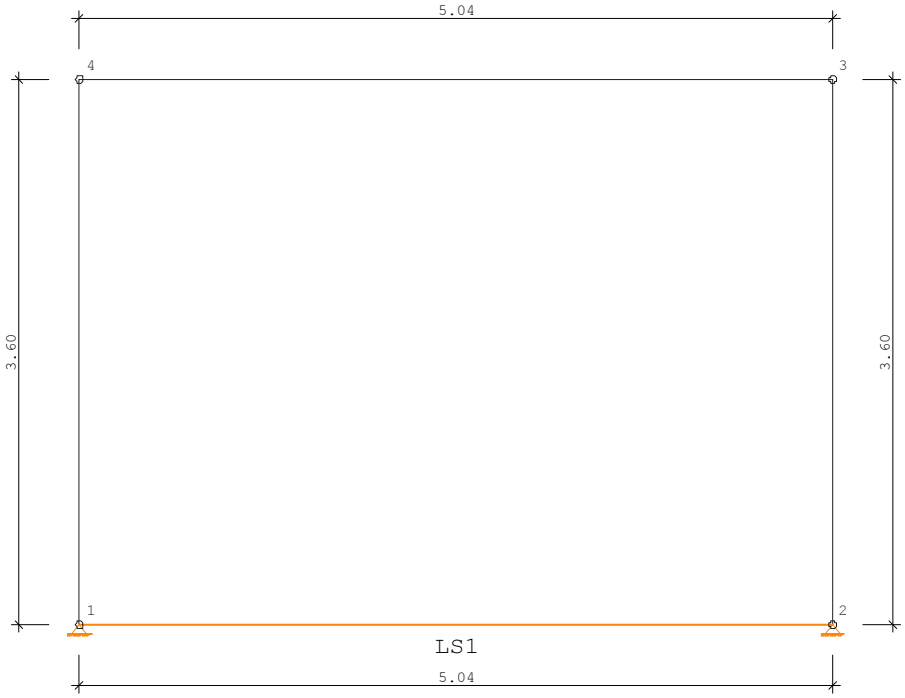


Item: AB stena

Walls by Finite Elements SCN 01/2022 (Frilo R-2022-1/P05)

System

View
Scale 1 : 50



Overview

Slab thickness	30	[cm]
System points	4	
Line support	1	

Material

Concrete:				C 25/30	
Modulus of elasticity:				3100	[kN/cm²]
Poisson's ratio				0.20	
Specific weight				25	[kN/m³]
Coefficient of thermal expansion				1.0e-05	[1/degree]
Reinforcement steel				B500A	
Reinforcement layer, face side	d-1	: 3.0	d-2 :	3.5	[cm]
Reinforcement layer, back side	d-1	: 3.0	d-2 :	3.5	[cm]

Design: Settings

code DIN EN 1992-1-1/NA:2015-12

Ultimate Limit State

Compressive reinforcement	YES
No stability check!	
Stability has to be verified separately.	
Include minimum reinforcement	YES
- as deep beam member	
No stability check!	
Stability has to be verified separately.	

FE Properties

FE mesh	Quadrilateral elements
Number of nodes	1887
Number of elements	1800
Average element size	10 [cm]
Calculation of element results at the	Midpoints of the element edges

System points

Point	x [m]	y [m]	Point	x [m]	y [m]
1	0.000	0.000	2	5.040	0.000
3	5.040	3.600	4	0.000	3.600

Slab

Edge	From Point	To Point	Radius [m]	x center [m]	y center [m]
1	1	2			
2	2	3			
3	3	4			
4	4	1			

Line support

Number	From Point	To Point	Support conditions (per Meter) Displacement Horizontal [kN/m]	Vertical [kN/m]
1	1	2	rigid	rigid

Load Case 1 "Stalna"

Overview

Type	non permanent	
Self-weight of the slab is included	YES	
Action	Cat. A: domestic, residental areas	
Partial safety coefficient	1.50	
Partial safety factor concrete	1.50	
Partial safety factor steel	1.15	
Load points	2	
Point loads	0	
Line loads	1	
Temperature loads	0	
Forces, vertical		
Total of input loads	5	[kN]
Portion on the slab		
Self-weight of the slab	136	[kN]
Total of all loads´	141	[kN]
Total of all support reactions	141	[kN]
Forces, horizontal		
Total of input loads	0	[kN]
Portion on the slab		
Total of all support reactions	0	[kN]

NOTE
All effects of actions (like internal forces, support reactions, displacements, etc.) of an individual load case are, unlike the results of a superposition of load cases, simple, i.e. characteristic, values
.
Design results are based on design quantities including the partial safety coefficients.

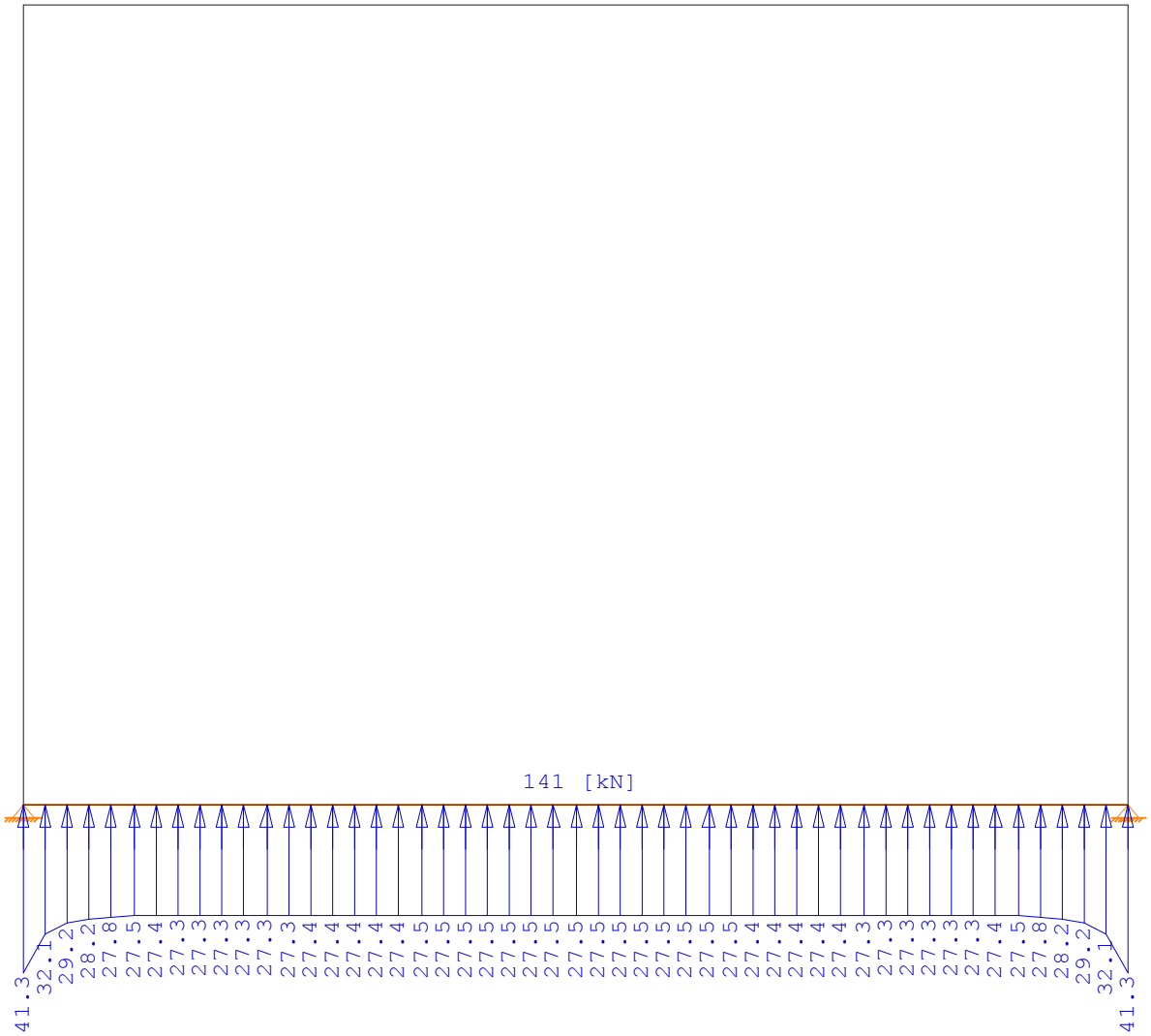
Load Case 1 "Stalna"

Line loads
Scale 1 : 33



Load Case 1 "Stalna"

Support Reactions in Y direction (Diagram) [kN/m] - Total: 141 [kN]
Characterist. Values (x 1)
Scale 1 : 33



Load Case 1 "Stalna"

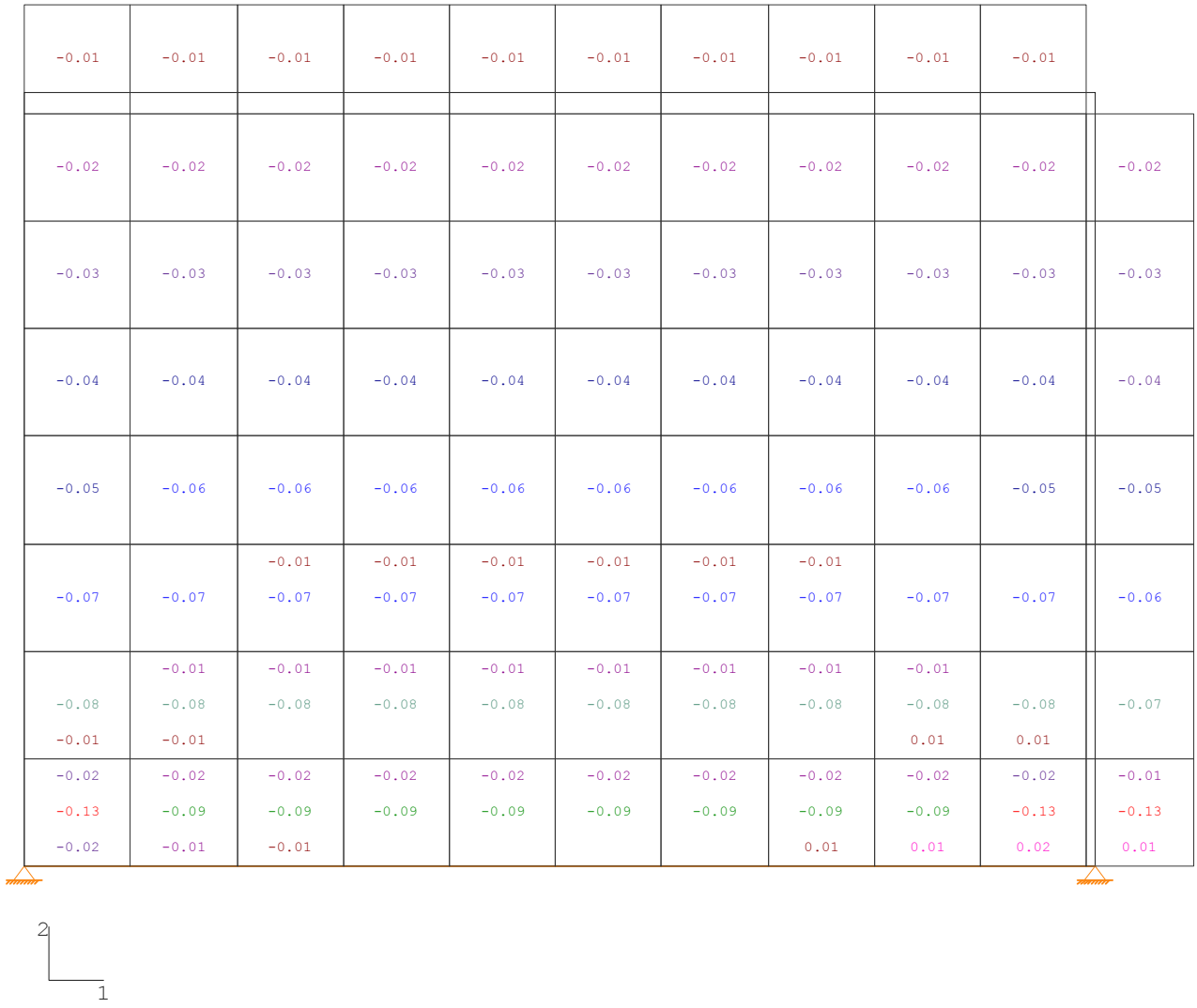
Slab Forces - n-11, n-22, n-12 [kN/m]
Characterist. Values (x 1)
Scale 1 : 33

0.09 -1.75 0.04	0.39 -1.75 0.07	0.78 -1.75 0.07	1.06 -1.75 0.06	1.17 -1.75 0.03	1.17 -1.75 -0.03	1.06 -1.75 -0.06	0.78 -1.75 -0.07	0.41 -1.75 -0.07	0.09 -1.75 -0.04	
0.12 -5.37 0.21	0.37 -5.48 0.30	0.69 -5.56 0.30	0.93 -5.59 0.24	1.03 -5.60 0.13	1.03 -5.60 -0.13	0.93 -5.59 -0.24	0.69 -5.56 -0.30	0.39 -5.48 -0.30	0.12 -5.37 -0.21	-5.02
0.09 -8.94 0.32	0.23 -9.23 0.38	0.36 -9.41 0.38	0.45 -9.48 0.30	0.48 -9.50 0.16	0.48 -9.50 -0.14	0.45 -9.48 -0.28	0.36 -9.41 -0.37	0.23 -9.23 -0.38	0.09 -8.94 -0.32	-8.36
0.03 -12.5 0.34	-0.12 -13.0 0.38	-0.28 -13.3 0.38	-0.42 -13.4 0.29	-0.48 -13.4 0.15	-0.48 -13.4 -0.14	-0.42 -13.4 -0.28	-0.28 -13.3 -0.37	-0.12 -13.0 -0.38	0.03 -12.5 -0.34	-11.6
-0.11 -16.2 0.32	-0.46 -16.9 0.34	-0.85 -17.1 0.31	-1.12 -17.2 0.20	-1.22 -17.2 0.09	-1.22 -17.2 -0.09	-1.12 -17.2 -0.20	-0.85 -17.1 -0.31	-0.46 -16.9 -0.34	-0.11 -16.2 -0.32	-14.7
-0.39 -20.2 -0.28	-1.19 -20.7 -0.54	-1.83 -20.8 -0.54	-2.19 -20.8 -0.42	-2.31 -20.8 -0.21	-2.31 -20.8 0.21	-2.19 -20.8 0.42	-1.83 -20.8 0.54	-1.19 -20.7 0.54	-0.39 -20.2 0.28	-18.1 -0.01
-1.44 -24.6 -1.59	-2.82 -24.5 -1.65	-3.41 -24.3 -1.32	-3.68 -24.2 -0.83	-3.77 -24.2 -0.40	-3.77 -24.2 0.37	-3.68 -24.2 0.82	-3.41 -24.3 1.32	-2.82 -24.5 1.65	-1.44 -24.6 1.59	0.02 -22.2 -0.01
-7.15 -39.8 -7.00	-5.49 -27.4 -2.93	-5.48 -27.4 -1.79	-5.50 -27.5 -1.06	-5.50 -27.5 -0.49	-5.50 -27.5 0.45	-5.50 -27.5 1.00	-5.48 -27.4 1.72	-5.49 -27.4 2.80	-7.15 -39.8 7.00	-3.51 -39.8 4.18



Load Case 1 "Stalna"

Slab Stresses - s-11, s-22, s-12 [MN/m²]
Characterist. Values (x 1)
Scale 1 : 33



Load Case 1 "Stalna"

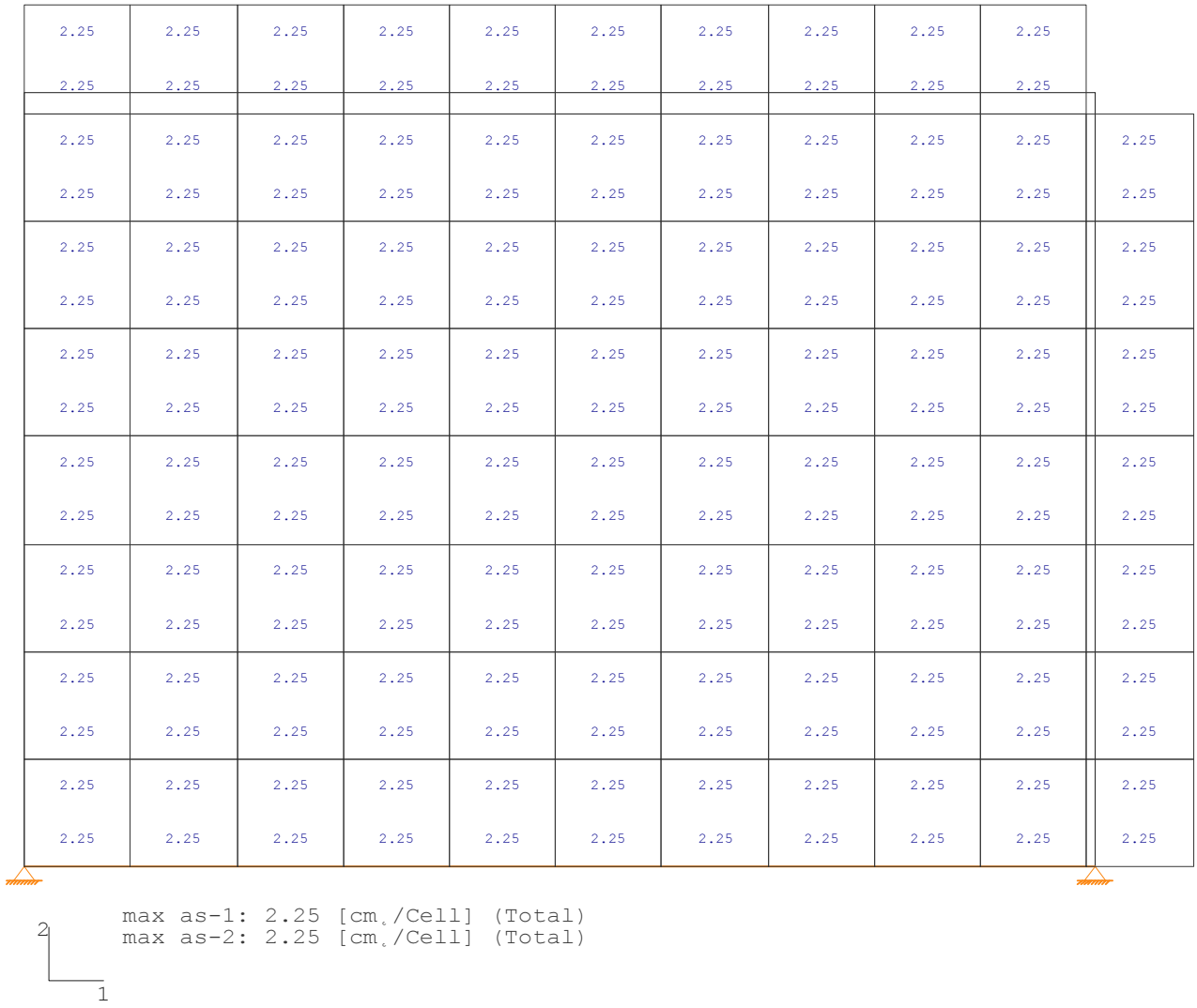
Design Forces - nB-1, nB-2 [kN/m]
Characterist. Values (x 1)
Scale 1 : 33

0.09 -1.79	0.39 -1.82	0.78 -1.82	1.06 -1.81	1.17 -1.78	1.17 -1.78	1.06 -1.81	0.78 -1.83	0.41 -1.82	0.09 -1.79	
0.12 -5.58	0.37 -5.78	0.70 -5.82	0.94 -5.81	1.03 -5.72	1.03 -5.72	0.94 -5.81	0.70 -5.82	0.39 -5.78	0.12 -5.58	-5.02
0.10 -9.25	0.24 -9.61	0.37 -9.71	0.45 -9.71	0.48 -9.63	0.48 -9.63	0.45 -9.71	0.37 -9.71	0.24 -9.61	0.10 -9.25	-8.36
-0.34 -12.8	-0.44 -13.3	-0.50 -13.5	-0.53 -13.5	-0.53 -13.5	-0.53 -13.5	-0.53 -13.5	-0.50 -13.5	-0.44 -13.3	-0.34 -12.8	-11.6
-0.34 -16.4	-0.51 -16.9	-0.88 -17.1	-1.15 -17.2	-1.23 -17.2	-1.23 -17.2	-1.15 -17.2	-0.88 -17.1	-0.53 -16.9	-0.34 -16.4	-14.7
-0.64 -20.5	-1.73 -21.3	-2.28 -21.3	-2.44 -21.2	-2.43 -21.0	-2.43 -21.0	-2.44 -21.2	-2.28 -21.3	-1.73 -21.3	-0.64 -20.5	-18.1
-3.02 -26.2	-4.24 -26.2	-4.35 -25.6	-4.30 -25.0	-4.08 -24.6	-4.08 -24.6	-4.30 -25.0	-4.35 -25.6	-4.24 -26.2	-3.02 -26.2	0.02 -22.2
-14.1 -46.8	-8.30 -30.3	-7.18 -29.0	-6.49 -28.4	-5.95 -27.9	-5.95 -27.9	-6.49 -28.4	-7.18 -29.0	-8.30 -30.3	-14.1 -46.8	-7.70 -44.0



Load Case 1 "Stalna"

Reinforcement, Total - Cell: Total - aS-1, aS-2 [cm²/Cell]
Scale 1 : 33



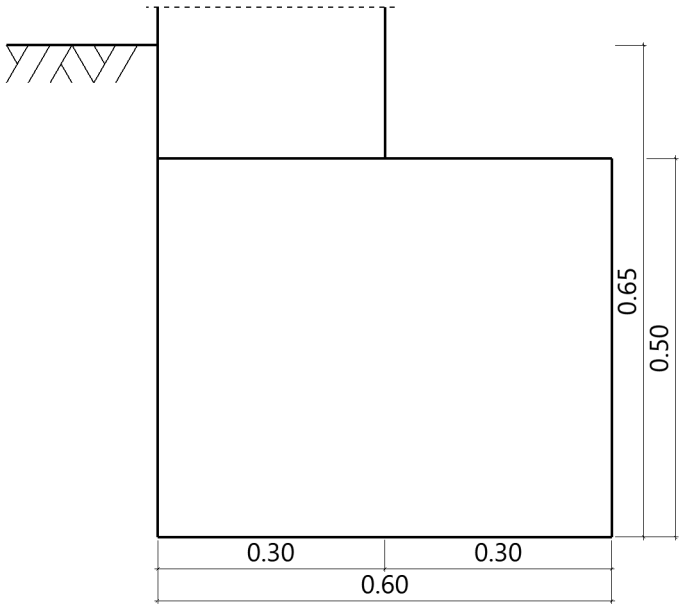
Item: Pasovni temelj

Strip Foundation FDS+ 01/2022C (FRILO R-2022-1/P05)

System

View

Scale 1 : 10



Strip Foundation to DIN EN 1992-1-1/NA/A1:2015-12 and DIN EN 1997-1/NA:2010-12

Member

Member	Concrete	Steel	Width (x) m	Length (y) m	Height (z) m
Wall	C 30/37	B500B	0.30	5.04	
Foundation	C 30/37	B500B	0.60	5.04	0.50

Eccentricity relative to the wall axis Wall ex = -0.15m. Embedment depth of the foundation in the subsoil 0.65 m. Without groundwater Design value of the bearing pressure resistance $\sigma_{R,d}$ = 210.00 kN/m2.

Soil

No.	d m	from m	to m	γ kN/m³	γ' kN/m³	φ' °	c' kN/m²
1	1.50	0.65	-0.85	18.50	11.00	30.0	0.00

Further values of the soil layers for the settlement calculation

No.	d m	from m	to m	E_S kN/m²	x	E* kN/m²	k m/s	Drainage
1	1.50	0.65	-0.85	2473.00	0.50	4946.00	$1.000*10^{-9}$	one-sided

Loads

Actions (Act)

Act	Name	ψ_0	ψ_1	ψ_2	simultaneous load cases
g	Permanent loads	1.00	1.00	1.00	1

Wall loads - characteristic

characteristic load cases

No.	Actions	Description	$N_{z,vertical,k}$ kN/m	$M_{x,lengthwise,k}$ kNm	$M_{y,tansverse,k}$ kNm/m	$H_{x,tansverse,k}$ kN/m	$H_{y,lengthwise,k}$ kN	$q_{Left,k}$ kN/m2	$q_{Right,k}$ kN/m2	SIM	ALT
1	Permanent loads	Load case 1	28.00	0.00	0.00	0.00	0.0	0.00	0.00	0	0

Self-weight is taken into account in the proofs. Density Concrete : γ = 25.00 kN/m3. Total Foundation without wall 1.512 m3 / 37.80 kN. Torsion from horizontal loads is not considered.

Line loads - characteristic

No.	Considered in load case	p1 kN/m	x1 m	y1 m	p2 kN/m	x2 m	y2 m
1	1	11.50	0.15	-2.50	11.50	0.15	2.50

Superposition

No.	DS	Superposition
1	P	1.0 x (1)
2	P	0.9 resp. 1.1 x (1)
3	P	1.35 x (1)

DS: design situation P: Permanent
The load case numbers are listed in parentheses.

Results

Preview Checks

Check	Superposition	η
Gaping joint only permanent loads	1	0.53
Gaping joint permanent and variable loads	1	0.07
Stability	2	0.00
Simplified method	3	0.61

Simplified method

Design value of the bearing pressure resistance $\sigma_{R,d}$ = 210.00 kN/m2

σ_{Rd} = 210.00 kN/m^2. The design value of bearing pressure resistance has been specified directly.

Simplified method Superposition

No.	N_d kN	a' m	b' m	σ_d kN/m2	σ_{Rd} kN/m2	η
3	319.2	0.49	5.04	128.22	210.00	0.61

The bearing pressure is influenced by partial safety factors.

Settlement to DIN 4019:2015

Calculation

Schnittgrößen in der Sohlfuge Th.1.O

Sohldruckresultierende	N =	236.4	kN
Sohldruckresultierende	Mx =	0.00	kNm
Sohldruckresultierende	My =	-12.54	kNm
Sohldruckresultierende	Hx =	0.0	kN
Sohldruckresultierende	Hy =	0.0	kN

Stress arrangement - Superposition 1

	mNN m	z m	Δd m	γ kN/m^3	Δσa kN/m^2	σa kN/m^2	0,2*σa kN/m^2	z/b	i	σz kN/m^2
1	-0.65	0.00	0.65	18.50	12.03	12.03	2.41	0.00	1.00	66.16
2	-1.50	0.85	0.85	18.50	15.73	27.75	5.55	1.42	0.39	25.80

Attention! The limit depth is not reached. The stress analysis is made for rigid footing in the characterizing point by
by DIN 4019:2014 A6.

Settlement - Superposition 1

	mNN m	z m	Δd m	σ0' kN/m^2	b m	E* kN/m^2	a/b	z/b	f_{s01}	f_{s02}	f_{s00}	s cm	s0 cm	s1 cm
1	-0.65	0.00	0.65	66.16	0.00	4946.00	8.40	0.00	0.00	0.00	0.00	0.0	0.0	0.0
2	-1.50	0.85	0.85	66.16	0.00	4946.00	8.40	1.42	0.82	0.00	0.82	0.7	0.7	0.0
												0.7	0.7	0.0

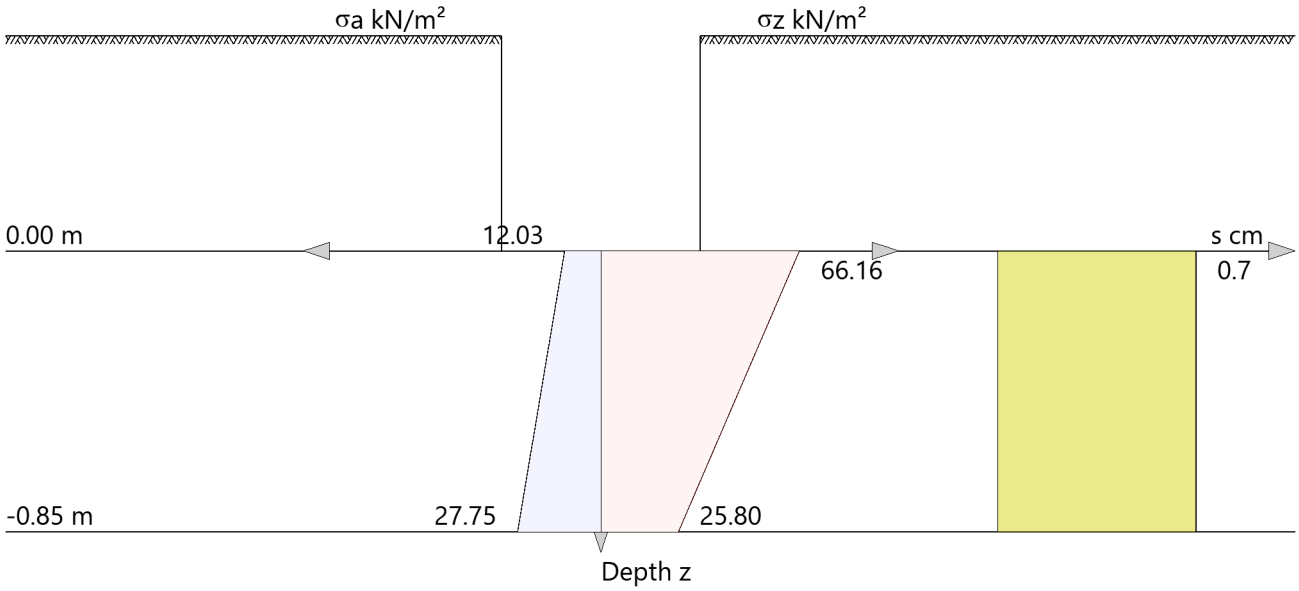
Settlement factor for the characteristic point by DIN 4019:2014 B3. Consolidation settlement s at the time of τ = 1.00 to DIN 4019:2014 12.2. Settlements from permanent and variable loads $G_{k,j}+Q_{k,1}+Q_{k,i}*\psi_{0,i}$. Secondary settlements are not considered

Calculation of different settlement portions Δs

(Δsx = 2*V*e_a/a2*E_m)*f(s,Δs) = (2*236.4*0.05 / 0.002*4946.00)*0.13 = 0.2 cm
(Δsy = 2*V*e_b/b2*E_m)*f(s,Δs) = (2*236.4*0.00 / 0.002*4946.00)*2.25 = 0.0 cm

Settlement Stresses permanent and variable loads $G_{k,j}+Q_{k,1}+Q_{k,i}*\psi_{0,i}$

Scale 1 : 23.0



Bending

Design

Bending design

$M_{Ed,y}$[1] = 0.004 kNm/m $a_{s,req,x}$[2] = 579 mm2/m $a_{s,exist,x}$ = 608 mm2/m bottom
Min. reinforcement to DIN EN 1992-1-1/NA/A1:2015-12 considered.
Layer of reinforcement Reinforcement in xy-direction d1,x,y = 3.7 cm

1) Superposition 3
2) Min. reinforcement

Connection Reinforcement

Wand	C 30/37	B500B	erf ges As	=	450	mm2/m
			je Seite As	=	225	mm2/m

Minimal eccentricity for compression members not considered.
Minimal reinforcement for pressed parts considered.
Layer of reinforcement d_1 = 5.0 cm

Check Shear Force

Check Shear Force: No shear force reinforcement necessary.

Flexural reinforcement

Layer	Direction	Item	A_s mm2
bottom	tansverse	39Ø10/12.5 cm	3063
bottom	lengthwise	3Ø12/20 cm	339

Item: Nosilec za gang ... Konzolna nosilna konstrukcija za gang

Continuous Beam Steel STM+ 01/22 (FRILO R-2022-1/P05)

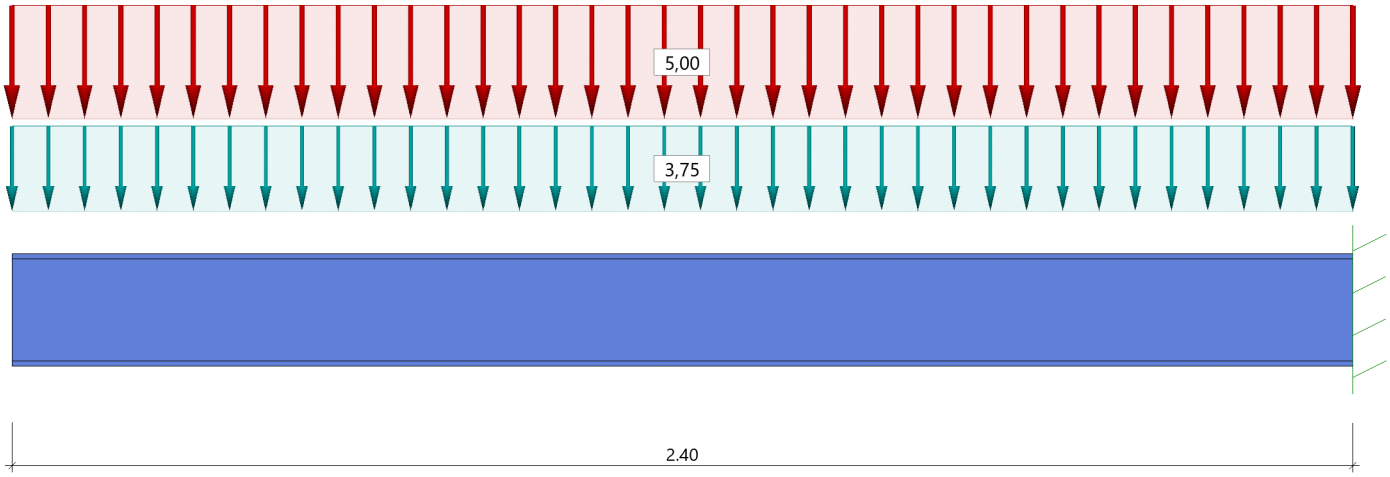
Basic Parameters

Steel girder, DIN EN 1993-1-1/NA:2015-08

Steel grade:S235

System

System Graphic



Material

Material S235

	E_k	=	210000	N/mm²	G_k	=	80769 N/mm²
	γ	=	78.50	kN/m³	μ	=	0.30
Elastic limit	t	≤	40	mm	f_{yk}	=	235.00 N/mm²
Tensile strength	t	≤	40	mm	f_{uk}	=	360.00 N/mm²

Geometry

Cross-sections

Name	I_y [cm⁴]	I_z [cm⁴]	W_y [cm³]	W_z [cm³]	A [cm²]
IPE 200	1943.0	142.4	194.0	28.5	28.5
Cross-section is constant over the entire length of the beam.					

Support (Bearing conditions)

No	x [m]	uy [kN/m]	uz [kN/m]	Rotations*) Φ_x [kNm/rad]	Φ_y [kNm/rad]	Φ_z [kNm/rad]
1	2.40	-1	-1	-1	-1	-1

*) -1 = fixed, 0 = free, > 0 = elastically restraint

Obtežba na KONZOLO:

- STALNA:
  - AB plošča deb. 12cm + stalna obtežba = 3,75 kN/m
- KORISTNA:
  - Koristna C3 = 5,00 kN/m

Loads

Line loads

Reference	No	Type	A [m]	L1 [m]	L2 [m]	W1 [kN/m]	W2 [kN/m]	GF	Sim	Alt
Cantilever left	1	GL		2.40		3.75		Permanent		
	2	GL		2.40		5.00		Cat. C		

Reference : System-related (front edge of beam) or span load
Type : 1 - uniformly distributed load (GL), 4 - trapezoidal load (TL), 5 - triangular load (DL)
A : Distance to the load from the beginning of the span or the front edge of the beam
GF : Load effect
Sim : Simultaneous group
Alt : Alternate group

Self-weight

Total weight = 54 kg taken into account with gamma = 78.50 kN/m³.

Overview of the actions used

Actions

Designation	ψ_0	ψ_1	ψ_2	$\gamma_{F,inf}$	$\gamma_{F,sup}$
Permanent loads				1.00	1.35
Cat. C: congregation areas	0.70	0.70	0.60		1.50

Consequences class CC 2 according to EN 1990 Tab. B1 -> K_{Fi} = 1.0 Tab. B3

Results

Design parameter

Design code	:	DIN EN 1993-1-1/NA:2015-08
Safety concept / load combinatorics	:	DIN EN 1990/NA:2010-12
Consequence class	:	CC 2
Ψ_2 = 0.5 for snow (AE)	:	not considered
Permanent loads	:	all equal γ_F ($\gamma_{G,sup}$ or $\gamma_{G,inf}$)
Check of cross-section	:	elastic
Stability	:	6.3.3 - annex B
Design situation serviceability	:	characteristic
Check of relative deformation	δ_{lim} =	Cantilever l_{eff}/ 150
	δ_{lim} =	Spans l_{eff}/ 300

Summary

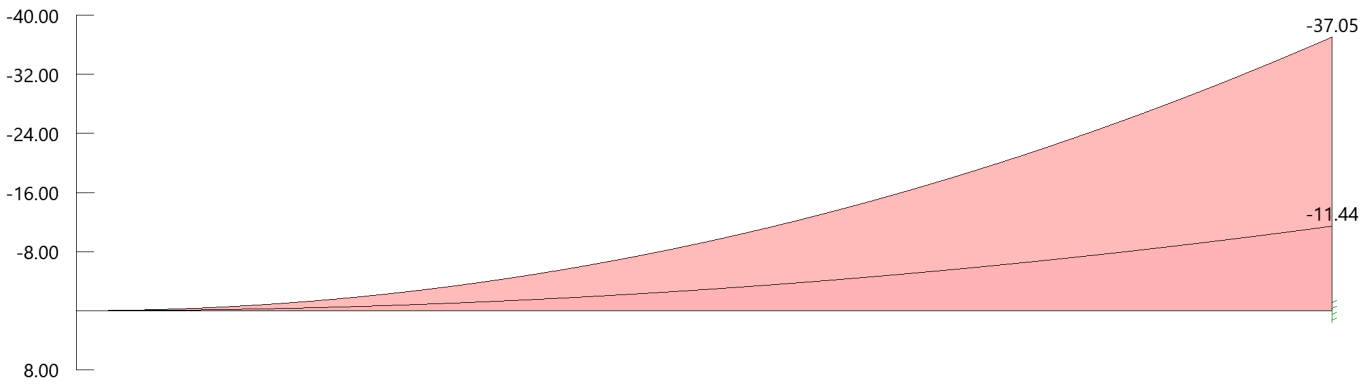
Check	Design situation	η_{Qs}	η_{Stabi}	$\eta_{Deformation}$
Load capacity	persistent/transient	0.81	[1]	
Serviceability	characteristic			0.57

[1] Stability check was not carried out because the upper chord is held continuously.

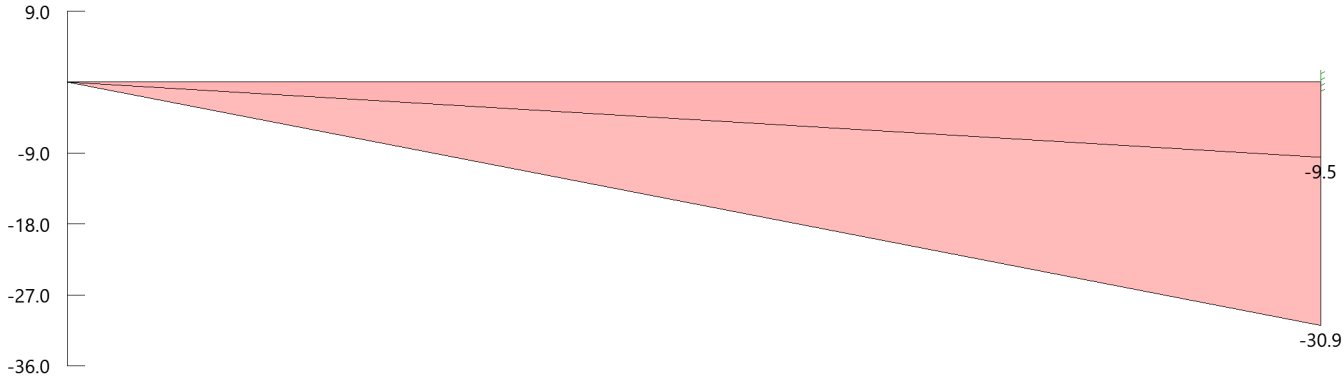
Structural safety - Load combination persistent/transient

Internal forces

Envelope of the moments



Envelope of the transverse forces



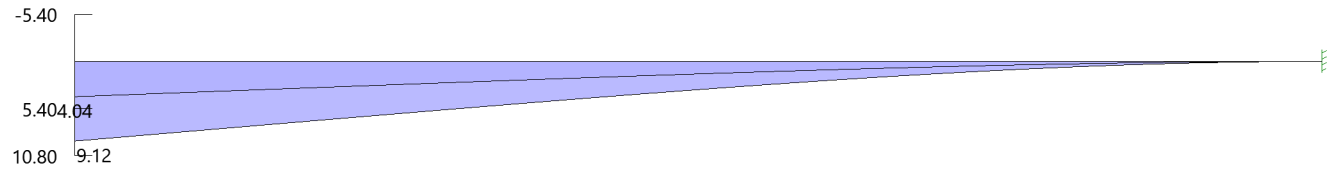
Cross-sectional bearing capacity

Internal forces/Cross-section load capacity elastic

Span	x [m]	CS.Cl	$V_{z,Ed}$ [kN]	$M_{y,Ed}$ [kNm]	σ_d [N/mm²]	τ_d [N/mm²]	$\sigma_{d,V}$ [N/mm²]	η	Lcomb
Cantilever left	2.40	1	-30.9	-37.05	-190.7	30.4	191.1	0.81	2

Graphics Deformations

Envelope of the deformations - Serviceability



Serviceability - Load combination characteristic

Deformation analysis - Relative deflection in z Kragarm: $f_{Cd} = l_{eff}/150$

x [m]	l_{eff} [m]	$l_{eff,x0}$ [m]	$l_{eff,x1}$ [m]	$f_{z,Ed}$ [mm]	$f_{z,Cd}$ [mm]	η	Comb
0.00	2.40	0.00	2.40	9.12	16.00	0.57	3
0.00	0.00	2.40	2.40	0.00	0.00	0.00	3

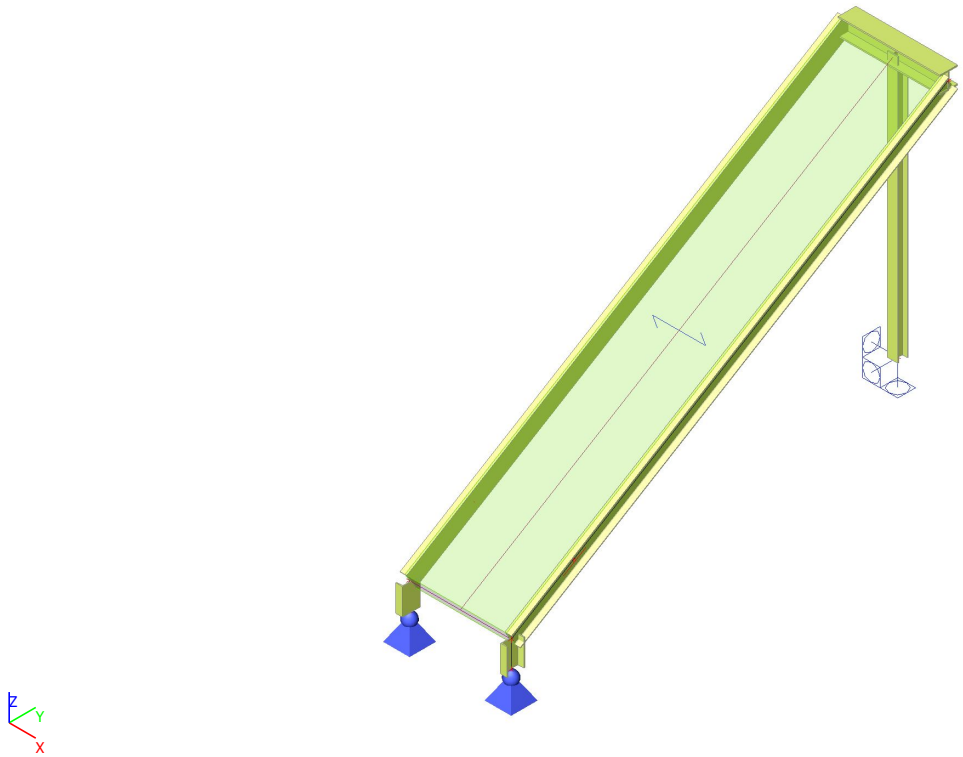
x : Coordinate X of the calculated position
l_{eff} : effective length of this section
$l_{eff,x0}$: Begin of effective length of this section (point of return in the bend line)
$l_{eff,x1}$: End of effective length of this section (point of return in the bend line)
$f_{z,Ed}$: Design value of the displacement
$f_{z,Cd}$: permissible displacement from leff
η : largest utilization of the calculated position
Comb : Load case combination

Support forces

Support forces - characteristic of each action

No	x [m]	Action	$R_{z,min}$ [kN]	$R_{z,max}$ [kN]	$M_{y,min}$ [kNm]	$M_{y,max}$ [kNm]
1	2.40	Permanent loads		9.5		11.44
		Cat. C: congregation areas		12.0		14.40

1. 3D model



2. Točke

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N1	0,000	0,000	0,000
N2	0,000	4,950	3,000
N3	1,150	0,000	0,000
N4	1,150	4,950	3,000

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N5	0,575	4,950	3,000
N6	0,575	4,950	0,000
N7	0,000	0,707	0,429
N8	1,150	0,707	0,429

Name	Coord X [m]	Coord Y [m]	Coord Z [m]
N9	0,000	0,000	-0,300
N10	1,150	0,000	-0,300

3. Members

Name	Cross-section	Material	Length [m]	Beg. node	End node	Type
B1	CS2 - U200	S 235	5,788	N1	N2	general (0)
B2	CS2 - U200	S 235	5,788	N3	N4	general (0)
B3	CS3 - HEB200	S 235	1,150	N2	N4	general (0)
B4	CS1 - HEB120	S 235	3,000	N5	N6	general (0)
B5	CS2 - U200	S 235	0,300	N1	N9	general (0)
B7	CS2 - U200	S 235	0,300	N3	N10	general (0)

4. Nodal supports

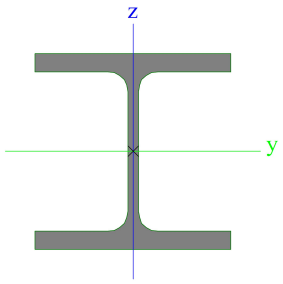
Name	Node	System	Type	X	Y	Z	Rx	Ry	Rz
Sn3	N6	GCS	Standard	Rigid	Rigid	Rigid	Rigid	Rigid	Rigid
Sn1	N9	GCS	Standard	Rigid	Rigid	Rigid	Free	Free	Free
Sn4	N10	GCS	Standard	Rigid	Rigid	Rigid	Free	Free	Free

5. Cross-sections

CS1		
Type	HEB120	
Item material	S 235	

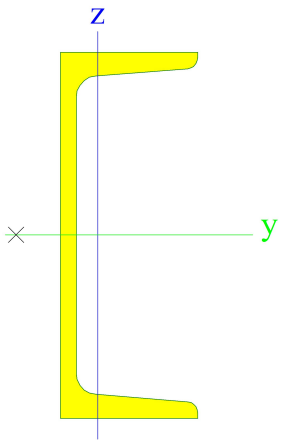
Fabrication	rolled	
Flexural buckling y-y, Flexural buckling z-z	b	c
A [m^2]	3,4010e-03	
A_y [m^2], A_z [m^2]	2,5923e-03	8,4095e-04
I_y [m^4], I_z [m^4]	8,6440e-06	3,1750e-06
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	1,4410e-04	5,2920e-05
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	1,6520e-04	8,0970e-05
I_w [m^6], I_t [m^4]	9,4098e-09	1,3840e-07
d_y [mm], d_z [mm]	0	0
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	60	60
α [deg]	0,00	
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	38848,89	38848,89
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	19031,63	19031,63
A_L [m^2/m], A_D [m^2/m]	6,8600e-01	6,8630e-01

Picture



CS2		
Type	U200	
Item material	S 235	
Fabrication	rolled	
Flexural buckling y-y, Flexural buckling z-z	c	c
A [m^2]	3,2200e-03	
A_y [m^2], A_z [m^2]	1,6758e-03	1,6900e-03
I_y [m^4], I_z [m^4]	1,9100e-05	1,4800e-06
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	1,9100e-04	2,7000e-05
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	2,3175e-04	5,1874e-05
I_w [m^6], I_t [m^4]	1,0499e-08	1,1900e-07
d_y [mm], d_z [mm]	-44	0
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	20	100
α [deg]	0,00	
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	53537,32	53537,32
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	12190,47	12190,47
A_L [m^2/m], A_D [m^2/m]	6,6000e-01	6,6027e-01

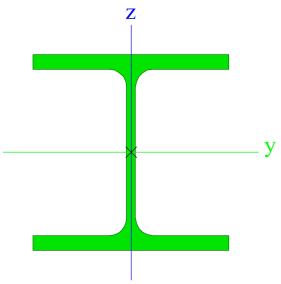
Picture



CS3

Type	HEB200	
Item material	S 235	
Fabrication	rolled	
Flexural buckling y-y, Flexural buckling z-z	b	c
A [m^2]	7,8080e-03	
A_y [m^2], A_z [m^2]	5,7750e-03	1,9112e-03
I_y [m^4], I_z [m^4]	5,6960e-05	2,0030e-05
$W_{el.y}$ [m^3], $W_{el.z}$ [m^3]	5,6960e-04	2,0030e-04
$W_{pl.y}$ [m^3], $W_{pl.z}$ [m^3]	6,4250e-04	3,0580e-04
I_w [m^6], I_t [m^4]	1,7112e-07	5,9280e-07
d_y [mm], d_z [mm]	0	0
$c_{Y.UCS}$ [mm], $c_{Z.UCS}$ [mm]	100	100
α [deg]	0,00	
$M_{pl.y.+}$ [Nm], $M_{pl.y.-}$ [Nm]	151093,74	151093,74
$M_{pl.z.+}$ [Nm], $M_{pl.z.-}$ [Nm]	71879,29	71879,29
A_L [m^2/m], A_D [m^2/m]	1,1500e+00	1,1510e+00

Picture



6. Materials

Steel EC3

Name	ρ [kg/m^3]	E_{mod} [MPa]	μ	Lower limit [mm]	Upper limit [mm]	F_y [MPa]	F_u [MPa]	Colour
		G_{mod} [MPa]	α [m/mK]					
S 235	7850,00	2,1000e+05	0.3	0	40	235,0	360,0	
		8,0769e+04	0,01e-003	40	80	215,0	360,0	

7. Load cases

Name	Description	Action type	Load group	Direction	Duration	Master load case
	Spec	Load type				
LC1	Self weight	Permanent	LG1	-Z		
		Self weight				
LC2	Stalna obtežba	Permanent	LG1			
		Standard				
LC3	Koristna obtežba	Variable	LG2		Short	None
	Standard	Static				

8. Load groups

Name	Load	Relation	Type
LG1	Permanent		
LG2	Variable	Standard	Cat C : Congregation

9. Combinations

Name	Description	Type	Load cases	Coeff. [-]
ULS-Set B (auto)		EN-ULS (STR/GEO) Set B	LC1 - Self weight	1,00
			LC2 - Stalna obtežba	1,00
			LC3 - Koristna obtežba	1,00
SLS-Char (auto)		EN-SLS Characteristic	LC1 - Self weight	1,00
			LC2 - Stalna obtežba	1,00
			LC3 - Koristna obtežba	1,00
ULS-Set B (auto)3		Envelope - ultimate	LC1 - Self weight	1,35
			LC2 - Stalna obtežba	1,35
			LC3 - Koristna obtežba	1,50
SLS-Char (auto)2		Envelope - serviceability	LC1 - Self weight	1,00
			LC2 - Stalna obtežba	1,00
			LC3 - Koristna obtežba	1,00

10. Reactions

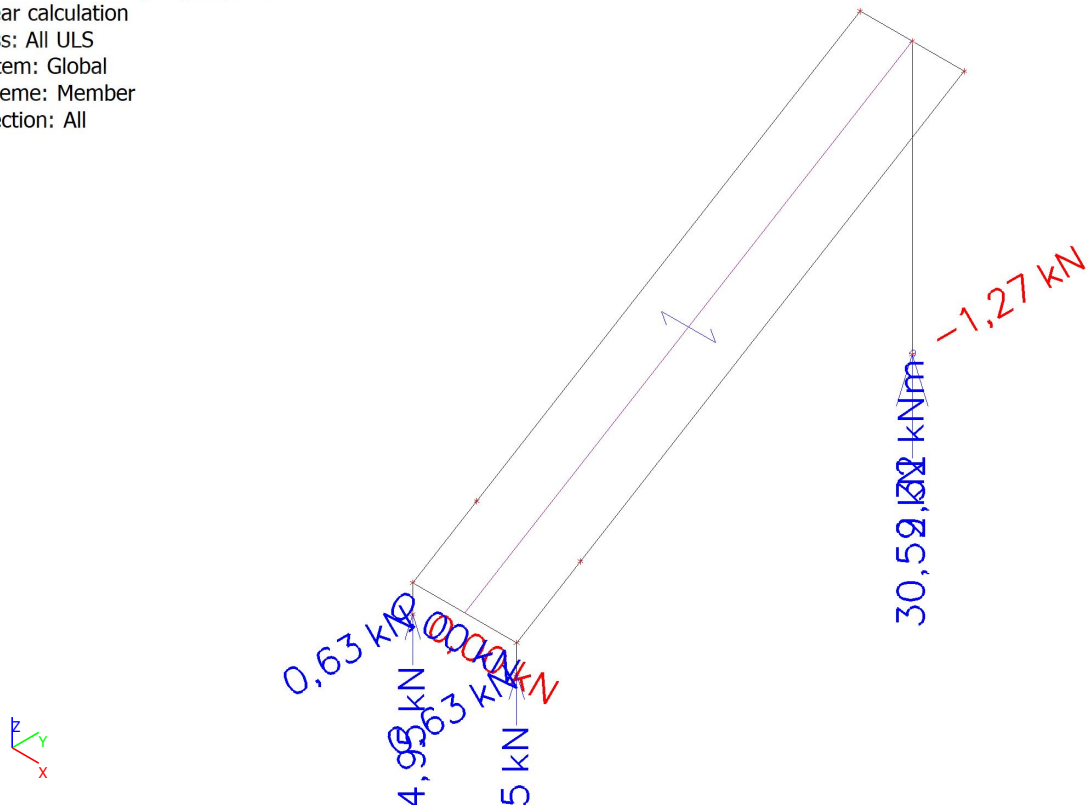
Linear calculation
Class: All ULS
System: Global
Extreme: Global
Selection: All
Nodal reactions

Name	Case	R_x [kN]	R_y [kN]	R_z [kN]
Sn1/N9	ULS-Set B (auto)/1	**0,00**	0,63	14,95
Sn4/N10	ULS-Set B (auto)/1	**0,00**	**0,63**	14,95
Sn3/N6	ULS-Set B (auto)/1	0,00	**-1,27**	**30,59**
Sn1/N9	ULS-Set B (auto)/2	0,00	0,07	**1,65**

Name	Combination key
ULS-Set B (auto)/1	1,35*LC1 + 1,35*LC2 + 1,50*LC3
ULS-Set B (auto)/2	LC1 + LC2

11. Reakcije v podporah

Values: R_x, R_y, R_z, M_x, M_y, M_z
Linear calculation
Class: All ULS
System: Global
Extreme: Member
Selection: All



12. 1D internal forces

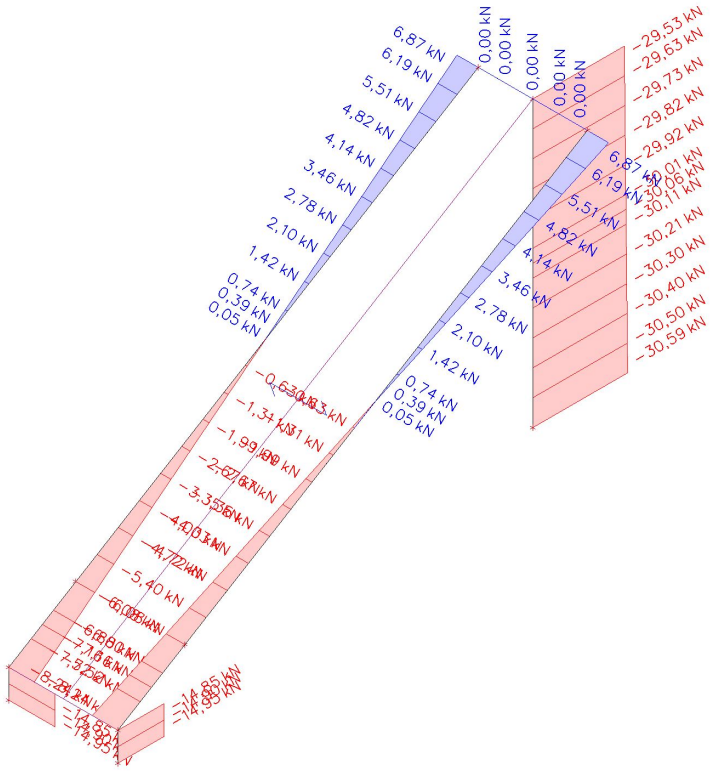
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Global
Selection: All

Name	dx [m]	Case	N [kN]	V_y [kN]	V_z [kN]	M_x [kNm]	M_y [kNm]	M_z [kNm]
B4	3,000	ULS-Set B (auto)/1	**-30,59**	0,00	-1,27	0,00	-2,32	**0,00**
B1	5,788	ULS-Set B (auto)/1	**6,87**	0,00	-12,56	0,00	-0,74	0,01
B3	0,575-	ULS-Set B (auto)/1	0,00	**0,63**	**-14,77**	**0,74**	-8,35	**0,37**
B3	0,575+	ULS-Set B (auto)/1	0,00	**-0,63**	**14,77**	**-0,74**	-8,35	0,37
B2	2,916	ULS-Set B (auto)/1	-0,63	0,00	0,19	0,00	**-17,56**	0,01
B1	2,916	ULS-Set B (auto)/1	-0,63	0,00	-0,19	0,00	**17,56**	0,01

Name	Combination key
ULS-Set B (auto)/1	1.35*LC1 + 1.35*LC2 + 1.50*LC3

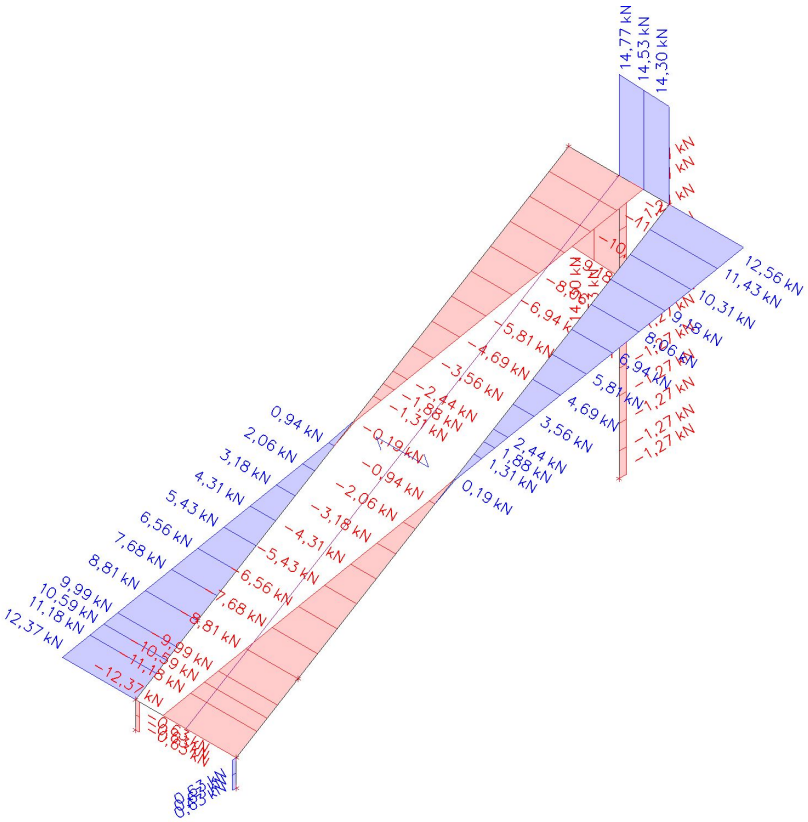
13. Osna sila

Values: **N**
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Section
Selection: All



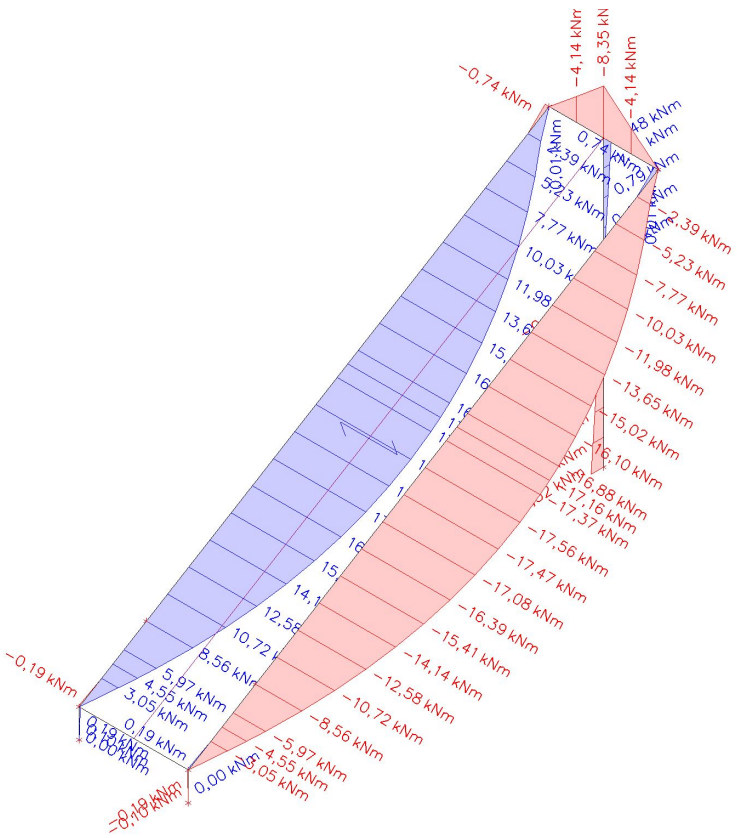
14. Prečna sila

Values: V_z
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Section
Selection: All



15. Upogibni moment

Values: M_y
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Section
Selection: All



16. EC-EN 1993 Steel check ULS

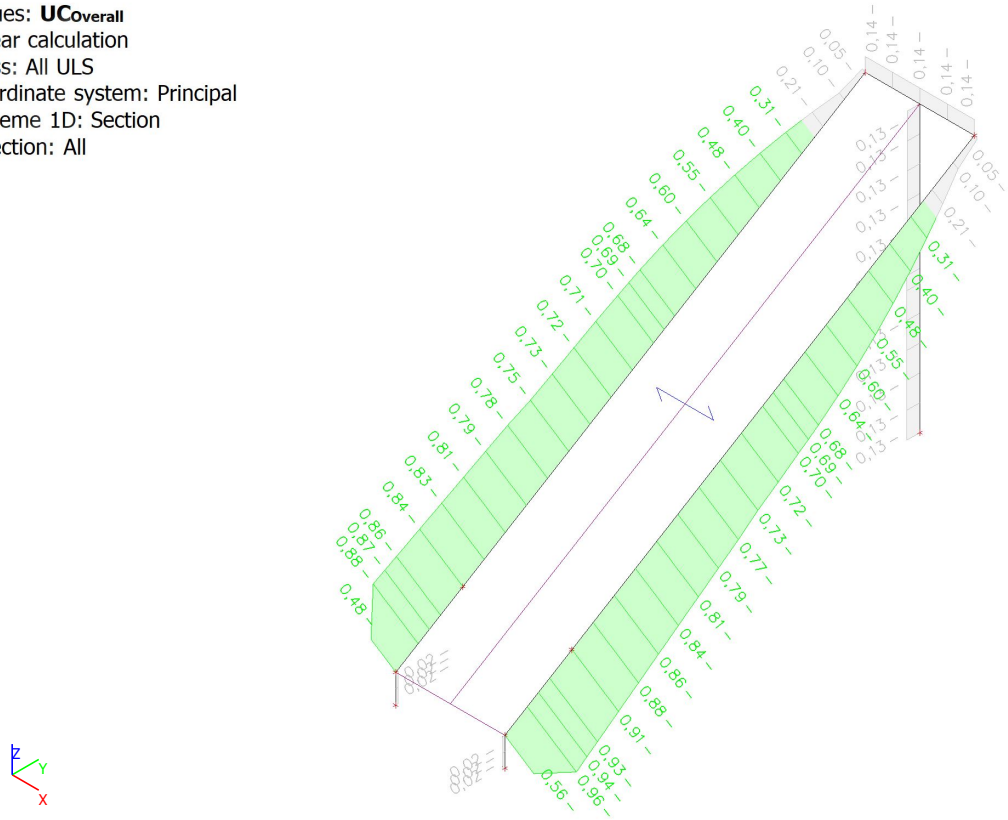
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Overall Unity Check

Name	dx [m]	Case	Cross-section	Material	$UC_{Overall}$ [-]	UC_{Sec} [-]	UC_{Stab} [-]
B2	0,276	ULS-Set B (auto)/1	CS2 - U200	S 235	**0,96**	0,07	0,96

Name	Combination key
ULS-Set B (auto)/1	1.35*LC1 + 1.35*LC2 + 1.50*LC3

17. Izkoriščenost

Values: **$UC_{Overall}$**
Linear calculation
Class: All ULS
Coordinate system: Principal
Extreme 1D: Section
Selection: All



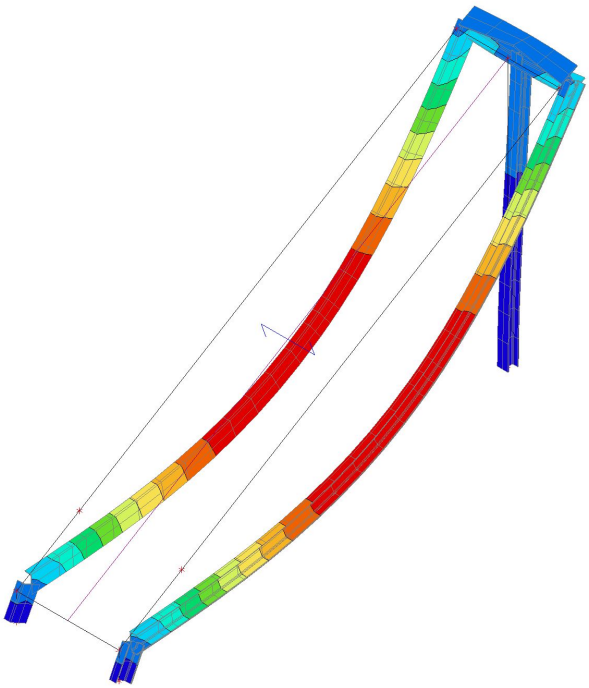
18. EC-EN 1993 Steel Check SLS

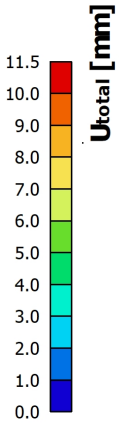
Linear calculation
Load case: LC1
Coordinate system: Principal
Extreme 1D: Global
Selection: All
Overall Unity Check

Name	dx [m]	Case	$u_{y,max}$ [mm] $u_{z,max}$ [mm]	$u_{y,var}$ [mm] $u_{z,var}$ [mm]	Lim. $u_{y,max}$ [mm] Lim. $u_{z,max}$ [mm]	Lim. $u_{y,var}$ [mm] Lim. $u_{z,var}$ [mm]	Check $u_{y,max}$ [-] Check $u_{z,max}$ [-]	Check $u_{y,var}$ [-] Check $u_{z,var}$ [-]	Camber dx u_z [mm] Camber [mm]	Check $_{Overall}$ [-]
B1	2,916	LC1	0,0 -0,8	- -	57,9 57,9	32,2 32,2	0,00 0,01	- -	- -	**0,01**

19. Pomiki

Values: U_{total}
Linear calculation
Combination: SLS-Char (auto)
Selection: All
Location: In nodes avg. on macro.
System: LCS mesh element







2.6 OPAŽNO ARMATURNI NAČRTI

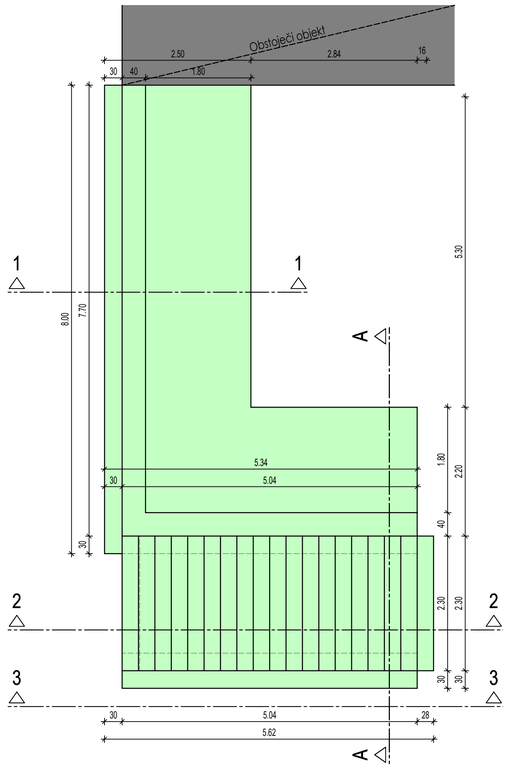
01 OPORNA ZIDA S STOPNICAMI - opažno armaturni načrt
02 POŽARNE STOPNICE - opažno armaturni načrt

OPORNA ZIDA S STOPNICAMI

Opažno armaturni načrt

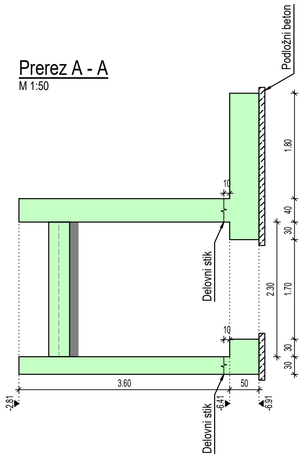
Tloris...Opaž

M 1:50



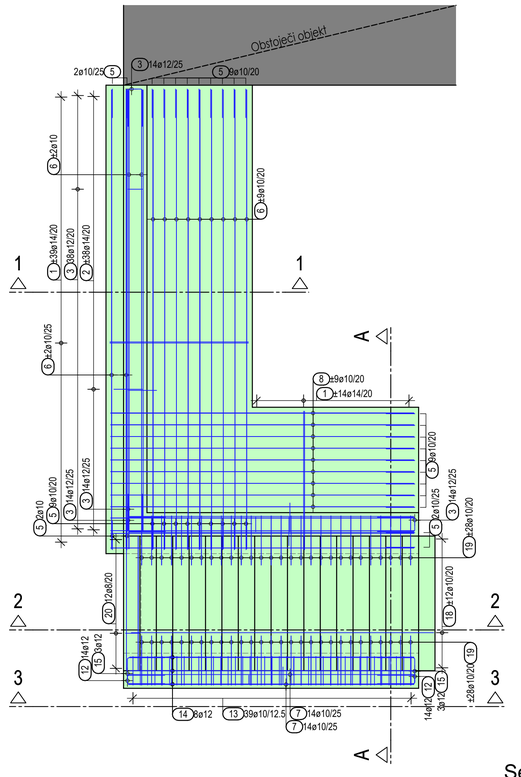
Prerez A - A

M 1:50

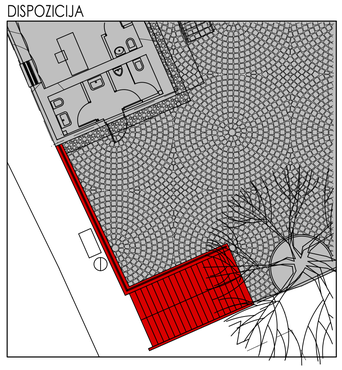


Tloris...Armatura

M 1:50

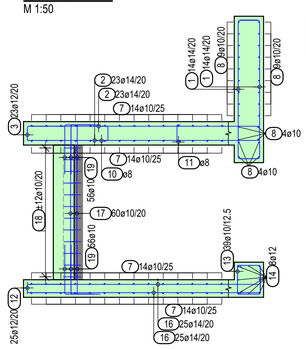


DISPOZICIJA



Prerez A - A

M 1:50



OPOZORILO:
Armaturni koš stopnic se preko pozicije (17) in (19) poveže z opornim zidom in AB steno.

Prerez 1 - 1

M 1:50

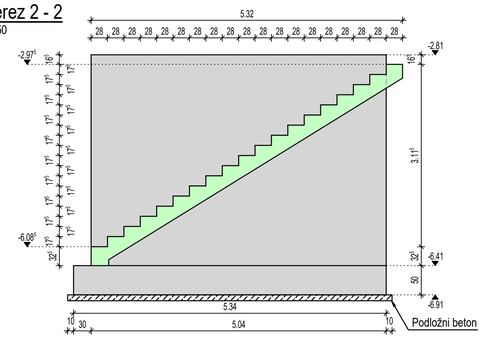
OPOZORILO:
Pozicije (9), (10) in (11) se razporedijo 2kom/m^2.

Prerez 1 - 1

M 1:50

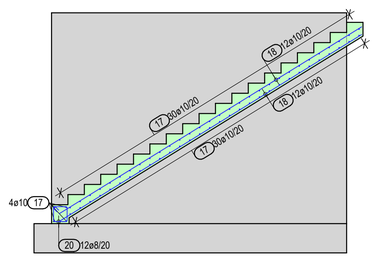
Prerez 2 - 2

M 1:50



Prerez 2 - 2

M 1:50

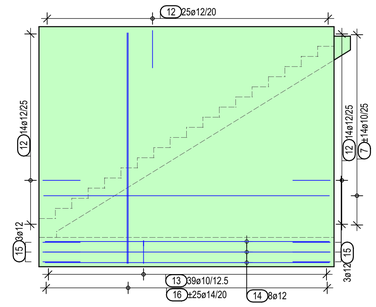


Prerez 3 - 3

M 1:50

Prerez 3 - 3

M 1:50



Seznam palic - oblika krivljenja

Poz.	Kosov	Fi [mm]	Posam. dolžina [m]	Kotirana oblika krivljenja (ni v merilu)	Skupna dolžina [m]	Teža [kg]
1	106	14	3.08	35 / 238	326.48	395.04
2	122	14	4.45	395 / 50	542.90	656.91
3	117	12	1.56	65 / 26 / 755	182.52	162.08
4	28	10	7.55	35 / 50 / 785	211.40	130.43
5	33	10	1.35	489	44.55	27.49
6	26	10	7.85	519	204.10	125.93
7	56	10	4.89	25 / 35 / 25 / 26 / 7 / 30	273.84	168.96
8	26	10	5.19		134.94	83.26
9	40	10	1.44		57.60	35.54
10	90	8	0.76		68.40	27.02
11	90	8	0.44		39.60	15.64
12	53	12	1.46	65 / 16 / 50 / 40 / 40 / 487	77.38	68.71
13	39	10	2.51		97.89	60.40
14	8	12	4.87		38.96	34.60
15	6	12	1.76	65 / 46 / 30 / 395	10.56	9.38
16	50	14	4.25		212.50	257.13
17	64	10	2.30	230	147.20	90.82
18	24	10	6.08	608	145.92	90.03
19	120	10	1.25	85 / 40 / 24 / 26	150.00	92.55
20	12	8	1.21		14.52	5.74

Skupna teža [kg] : 2537.66

BETON:

Peta opornega zidu = 14,05 m^3
Oporni zid = 17,30 m^3
Pasovni temelj = 1,70 m^3
AB Stena = 5,30 m^3
Stopnice = 3,95 m^3
Σ = 43,30 m^3

OPOMBE:
Pred izdelavo temeljev je potrebno izvesti, s strani geomehanika, kontrolo nosilnosti temeljnih tal in te ugotovitve podati z vpisom v gradbeni dnevnik.
Pri izračunu temeljev objekta je bila upoštevana nosilnost temeljnih tal in sicer:
- dopustna nosilnost tal: σ dop. = 200 kN/m^2,
- modul reakcije temeljnih tal: K min = 20 kN/m^3

V primeru manjše nosilnosti temeljnih tal od predpostavljenih, je potrebno temelje ponovno preračunati oz. izvesti sanacijo temeljnih tal po navodilih geomehanika.

Nosilnost planuma temeljnih tal: 20 MPa
Nosilnost planuma tampona: min E_{vd2} = 100 MPa
Zgoščenost vgrajene zmesi zm mora znašati v povprečju 98% glede na največjo gostoto zmesi zm po modificiranem postopku po Proctorju opredeljenem v SIST EN 13286. Spodnja mejna vrednost zgoščenosti lahko od povprečja odstopa največ 3%.

OPOZORILO:
Obvezno vse kote in mere preveriti na samem objektu! Preveriti tudi na skladnost z ostalimi pripadajočimi načrti.
Pazit na vgrajene elemente in predvje za potrebe inštalacij - glej pripadajoče načrte! Armature ob vgradnji inštalacij ni dovoljeno premikati ali spreminjati!Težave V primeru konfliktov med armaturo in vgrajnimi elementi se posvetovati s projektanti posameznih načrtov in le-te med sabo uskladiti!
V primeru morebitnih sprememb se obvezno posvetovati s projektantom!

Vgrajeni material	Količina	M. enota

BETON	
Tlačna trdnost betona	C 30/37
Stopnja izpostavljenosti	XC3
Zmavnost frakcij	Dmax 16
Dodatne zahteve	PV-II
ARMATURA	
Kvaliteta jekla - palice	S 500 (B)
ZAŠČITNI SLOJ	
Zaščitni sloj - spodaj	a = 5.0 cm
Zaščitni sloj - zgoraj	a = 5.0 cm

stranski zaščitni sloj: + 1 cm ter + 3c, + 3 cm ter + 3c, 15ø, 15ø, ds

Kljuke: 6 mm, < 20, 4ds; 20 - 28, 7ds, ds
Krivljenje

opis spremembe	datum	ime	podpis

projektirno podjetje

ASPA • ING

PROJEKTIRANJE GSM: 041 756 708
NADZORI GSM: 041 394 716
MERITVE www.aspa-ing.si
VIZUALIZACIJE info@aspa-ing.si
IZDELAVA GRADBENIH KONSTRUKCIJ

Dogovor ter dokumentacija nujno, kakor tudi kopiranje, uporabljanje in dajanje izkvarelo v ogled vsakršni, če ni posebej odobreno. Zoi vsa opravila, ki bi bila v nasprotju s tem določilom je predvideno denarno nadomestilo za nastalo škodo. Projekt v celoti avtorsko delo je zo dokončnega plačila last podjetja ASPA-ING in se ga ne sme uporabljati.

investitor: OBČINA LENDAVA, Glavna ulica 20, 9220 Lendava

objekt: PRENOVA HIŠE OBRTI IN ROKODELSTVA

faza: **OPORNA ZIDA S STOPNICAMI**

OPAŽNO ARMATURNI NAČRT

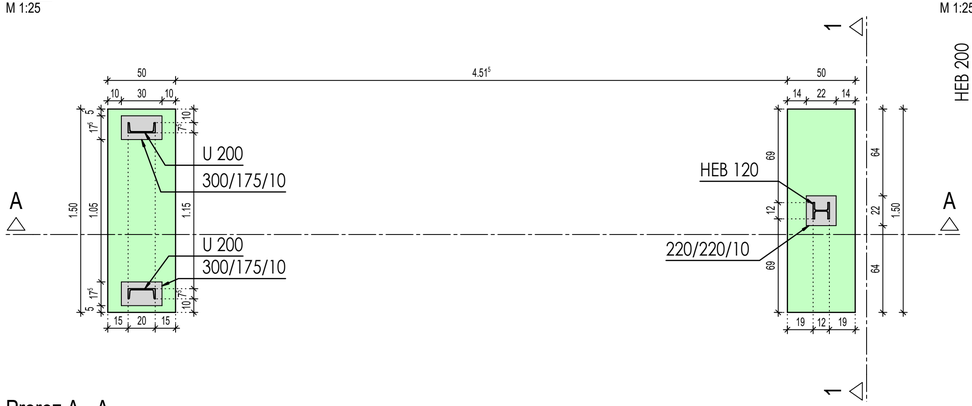
odgovorni vodja projekta	Aleksander PLEJ, dipl. inž. grad., G-3439	št. projekta	D - 31/2021
odgovorni projektant	Aleksander PLEJ, dipl. inž. grad., G-3439	št. načrta	D - 31/2021 - GK
strokovni sodelavec	Ždenko BLUČ, mag. inž. grad.		
vrsta načrta	2 NAČRT GRADBENIH KONSTRUKCIJ	vrsta proj. dokumentacije	PZI
		datum	februar 2022
lokacija	k.o. 166 Lendava	merilo	1 : 50
		številka lista	01

POŽARNE STOPNICE

Opažno armaturni načrt

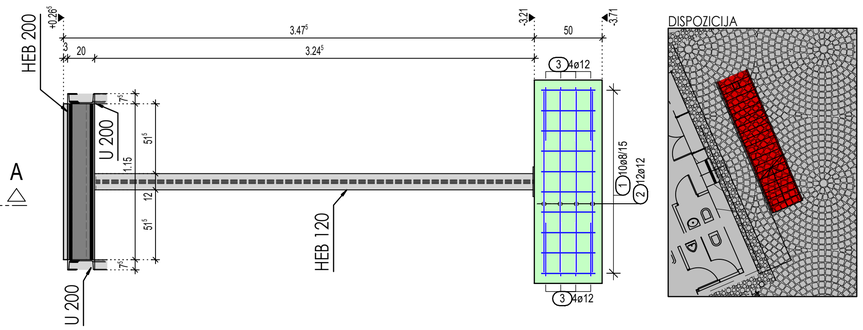
Tloris

M 1:25



Prerez 1 - 1

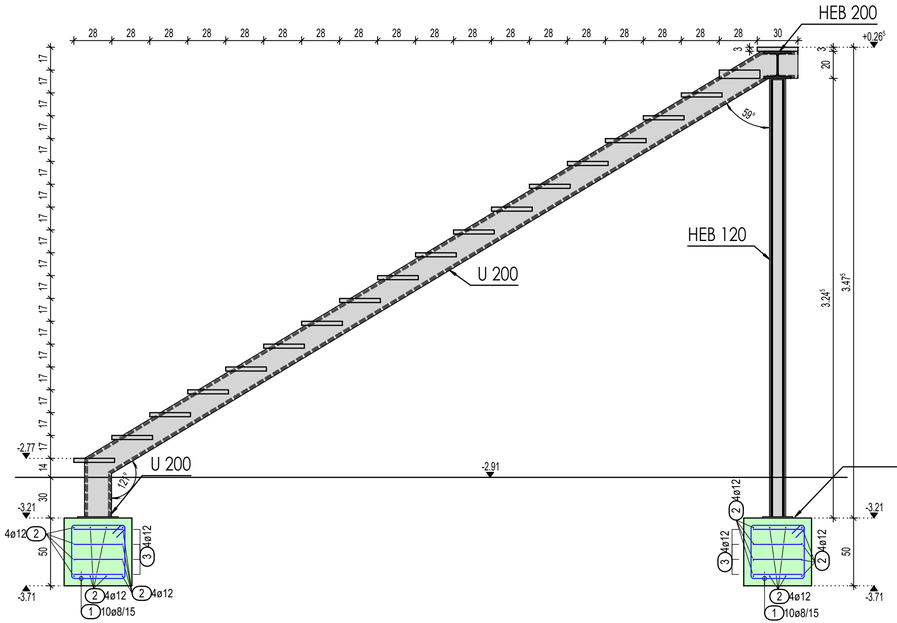
M 1:25



DISPOZICIJA

Prerez A - A

M 1:25



Seznam palic - oblika krivljenja

Poz.	Kosov	Fi [mm]	Posam. dolžina [m]	Kotirana oblika krivljenja (ni v merilu)	Skupna dolžina [m]	Teža [kg]
1	20	8	1.81	40 / 40 / 10	36.20	14.30
2	24	12	1.34	134	32.16	28.56
3	16	12	1.17	40 / 37	18.72	16.62
				Skupna teža [kg] :		59.48

OPOZORILO:

Jeklena konstrukcija se na pasovna temelja pritrdi s pomočjo HILTI kemičnih sider.

BETON:

2x Pasovni temelj = 0,75 m^3

OPOMBE:

Pred izdelavo temeljev je potrebno izvesti, s strani geomehanika, kontrolo nosilnosti temeljnih tal in te ugotovitve podati z vpisom v gradbeni dnevnik.
Pri izračunu temeljev objekta je bila upoštevana nosilnost temeljnih tal in sicer:
- dopustna nosilnost tal: σ dop. = 200 kN/m^2,
- modul reakcije temeljnih tal: K min = 20 kN/m^3

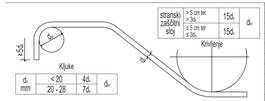
V primeru manjše nosilnosti temeljnih tal od predpostavljenih, je potrebno temelje ponovno preračunati oz. izvesti sanacijo temeljnih tal po navodilih geomehanika.

Nosilnost planuma temeljnih tal: 20 MPa
Nosilnost planuma tampona: min E_{vd} = 100 MPa
Zgoščenost vgrajene zmesi zrn mora znašati v povprečju 98% glede na navečjo gostoto zmesi zn po modificiranem postopku po Proctorju opredeljenem v SIST EN 13286. Spodnja mejna vrednost zgoščenosti lahko od povprečja odstopa največ 3%.

OPOZORILO:

Obvezno vse kote in mere preveriti na samem objektu! Preveriti tudi na skladnost z ostalimi pripadajočimi načrti.
Paziti na vgradne elemente in preboje za potrebe inštalacij - glej pripadajoče načrte! Armature ob vgradnji inštalacij ni dovoljeno premikati ali spreminjati/rezati! V primeru konfliktov med armaturo in vgradnimi elementi se posvetovati s projektanti posameznih načrtov in le-te med sabo uskladiti!
V primeru morebitnih sprememb se obvezno posvetovati s projektantom!

Vgrajeni material	Količina	M. enota



BETON	
Tlačna trdnost betona	C 30/37
Stopnja izpostavljenosti	XC2
Zrnavost frakcij	Dmax 16
Dodatne zahteve	PV-II
ARMATURA	
Kvaliteta jekla - palice	S 500 (B)
ZAŠČITNI SLOJI	
Zaščitni sloj - spodaj	a = 5,0 cm
Zaščitni sloj - zgoraj	a = 5,0 cm

opis spremembe	datum	ime	podpis

projektivno podjetje

ASPA • ING

PROJEKTIRANJE NADZORI MERITVE VIZUALIZACIJE
GSM: 041 756 758
GSM: 041 594 716
www.aspa-ing.si
aplej@aspa-ing.si
IZDELAVA GRADBENIH KONSTRUKCIJ

Dopisje ne dokumentacije vrsnej, kakor tudi kopiranje, uporabljanje in objavljanje celotnega ali njenih vsebin ni dovoljeno. Za vsi posebej, odobreno. Za vsa oprtvila, ki bi bila v nasprotju s tem določilom je predvideno materialno odgovornost po naslnji škodo. Projekt s vsemi sestavnimi deli je oz dokončnega plačila last podjetja ASPA-ING in se ga ne sme uporabljati.

investitor
OBČINA LENDAVA
Glavna ulica 20
9220 Lendava

objekt
PRENOVA HIŠE OBRTI IN ROKODELSTVA

risba
POŽARNE STOPNICE
OPAŽNO ARMATURNI NAČRT

odgovorni vodja projekta	št. projekta
Aleksander P.I.E.I. dipl. inž. grad., G-3439	D - 31/2021
odgovorni projektant	št. načrta
Aleksander P.I.E.I. dipl. inž. grad., G-3439	D - 31/2021 - GK
strokovni sodelavec	
Zdenko BLUČ, mag. inž. grad.	

vrsta načrta	vrsta proj. dokumentacije	datum
2 NAČRT GRADBENIH KONSTRUKCIJ	PZI	februar 2022
lokacija	merilo	številka lista
k.o. 166 Lendava	1 : 25	02