

Bo/Lo/Ho/D (CM)= 150/150/200

ARMATURA: B 500

DIMENZIJE

$k_a = (\tan(45^\circ - \alpha/2))^2 =$	0,333
$k_m = 1 - \sin(\alpha) =$	0,500

MODEL 1

60	kN/m ²
5,00	

GORNJA PLOČA

RASPON PLOČE	2,25	m
OPT.OD NADSLOJA	1,52	kN/m ²
OD PLOČE	5,00	kN/m ²
STALNO OPTER.PLOČE	6,52	kN/m ²

ŠIRINA RASPROSTIRANJA OD KOTAČA

POPREČNO NA SMJER VOŽNJE	$BQ = 0,40 + HE + DO =$	2,48	m
UZDUŽNO NA SMJER VOŽNJE	$BF = 0,40 + HE + DO =$	2,48	m

POVRŠINA	$F = BQ * BF =$	6,15	m ²
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DINAMIČKI KOEFICIJENT (UKLJUČEN U OPTER. EC-1)	KD =	1,00
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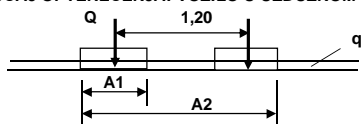
POKRETNOST OPTEREĆENJE.	$Q = P =$	120	KN
	$P1 = Q1 / F =$	9,76	kN/m ²

STALNO OPTEREĆENJE

REAKCIJA	$RG = QD * LB / 2 =$	7,34	kN
MOMENT	$MG = QD * LB^2 / 8 =$	4,13	kNm

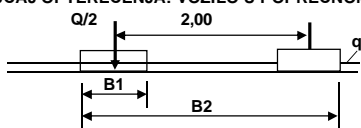
POKRETNOST OPTEREĆENJE

SLUČAJ OPTEREĆENJA: VOZILO U UZDUŽNOM SMJERU



$P =$	120,00	kN
$A1 = BF =$	2,48	m
$A2 = BF + 1,20 =$	3,68	m

SLUČAJ OPTEREĆENJA: VOZILO U POPREČNOM SMJERU



$P =$	120,00	kN
$B1 = BQ =$	2,48	m
$B2 = BQ + 2,00 =$	4,48	m

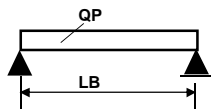
POVRŠINA:	$F1 = A1 * B1 =$	6,15	m ²
	$F2 = A2 * B2 =$	16,49	m ²

INTENZITET POKRETNOST OPTEREĆENJA.	$QP1 = P / 2 / F1 + q =$	18,76	kN/m ²
	$QP2 = 2 * Q / F2 + q =$	23,56	kN/m ²
	ILI ZA Q = 0 $p =$	5,00	kN/m ²

PRESJEČNE SILE

MJERODAVNO POKRETNOST OPTEREĆENJE:

QP = 23,56 kN/m²



Qmax = QG + QP = 30,08 kN/m²

LB = B - DW = 1,75 m

REAKCIJA
MOMENT

RP = QP * LB / 2 = 20,50 kN
MP = QP * LB² / 8 = 14,91 kNm

REAKCIJA
MOMENT

RMAX = RG + RP = 33,84 kN
MPMAX = MG + MP = 19,03 kNm

DIMENZIONIRANJE GORNJE PLOČE

MAX. REAKCIJA
MAX. MOMENT

RMAX = RG + RP = 33,84 kN
MPMAX = MG + MP = 19,03 kNm

AB- PRESJEK - HRN EN 1992 - 1 (EC-2)

BETON:				ARMATURA:			
b / h =	100,0	20,0	CM MB	40	▲	▲	B-500
a =	4,0			C30/37	▼	▼	
		0,85	fck =	30,0	N/mm ²	f _{yd} =	500,0 N/mm ²
			fcd = a*fck/gc =	17,0	N/mm ²	f _{yd} = f _{yd} /gs =	434,8 N/mm ²
			KOEF.SIG.OPTER.			KOEF.SIG.BETON I ARMAT	
			γ _g =	1,35		γ _c =	1,50
			γ _q =	1,50		γ _s =	1,15
			Msd = 1,35*Mg+1,5*Mp			Nsd = 1,35*Ng+1,5*Np	
			M Rd,lim = m,lim*(b*d ²)*fcd =	109,67	kNm		
			m _{lim} =	0,252	EC-2		
			D M = Msd - M Rd,lim =				
			As2 = D M / ((d-d2)*f _{yd}) =				

PRESJEČNE SILE

M (kNm) = 19,03
Q (kN) = 33,84
N (kN) = 0,00

DIMENZIONIRANJE EC-2

a (cm) =	4,0	fcd = a*fck/gc =	17,0	f _{yd} = f _{yd} /gs =	434,8	N/mm ²			
b	d = h-a	Msd	Vsd	Nsd	MRd,lim	μ _{sd}	ω	As1	As2
(CM)	(CM)	(KNM)	(KN)	(KN)	(KNM)			(cm ²)	(cm ²)
100	16,0	28,55	50,00	4,00	109,67	0,066	0,062	3,89	0,00

IZBOR ARMATURE:

AMIN = b*d*0,0015 =				2,40				
As1,potr =				3,89	ILI MREŽA:			
DOLJE:	(As1 =	8	Φ 8	(AS =	As =	4,0 cm2	Q -	
					e (cm) =	12,5		385
					As2,potr =	3,89		
GORE:	(As2 =	8	Φ 8	(AS =	As =	4,0 cm2	Q -	
					e (cm) =	12,5		385

POSMIK EC-2:

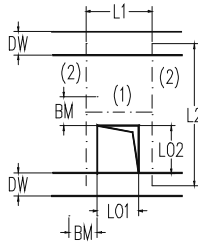
POTREBNE VILICE:

RAZMAK

USVOJENO

Tau, sd = Vsd / (b * 0,85 * d) =	0,04	KN/CM2	Tau, Rd =	0,03	KN/CM2
Asw = m * As1 = Tau, sd * b * 100 / f _{yd} =	0,85	CM2/M	m =	0	
sw = Asw1 * m * 0,85 * d * f _{yd} / Vsd =	0,00	CM2/M	Asw1 =	0,00	cm ²
	Φ	0	As(CM2/M) =	0,00	> Asw

NOSACI U PLOCI OKO OTVORA: 60/60 cm



OTVOR LO1 =	0,60	m
LO2 =	0,60	m
NOSAČ L1 =	1,10	m
NOSAČ L2 =	1,75	m
ŠIRINA NOSAČA BM =	0,50	m

NOSAČ 1

$$L1 = LO1 + BM = 1,10 \text{ m}$$

$$Q1 = QD \cdot (L2 - LO2) / 2 + P1 / L1 = 58,29 \text{ kN/m}$$

$$R1 \text{ MAX} = Q1 \cdot L1 / 2 = 32,06 \text{ kN}$$

$$M1 \text{ MAX} = Q1 \cdot L1^2 / 8 = 8,82 \text{ kNm}$$

DIMENZIONIRANJE EC-2

a (CM) =	4,0	fcd = a * fck / gc =	17,0	N/mm ²	fyd = fyd / gs =	434,8	N/mm ²		
b	d = h - a	Msd	Vsd	Nsd	MRd,lim	μsd	ω	As1	As2
(CM)	(CM)	(KNM)	(KN)	(KN)	(KNM)			(CM ²)	(CM ²)
50	16,0	13,23	48,09	0,00	54,84	0,061	0,062	1,94	0,00

IZBOR ARMATURE:

		AMIN = b * d * 0,0015 =		1,20				
		As1,potr =		1,94	ILI MREŽA:			
DOLJE:	(As1 =	3	Φ 12	(AS =	As =	3,4 cm ²	Q -	
					e (CM) =	16,7		
					As2,potr =	1,94		
GORE:	(As2 =	2	Φ 12	(AS =	As =	2,3 cm ²	Q -	
					e (CM) =	25,0		

POSMIK EC-2:

POTREBNE VILICE:

RAZMAK

USVOJENO

$$\text{Tau, sd} = \text{Vsd} / (b * 0,85 * d) = 0,07 \text{ KN/CM}^2$$

$$\text{Asw} = m * \text{As1} = \text{Tau, sd} * b * 100 / \text{fyd} = 0,81 \text{ CM}^2/\text{M}$$

$$\text{sw} = \text{Asw1} * m * 0,85 * d * \text{fyd} / \text{Vsd} = 0,00 \text{ CM}^2/\text{M}$$

Φ	8	/	15
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$$\text{Tau, Rd} = 0,03 \text{ kN/cm}^2$$

$$m = 2$$

$$\text{Asw1} = 0,50 \text{ cm}^2$$

$$(AS = 6,70 \text{ cm}^2)$$

NOSAČ 2

$$L2 = L + DW = 1,75 \text{ m}$$

$$R2 \text{ MAX} = \text{RMAX} * \text{BM} + \text{R1} * (L2 - LO2) / L2 = 37,99 \text{ kN}$$

$$M2 \text{ MAX} = \text{MMAX} * \text{BM} + \text{R1} * (L2 - LO2 + \text{BM} / 2) * (LO2 + \text{BM} / 2) / L2 = 31,32 \text{ kNm}$$

DIMENZIONIRANJE EC-2

a (CM) =	4,0	fcd = a * fck / gc =	17,0	N/mm ²	fyd = fyd / gs =	434,8	N/mm ²		
b	d = h - a	Msd	Vsd	Nsd	MRd,lim	μsd	ω	As1	As2
(CM)	(CM)	(KNM)	(KN)	(KN)	(KNM)			(CM ²)	as2
50	16,0	46,98	56,98	0,00	54,84	0,216	0,240	7,49	0,00

IZBOR ARMATURE:

		AMIN = b * d * 0,0015 =		1,20				
		As1,potr =		7,49	ILI MREŽA:			
DOLJE:	(As1 =	4	Φ 16	(AS =	As =	8,0 cm ²	Q -	
					e (CM) =	12,5		
					As2,potr =	7,49		
GORE:	(As2 =	2	Φ 16	(AS =	As =	4,0 cm ²	Q -	
					e (CM) =	25,0		

POSMIK EC-2:

POTREBNE VILICE:

RAZMAK

USVOJENO

$$\text{Tau, sd} = \text{Vsd} / (b * 0,85 * d) = 0,08 \text{ KN/CM}^2$$

$$\text{Asw} = m * \text{As1} = \text{Tau, sd} * b * 100 / \text{fyd} = 0,96 \text{ CM}^2/\text{M}$$

$$\text{sw} = \text{Asw1} * m * 0,85 * d * \text{fyd} / \text{Vsd} = 0,12 \text{ CM}^2/\text{M}$$

Φ	8	/	15
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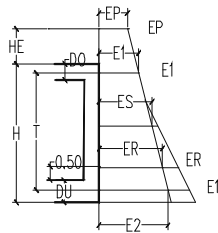
$$\text{Tau, Rd} = 0,03 \text{ kN/cm}^2$$

$$m = 2$$

$$\text{Asw1} = 0,50 \text{ cm}^2$$

$$\text{As(CM}^2/\text{M)} = 6,70 > \text{Asw}$$

ZIDOVI OKNA/CS - POTISAK TLA I VODE IZVANA



KOEF. MIRNOG POTISKA TLA
POTISAK TLA

$$K_o = 1 - \sin(FI) = 0,500$$

$$EP = PS \cdot K_o = 13,36 \text{ kN/m}^2$$

$$E1 = EP + GAMA \cdot (HE + DO/2) = 16,78 \text{ kN/m}^2$$

$$E2 = E1 + GAMA \cdot (H - DO/2 - DU/2) \cdot K_o = 37,93 \text{ kN/m}^2$$

$$ES = (E1 + E2)/2 = 27,35 \text{ kN/m}^2$$

$$W1 = 10 \cdot HW = 25,00 \text{ kN/m}^2$$

$$WS = 10 \cdot (HW - H/2) = 12,75 \text{ kN/m}^2$$

POTISAK TLA U TEŽIŠTU ZIDA
PRITISAK VODE

MJERODAVNI POTISAK TLA (NA 0,50 M OD DNA):
SUHO

$$T = H - DO/2 - DU/2 = 2,23 \text{ m}$$

$$ER = EP + GAMA \cdot (HE + DO/2 + T - 0,50) \cdot K_o = 31,46 \text{ kN/m}^2$$

U VODI

$$W1R = 10 \cdot (HW - 0,50) = 20,00 \text{ kN/m}^2$$

$$ER1 = EP + GAMA1 \cdot (HE + DO/2 + T - 0,50) \cdot K_o + W1R = 33,36 \text{ kN/m}^2$$

$$ES1 = EP + GAMA1 \cdot (HE + DO/2 + T/2) \cdot K_o + WS = 31,93 \text{ kN/m}^2$$

POTISAK OD POKRETNOSTI OPTEREĆENJA U TEŽIŠTU ZIDA

POKRETNOST: PROPISI EC-1

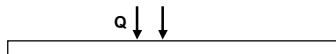
HRN EN 1991-1

Težina vozila:

615

kN

EKVIV. OPT. PREMA DIN 1072 SLW = 60



$$HS = HE + H/2 = 1,31 \text{ m}$$

$$BR = 3,00 + HS/2 = 3,65 \text{ m}$$

$$LR = 5,00 + 2 \cdot HS/2 = 6,31 \text{ m}$$

$$FR = BR \cdot LR = 23,03 \text{ m}^2$$

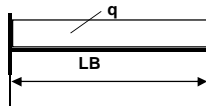
$$PS = SQ / FR = 26,71 \text{ kN/m}^2$$

MJERODAVNO OPTEREĆENJE ZIDA

$$QR = ER(ER1) = 33,36 \text{ kN/m}^2$$

POPREČNI ZID B*H*Dw

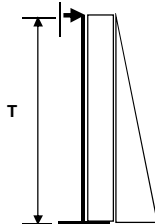
PRESJEČNE SILE - HORIZONTALNI SMJER



$$\begin{aligned} LB &= B - DW = 1,75 \text{ m} \\ QR &= 33,36 \\ MHMAX &= QR * LB^2 / 12 = 8,51 \text{ kNm} \\ RH &= QR * LB / 2 = 29,19 \text{ kN} \end{aligned}$$

6

PRESJEČNE SILE - VERTIKALNI SMJER



$$\begin{aligned} T &= H - DO/2 - DU/2 = 2,23 \text{ m} \\ QV &= ES(ES1) = 31,93 \\ MVMAX &= QV * T^2 / 8 = 19,76 \text{ kNm} \\ RH &= QR * LB / 2 = 35,52 \text{ kN} \end{aligned}$$

DIMENZIONIRANJE POPREČNOG ZIDA - HORIZONTALNI SMJER MJERODAVNO!

MJERODAVNI MOMENT $M = 8,51 \text{ kNm}$
MJERODAVNA POPREČNA SILA $Q = 29,19 \text{ kN}$

DIMENZIONIRANJE EC-2

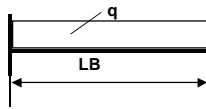
a (CM) =	4,0	fcd = $\alpha * f_{ck} / \gamma_c =$	17,0	N/mm ²	f _{yd} = f _{yk} / $\gamma_s =$	434,8	N/mm ²		
b	d = h - a	Msd	Vsd	Nsd	MRd,lim	μ_{sd}	ω	As1	As2
(CM)	(CM)	(KNM)	(KN)	(KN)	(KNM)			(CM ²)	(CM ²)
100	21,0	12,77	43,78	0,00	188,92	0,017	0,010	0,83	0,00

IZBOR ARMATURE:

						AMIN = $b * d * 0,0015 =$	3,15		
						As1,poth =	3,15	ILI MREŽA:	
VAN I UNUTRA:	(As1 =	7	Φ 8	(As =	As =	3,5 cm ²	Q -		
					e (CM) =	14,3		335	
					As2,poth =	3,15			
RAZDJELNA ARM	(As2 =	7	Φ 8	(As =	As =	3,5 cm ²	Q -		
					e (CM) =	14,3		335	
						+ DODATNO	0	Φ 0	
POSMIK EC-2:	Tau, sd = Vsd / (b * 0,85 * d) =					0,02	KN/CM ²	Tau, Rd =	0,03 kN/cm ²
POTREBNE VILICE:	Asw = m * As1 = Tau, sd * b * 100 / f _{yk} =					0,56	CM ² /M	m =	2
RAZMAK	sw = Asw1 * m * 0,85 * d * f _{yk} / Vsd =					178,11	CM ² /M	Asw1 =	0,50 cm ²
USVOJENO						Φ 8	/	100	As(CM ² /M) = 1,00 > Asw

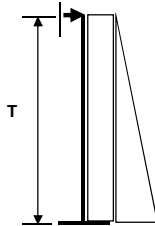
UZDUŽNI ZID LS*H*Dw

PRESJEČNE SILE - HORIZONTALNI SMJER



$$\begin{aligned} LL &= LS - DW = 1,75 \text{ m} \\ QR &= 33,36 \\ MHMAX &= QR * LB^2 / 12 = 8,51 \text{ kNm} \\ RH &= QR * LB / 2 = 29,19 \text{ kN} \end{aligned}$$

PRESJEČNE SILE - VERTIKALNI SMJER



$$\begin{aligned} T &= H - DO/2 - DU/2 = 2,23 \text{ m} \\ QV &= ES(ES1) = 31,93 \\ MVMAX &= QV * T^2 / 8 = 19,76 \text{ kNm} \\ RH &= QR * LB / 2 = 35,52 \text{ kN} \end{aligned}$$

DIMENZIONIRANJE UZDUŽNOG ZIDA -

HORIZONTALNI SMJER

MJERODAVNO!

MJERODAVNI MOMENT

$$M = 8,51 \text{ kNm}$$

MJERODAVNA POPREČNA SILA

$$Q = 29,19 \text{ kN}$$

DIMENZIONIRANJE EC-2

a (CM) =	4,0	fcd = a*fck/gc =	17,0	N/mm2	fyd = fyd/gs =	434,8	N/mm2			
b	d = h-a	Msd	Vsd	Nsd	MRd,lim	μsd	ω	As1	As2	
(CM)	(CM)	(KNM)	(KN)	(KN)	(KNM)			(CM2)	(CM2)	
100	21,0	12,77	43,78	0,00	188,92	0,017	0,010	0,83	0,00	

IZBOR ARMATURE:

$$AMIN = b * d * 0,0015 = 3,15$$

$$As1,potr = 3,15$$

ILI MREŽA:

VANI UNUTRA:	(As1 =	7	Φ 8	(AS =	As =	3,5 cm2	Q -	
					e (CM) =	14,3		335
					As2,potr =	3,15		
RAZDJELNA ARM	(As2 =	7	Φ 8	(AS =	As =	3,5 cm2	Q -	
					e (CM) =	14,3		335

POSMIK EC-2:

$$\tau_{sd} = Vsd / (b * 0,85 * d) = 0,02$$

KN/CM2

$$\tau_{sd} = 0,02$$

kN/cm²

POTREBNE VILICE:

$$Asw = m * As1 = \tau_{sd} * b * 100 / f_{yd} = 0,56$$

CM2/M

$$m = 2$$

RAZMAK

$$s_w = Asw1 * m * 0,85 * d * f_{yd} / Vsd = 178,11$$

CM2/M

$$Asw1 = 0,50$$

cm2

USVOJENO

$$\Phi$$

$$8$$

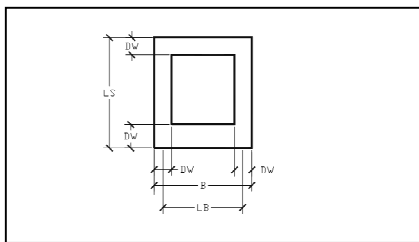
$$/$$

$$100$$

$$As(CM2/M) = 1,00$$

> Asw

PLOČA DNA OKNA/CS



OPTEREĆENJE

OD NADSLOJA..	GE = HE * GAMA =	1,52 kN/m ²
OD PLOČE...	GD = DO * 25 =	6,25 kN/m ²
OD ZIDOVA...	GW = DW*(H-DO-DU)*25/B =	12,50 kN/m ²
OD VODE...	QGW = HW*10 =	0,00 kN/m ²
OD POKRETNOSTI..	PDU = 2*RP/B =	26,50 kN/m ²
UKUPNO OPTEREĆENJE PLOČE DNA	QS =	46,77 kN/m ²

NAPONI NA TEMELJNOM TLU :

$$\text{Sigma} = \text{QS} + \text{DU} \cdot 25 + (\text{H} - \text{DO} - \text{DU}) \cdot 10 = 73,02 \text{ kN/m}^2$$

KRIŽNO ARMIRANA PLOČA - PREMA LOESERU:

RASPON:	LB = B - DW =	1,75 m
	LL = LS - DW =	1,75 m
ODNOS RASPONA:	LL / LB =	1,00 m

KOEF. SMANJENJA - PREMA LOESER-U:

$$\text{VS} = 1 - (5/6) \cdot (\text{LB}^2 \cdot \text{LL}^2) / (\text{LB}^4 + \text{LL}^4) = 0,58$$

MJERODAVNO OPTEREĆENJE ZA SMJER LB:

$$\text{QB} = \text{VS} \cdot \text{QS} = 27,28 \text{ kN/m}^2$$

PRESJEČNE SILE

MOMENT	MS = QB * LB^2 / 8 =	10,44 kNm
REAKCIJA	RS = QB * LB / 2 =	23,87 kN

DIMENZIONIRANJE - GORNJA ZONA

DIMENZIONIRANJE EC-2

a (CM) =	4,0	fcd = a*fck/gc =	17,0	N/mm ²	fyd = fy/d/gs =	434,8	N/mm ²			
b	d = h-a	Msd	Vsd	Nsd	MRd,lim	μsd	ω	As1	As2	
(CM)	(CM)	(KNM)	(KN)	(KN)	(KNM)			(CM ²)	(CM ²)	
100	21,0	15,67	35,81	0,00	188,92	0,021	0,020	1,67	0,00	

IZBOR ARMATURE:

IZBOR ARMATURE:						AMIN = b*d*0,0015 =	3,15			
						As1,potr =	3,15	ILI MREŽA:		
VANI UNUTRA:	(As1 =	7	Φ 8	(As =	As =	3,5 cm2	Q -			
						e (CM) =	14,3	335		
						As2,potr =	3,15			
RAZDJEJNA ARM	(As2 =	7	Φ 8	(As =	As =	3,5 cm2	Q -			
						e (CM) =	14,3	335		
						.+DODATNA				
POSMIK EC-2:	Tau,sd = Vsd / (b * 0,85 * d) =					0,02	kN/vm²	Tau,Rd =	0,03	kN/cm²
POTREBNE VILICE:	Asw = m * As1 = Tau,sd * b * 100 / fyd =					0,46	CM2/M	m =	2	
RAZMAK	sw = Asw1 * m * 0,85 * d * fyd / Vsd =					0,00	CM2/M	Asw1 =	0,00	cm2
USVOJENO	Φ	0	/	0			As(CM2/M) =	#DIV/0!	> Asw	