

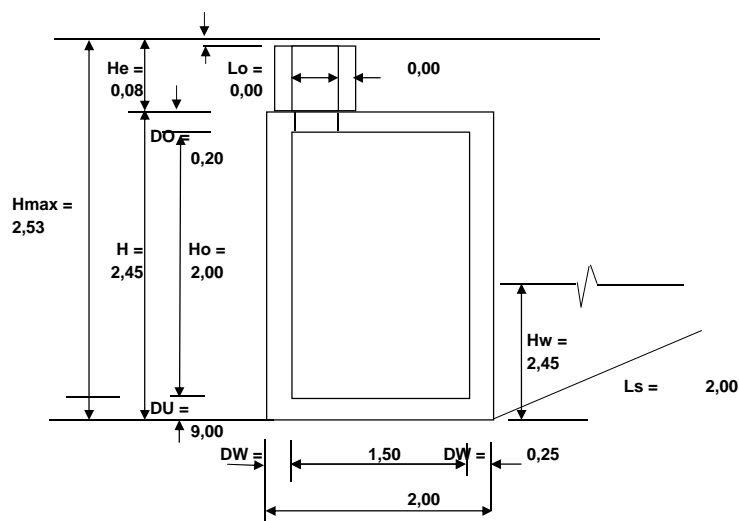
PRORAČUN - PREMA HRN EN 1992-1 EC-2

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

BETON: C 30/37

ARMATURA: B 500

SKICA



DIMENZIJE

NADSLOJ	0,08	m
ŠIRINA OKNA/CS	2,00	m
DUŽINA OKNA/CS	2,00	m
VISINA OKNA/CS	2,45	m
DEBLJINA GOR. PLOČE	0,20	m
DEBLJINA DONJE. PLOČE	0,25	m
DEBLJINA ZIDA	0,25	m
VISINA PODZ.VODE	2,45	m
ZAP.TEŽ.TLA	19,00	kN/m³
KUT UNUT.TRENJA	30,00	0
ZAP.TEŽ.POD VODOM	9,00	kN/m³

$$k_a = (\tan(45 - \alpha/2))^2 = 0,333$$

$$k_m = 1 - \sin(\alpha) = 0,500$$

PROMETNO OPTEREĆENJE EC1

MODEL 1

OSOVINSKO OPTEREĆENJE	300	kN
KOEF.SMANJENJA	9,00	kN/m²
OPTEREĆENJE KOTAČA	0,80	kN
	120	kN

OPTEREĆENJE VOZILA :

EKVIV. OPTER. SLW -	615	kN
	60	kN/m²
	5,00	kN/m²

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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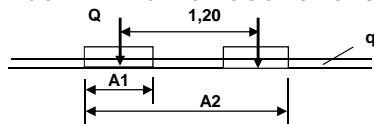
POKRETNOST OPTEREĆENJE.	$Q = P =$	120	kN
	$P1 = Q1 / F =$	9,76	kN/m ²

STALNO OPTEREĆENJE

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

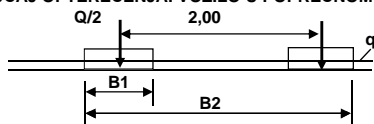
POKRETNOST OPTEREĆENJE

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

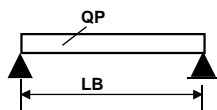
POVRŠINA:	$F1 = A1 * B1 =$	6,15	m ²
	$F2 = A2 * B2 =$	16,49	m ²

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 POKRETNO OPTEREĆENJE:

$QP = 23,56$ kN/m²



$Q_{max} = QG + QP = 30,08$ kN/m²

$LB = B - DW = 1,75$ m

REAKCIJA
MOMENT

$RP = QP \cdot LB / 2 = 20,50$ kN
 $MP = QP \cdot LB^2 / 8 = 14,91$ kNm

REAKCIJA
MOMENT

$R_{MAX} = RG + RP = 33,84$ kN
 $MP_{MAX} = MG + MP = 19,03$ kNm

DIMENZIONIRANJE GORNJE PLOČE

MAX. REAKCIJA
MAX. MOMENT

$R_{MAX} = RG + RP = 33,84$ kN
 $MP_{MAX} = MG + MP = 19,03$ kNm

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

BETON:				ARMATURA:			
$b/h =$	100,0	20,0	CM MB	40		B-500	
$a =$	4,5			C30/37			
		0,85	$f_{ck} =$	30,0	N/mm ²	$f_{yd} =$	500,0
			$f_{cd} = a \cdot f_{ck} / \gamma_c =$	17,0	N/mm ²	$f_{yd} = f_{yd} / \gamma_s =$	434,8
			KOEF.SIG.OPTER.			KOEF.SIG.BETON I ARMAT	
			$\gamma_g =$	1,35		$\gamma_c =$	1,50
			$\gamma_s =$	1,50		$\gamma_s =$	1,15
			$M_{sd} = 1,35 \cdot M_g + 1,5 \cdot M_p$		Nsd = 1,35*Ng+1,5*Np		

PRESJEČNE SILE

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

$M_{Rd,lim} = m_{lim} \cdot (b \cdot d^2) \cdot f_{cd} = 102,92$ kNm
 $m_{lim} = 0,252$ EC-2

$D M = M_{sd} - M_{Rd,lim} =$
 $As2 = D M / ((d-d2) \cdot f_{yd}) =$

DIMENZIONIRANJE EC-2

a (cm) =	4,5	$f_{cd} = a \cdot f_{ck} / \gamma_c =$	17,0	$f_{yd} = f_{yd} / \gamma_s =$	434,8	N/mm ²			
b	$d = h - a$	M_{sd}	V_{sd}	N_{sd}	$M_{Rd,lim}$	μ_{sd}	ω	$As1$	$As2$
(CM)	(CM)	(KNM)	(KN)	(KN)	(KNM)			(cm ²)	(cm ²)
100	15,5	28,55	50,00	4,00	102,92	0,070	0,062	3,77	0,00

IZBOR ARMATURE:

				$AMIN = b \cdot d \cdot 0,0015 =$	2,33				
				$As1,potr =$	3,77	ILI MREŽA:			
DOLJE:	($As1 =$	8	$\Phi 8$	($As =$	$As =$	4,0 cm ²	$Q -$		
					e (cm) =	12,5		385	
					$As2,potr =$	3,77			
GORE:	($As2 =$	8	$\Phi 8$	($As =$	$As =$	4,0 cm ²	$Q -$		
					e (cm) =	12,5		385	

POSMIK EC-2:

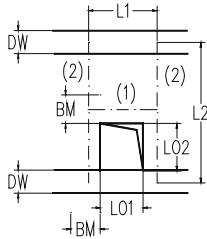
POTREBNE VILICE:

RAZMAK

USVOJENO

$\tau_{u,sd} = V_{sd} / (b \cdot 0,85 \cdot d) = 0,04$ KN/CM²
 $\tau_{u,Rd} = 0,03$ KN/CM²
 $Asw = m \cdot As1 = \tau_{u,sd} \cdot b \cdot 100 / f_{yd} = 0,87$ CM²/M
 $m = 0$
 $sw = Asw1 \cdot m \cdot 0,85 \cdot d \cdot f_{yd} / V_{sd} = 0,00$ CM²/M
 $Asw1 = 0,00$ cm²
 $As(CM2/M) = 0,00 > Asw$

NOSACI U PLOCI OKO OTVORA: 60/60 cm



OTVOR L01 =	0,60	m
L02 =	0,60	m
NOSAČ L1 =	2,25	m
NOSAČ L2 =	1,60	m
ŠIRINA NOSAČA BM =	0,50	m

NOSAČ 1

$L1 = L01 + BM =$	1,10	m
$Q1 = QD \cdot (L2 - L02) / 2 + P1 / L1 =$	29,93	kN/m
$R1 \text{ MAX} = Q1 \cdot L1 / 2 =$	33,67	kN
$M1 \text{ MAX} = Q1 \cdot L1^2 / 8 =$	4,53	kNm

DIMENZIONIRANJE EC-2

$a \text{ (CM)} =$	4,5	$fcd = a \cdot fck / gc =$	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	15,5	6,79	50,50	0,00	51,46	0,033	0,031	0,93	0,00	

IZBOR ARMATURE:

				$AMIN = b \cdot d \cdot 0,0015 =$	1,16					
				$As1,potr =$	1,16					
DOLJE:	(As1 =	2	Φ 12	(AS =	As =	2,3 cm ²	Q -			
					e (CM) =	25,0				
					$As2,potr =$	1,16				
GORE:	(As2 =	2	Φ 12	(AS =	As =	2,3 cm ²	Q -			
					e (CM) =	25,0				

POSMIK EC-2:

POTREBNE VILICE:

RAZMAK

USVOJENO

$Tau, sd = Vsd / (b \cdot 0,85 \cdot d) =$	0,08	KN/CM ²	$Tau, Rd =$	0,03	kN/cm ²
$Asw = m \cdot As1 = Tau, sd \cdot b \cdot 100 / fyd =$	0,88	CM ² /M	$m =$	2	
$sw = Asw1 \cdot m \cdot 0,85 \cdot d \cdot fyd / Vsd =$	0,00	CM ² /M	$Asw1 =$	0,50	cm ²
	Φ	8	/	15	(AS = 6,70 cm ²)

NOSAČ 2

$L2 = L + DW =$	1,60	m
$R2 \text{ MAX} = RMAX \cdot BM + R1 \cdot (L2 - L02) / L2 =$	37,96	kN
$M2 \text{ MAX} = MMAX \cdot BM + R1 \cdot (L2 - L02 + BM/2) \cdot (L02 + BM/2) / L2 =$	31,87	kNm

DIMENZIONIRANJE EC-2

$fcd = a \cdot fck / gc =$	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	15,5	47,81	56,94	0,00	51,46	0,234	0,267	8,08	0,00	

IZBOR ARMATURE:

				$AMIN = b \cdot d \cdot 0,0015 =$	1,16					
				$As1,potr =$	8,08					
DOLJE:	(As1 =	4	Φ 16	(AS =	As =	8,0 cm ²	Q -			
					e (CM) =	12,5				
					$As2,potr =$	8,08				
GORE:	(As2 =	2	Φ 16	(AS =	As =	4,0 cm ²	Q -			
					e (CM) =	25,0				

POSMIK EC-2:

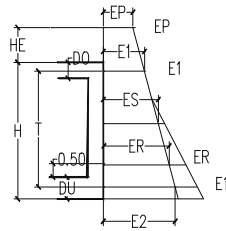
POTREBNE VILICE:

RAZMAK

USVOJENO

$Tau, sd = Vsd / (b \cdot 0,85 \cdot d) =$	0,09	KN/CM ²	$Tau, Rd =$	0,03	kN/cm ²
$Asw = m \cdot As1 = Tau, sd \cdot b \cdot 100 / fyd =$	0,99	CM ² /M	$m =$	2	
$sw = Asw1 \cdot m \cdot 0,85 \cdot d \cdot fyd / Vsd =$	0,12	CM ² /M	$Asw1 =$	0,50	cm ²
	Φ	8	/	15	$As(CM^2/M) = 6,70 > Asw$

ZIDOVI OKNA/CS - POTISAK TLA I VODE IZVANA



KOEF.MIRNOG POTISKA TLA
POTISAK TLA

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

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

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

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

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

$$W1 = 10 \cdot HW = 24,50 \text{ kN/m}^2$$

$$WS = 10 \cdot (HW - H/2) = 12,25 \text{ kN/m}^2$$

POTISAK TLA U TEŽIŠTU ZIDA
PRITISAK VODE

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

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

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

U VODI

$$W1R = 10 \cdot (HW - 0,50) = 19,50 \text{ kN/m}^2$$

$$ER1 = EP + \gamma \cdot (HE + DO/2 + T - 0,50) \cdot K_o + W1R = 32,86 \text{ kN/m}^2$$

$$ES1 = EP + \gamma \cdot (HE + DO/2 + T/2) \cdot K_o + WS = 31,43 \text{ kN/m}^2$$

POTISAK OD POKRETNOSTI OPTEREĆENJA U TEŽIŠTU ZIDA

POKRETNOST: PROPISI EC-1

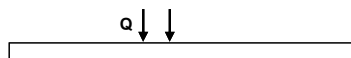
HRN EN 1991-1

Težina vozila:

615

kN

EKVIV.OPT.PREMA DIN 1072 SLW = 60



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

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

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

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

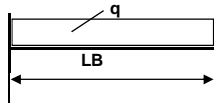
$$PS = SQ / FR = 26,71 \text{ kN/m}^2$$

MJERODAVNO OPTEREĆENJE ZIDA

$$QR = ER(ER1) = 32,86 \text{ kN/m}^2$$

POPREČNI ZID B*H*Dw

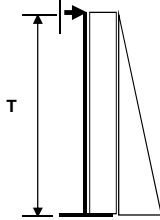
PRESJEČNE SILE - HORIZONTALNI SMJER



$$\begin{aligned} LB &= B - DW = 1,75 & \text{m} \\ QR &= 32,86 \\ MHMAX &= QR * LB^2 / 12 = 8,39 & \text{kNm} \\ RH &= QR * LB / 2 = 28,75 & \text{kN} \end{aligned}$$

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PRESJEČNE SILE - VERTIKALNI SMJER



$$\begin{aligned} T &= H - DO/2 - DU/2 = 2,23 & \text{m} \\ QV &= ES(ES1) = 31,43 \\ MVMAX &= QV * T^2 / 8 = 19,45 & \text{kNm} \\ RH &= QR * LB / 2 = 34,96 & \text{kN} \end{aligned}$$

DIMENZIONIRANJE POPREČNOG ZIDA -

HORIZONTALNI SMJER

MJERODAVNO!

MJERODAVNI MOMENT
MJERODAVNA POPREČNA SILA

$$\begin{aligned} M &= 8,39 & \text{kNm} \\ Q &= 28,75 & \text{kN} \end{aligned}$$

DIMENZIONIRANJE EC-2

a (CM) =	4,5	fcd = α*fck/gc =	17,0	N/mm2	fyd = fy/dgs =	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	20,5	12,58	43,13	0,00	180,04	0,018	0,010	0,81	0,00	

IZBOR ARMATURE:

$$AMIN = b * d * 0,0015 = 3,08$$

$$As1,potr = 3,08$$

VAN I UNUTRA:	(As1 =	7	Φ 8	(AS =	As =	3,5 cm2	Q -	
					e (CM) =	14,3		335
					As2,potr =	3,08		
RAZDJEJNA ARM:	(As2 =	7	Φ 8	(AS =	As =	3,5 cm2	Q -	
					e (CM) =	14,3		335

POSMIK EC-2:

POTREBNE VILICE:

RAZMAK

USVOJENO

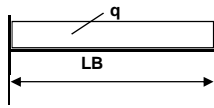
$$\begin{aligned} \tau_{sd} &= Vsd / (b * 0,85 * d) = 0,02 & \text{KN/CM2} \\ Asw &= m * As1 = \tau_{sd} * b * 100 / fyd = 0,57 & \text{CM2/M} \\ sw &= Asw1 * m * 0,85 * d * fyd / Vsd = 176,51 & \text{CM2/M} \end{aligned}$$

+.DODATNO

$$\begin{aligned} \tau_{sd} &= 0,03 & \text{kN/cm}^2 \\ m &= 2 \\ Asw1 &= 0,50 & \text{cm2} \\ As(CM2/M) &= 1,00 & > Asw \end{aligned}$$

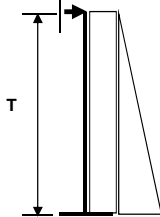
UZDUŽNI ZID LS*H*Dw

PRESJEČNE SILE - HORIZONTALNI SMJER



$$\begin{aligned} LL &= LS - DW = 1,75 & \text{m} \\ QR &= 32,86 \\ MHMAX &= QR * LB^2 / 12 = 8,39 & \text{kNm} \\ RH &= QR * LB / 2 = 28,75 & \text{kN} \end{aligned}$$

PRESJEČNE SILE - VERTIKALNI SMJER



$$\begin{aligned} T &= H - DO/2 - DU/2 = 2,23 & \text{m} \\ QV &= ES(ES1) = 31,43 \\ MVMAX &= QV * T^2 / 8 = 19,45 & \text{kNm} \\ RH &= QR * LB / 2 = 34,96 & \text{kN} \end{aligned}$$

DIMENZIONIRANJE UZDUŽNOG ZIDA -

HORIZONTALNI SMJER

MJERODAVNO!

MJERODAVNI MOMENT
MJERODAVNA POPREČNA SILA

$$\begin{aligned} M &= 8,39 & \text{KNM} \\ Q &= 28,75 & \text{KNM} \end{aligned}$$

DIMENZIONIRANJE EC-2

a (CM) =	4,5	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	20,5	12,58	43,13	0,00	180,04	0,018	0,010	0,81	0,00

IZBOR ARMATURE:

$$AMIN = b * d * 0,0015 = 3,08$$

$$As1,potr = 3,08$$

ILI MREŽA:

VANI UNUTRA:	(As1 =	7	Φ 8	(As =	As =	3,5 cm2	Q -	
					e (CM) =	14,3		335
					As2,potr =	3,08		
RAZDJEJNA ARM:	(As2 =	7	Φ 8	(As =	As =	3,5 cm2	Q -	
					e (CM) =	14,3		335

POSMIK EC-2:

POTREBNE VILICE:

RAZMAK

USVOJENO

$$\begin{aligned} \tau_{sd} &= Vsd / (b * 0,85 * d) = 0,02 & \text{KN/CM2} \\ Asw &= m * As1 = \tau_{sd} * b * 100 / f_{yd} = 0,57 & \text{CM2/M} \\ sw &= Asw1 * m * 0,85 * d * f_{yd} / Vsd = 176,51 & \text{CM2/M} \end{aligned}$$

Φ	8	/	100
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+.DODATNO

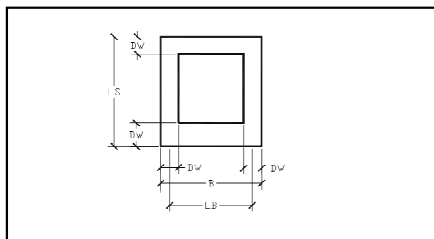
$$\tau_{sd} = 0,03 \text{ kN/cm}^2$$

$$m = 2$$

$$Asw1 = 0,50 \text{ cm2}$$

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

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*2/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 :

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

KRIŽNO ARMIRANA PLOČA - PREMA LOESERU:

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RASPON:	LB = B - DW =	1,75	m
ODNOS RASPONA:	LL = LS - DW =	1,75	m
KOEF. SMANJENJA - PREMA LOESER-U:	LL / LB =	1,00	m
VS = 1 - (5/6)*(LB^2*LL^2)/(LB^4+LL^4) =			
0,58			
MJERODAVNO OPTEREĆENJE ZA SMJER LB:	QB = VS*QS =	27,28	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) =		4,5	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	20.5	15.67	35.81	0.00	180.04	0.022	0.020	1.63	0.00			

IZBOR ARMATURE:

RAZDOR ARMATURE:					AMIN = b * d * 0,0015 =		3,08			
					As1,potr =		3,08	ILI MREŽA:		
VANI UNUTRA:	(As1 =	7	Φ 8	(AS =	As =	3,5 cm2	Q -			
					e (CM) =		14,3		335	
					As2,potr =		3,08			
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 =				0,47	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	