TEHNIČKO VELEUČILIŠTE U ZAGREBU
GRADITELJSKI ODJEL

BETONSKE KONSTRUKCIJE II

AUDITORNE VJEŽBE

Izrada ravninskog modela pomoću programskog paketa TOWER

Zagreb 25. ožujka 2008.

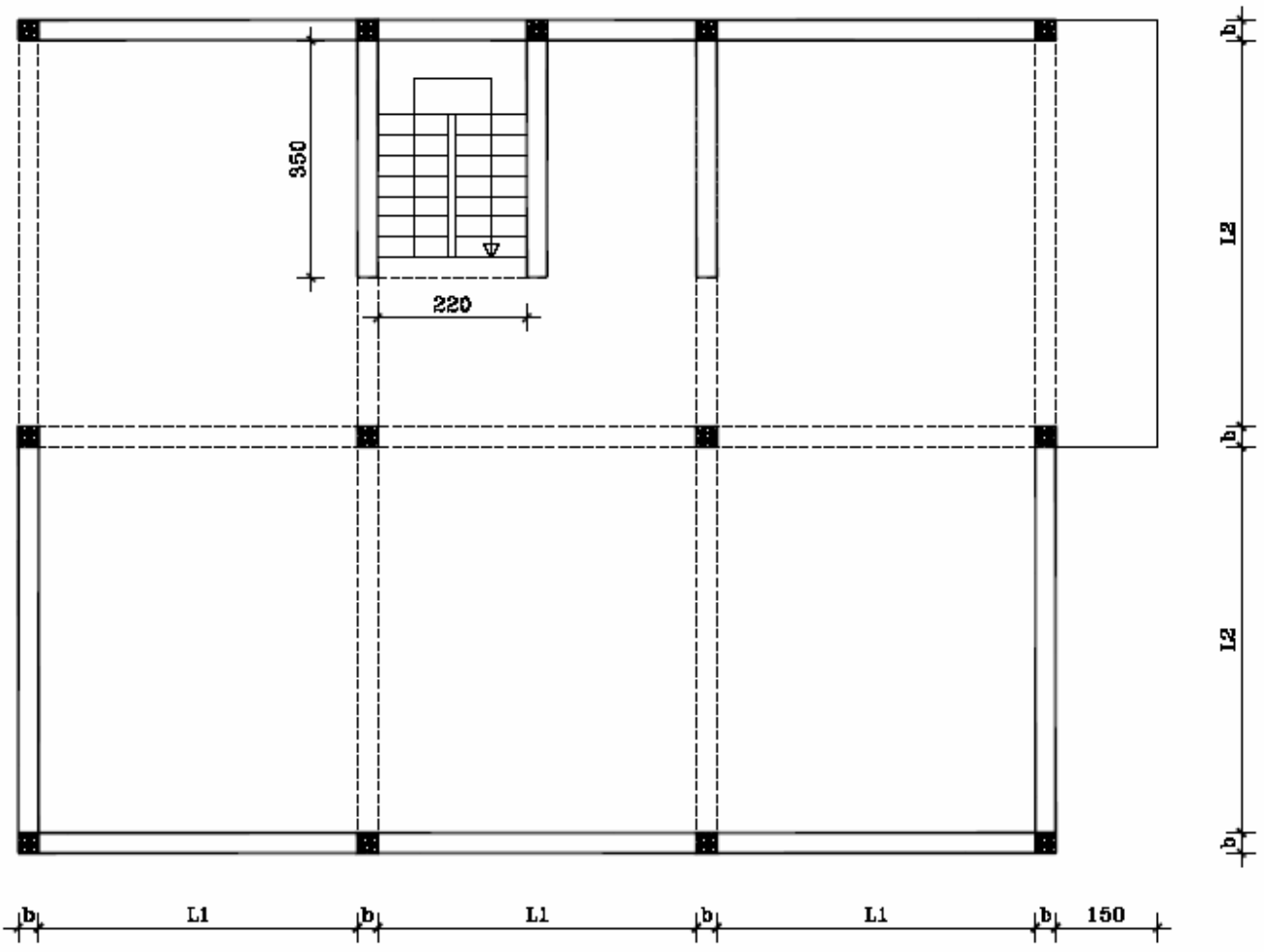
ZADATAK:

Zadano: C25/30, B500, zaštitni sloj c=2.0cm

L1 (m)	L2 (m)	b (cm)	h_0 (cm)	h (cm)	Δg (kN/m2)	q (kN/m2)
6.8	6.6	30	20	50	3.0	3.0

Zadatak:

1. Nacrtati plan oplate.
2. Odrediti armaturu ploče i greda.
3. Nacrtati plan armature ploče i jedne grede.



1. KREIRANJE MODELA

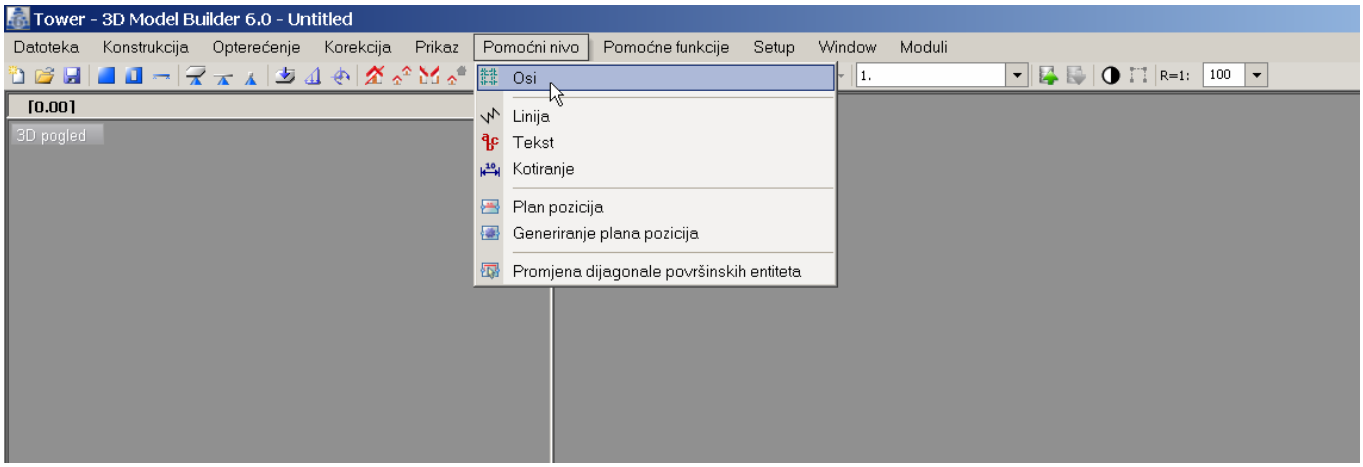
Neke osnovne napomene
Potvrda naredbe – ENTER ili DESNI KLIK MIŠA
Izlaz iz naredbe – ESC

Kliknuti DATOTEKA – NOVA

Prije početka modela potrebno je snimiti datoteku: DATOTEKA – SNIMI KAO – IME DATOTEKE

Prvi korak u modeliranju je kreiranje osi, tj.

- ***Crtanje rastera (raspona) osi konstrukcije***



U naredbenoj liniji (donji lijevi kut ekrana) potrebno je upisati L1+b, tj. 3*7.10 i potvrditi sa ENTER

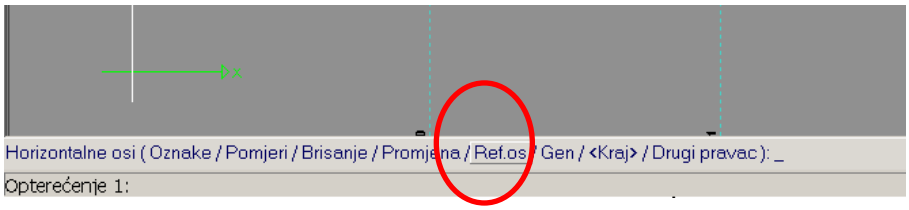


U ovom slučaju aktivirano je crtanje vertikalnih tj. Y osi

Sada je potrebno generirati horizontalne tj. X osi pa je potrebno kliknuti (lijevom tipkom miša) u naredbenu liniju na dio gdje piše **/Drugi pravac** kako bi se modul generiranja Y osi promijenio u modul za generiranje horizontalnih X osi. Ponovno se analogno kao u prethodnom slučaju upiše L2+b tj. 2*6.9

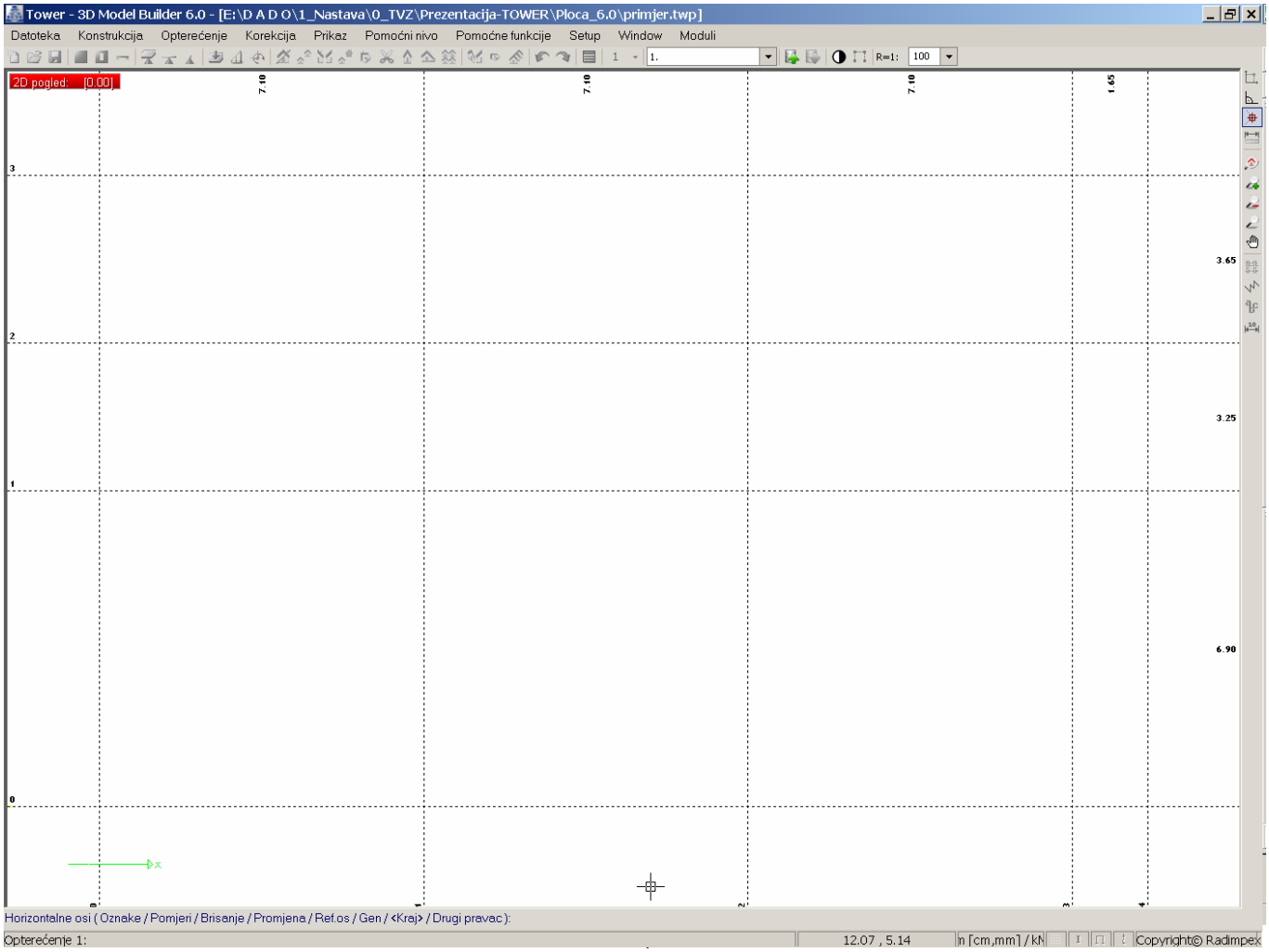


Definiranje osi stubišta i konzolnog dijela ploče.
Ostajemo u modulu generiranja horizontalnih [X] osi, ili ga ponovno pokrenemo odaberemo na naredbenoj liniji:



Zatim kliknemo na gornju horizontalnu os kako bi je odabrali te upišemo @-3.65 kao bi definirali odmak od te osi.
Pređemo u modul generiranja vertikalnih osi [Y] osi odaberemo naredbu kao u prethodnom slučaju odaberemo krajnju desnu vertikalnu os te upišemo @1.65 kako bi definirali odmak od te osi i na isti način definiraju se i druge potrebne osi.

Nakon provedenih operacija ekran izgleda ovako:

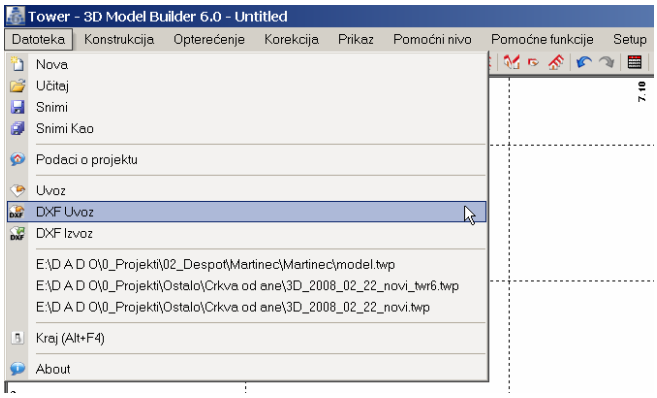


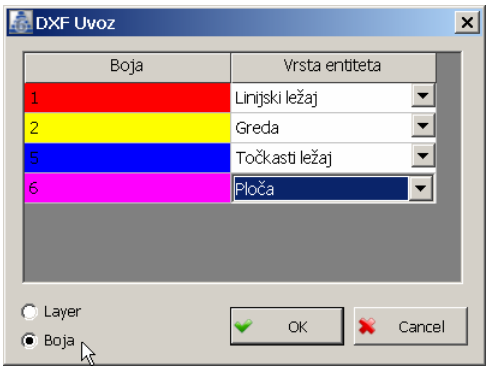
Na taj način definirana je tlocrtna geometriju naše konstrukcije i može se pristupiti modeliranju geometrijskih karakteristika, rubnih uvjeta i opterećenja konstrukcije.

Drugi način unosa geometrije konstrukcije je pomoću uvoza iz dxf. filea tj. geometrija i rasponi (osi) konstrukcije definiraju se u ACAD-u u različitim layerima ili bojama pa kao takvi uvoze u tower.

Napomena: sve konstruktivne elemente, (grede, zidove) potrebno je zadati u posebnom layeru ili boji.

Primjer dxf - uvoza

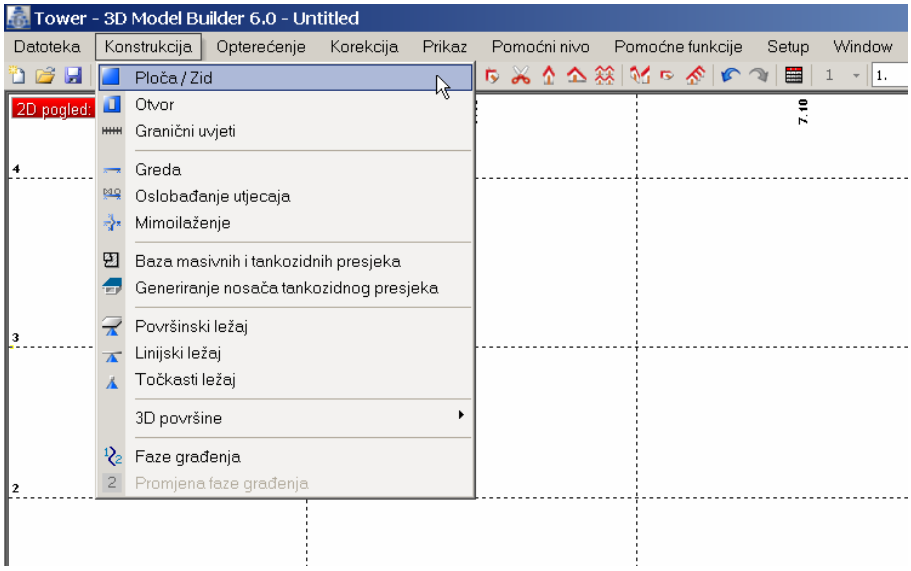




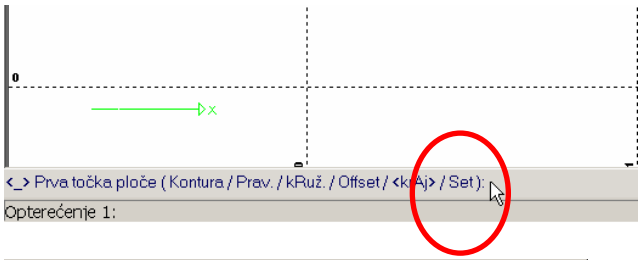
2. DEFINIRANJE GEOMETRIJSKIH KARAKTERISTIKA

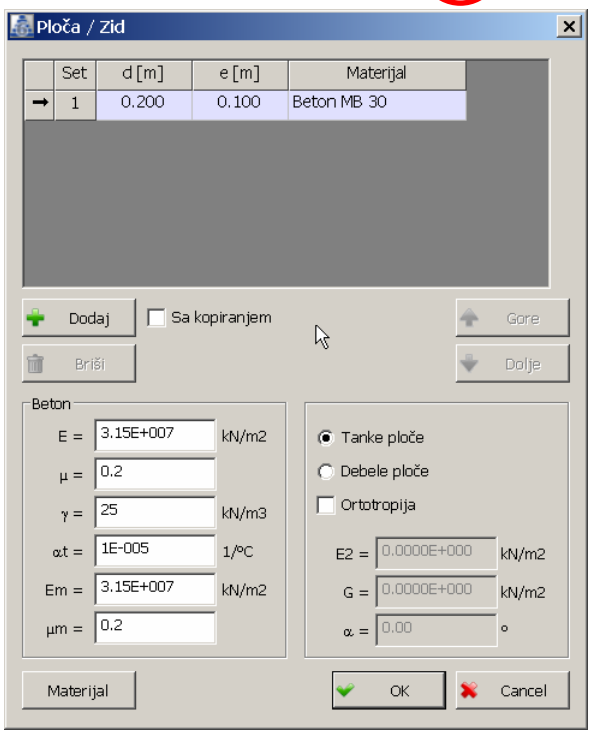
- ***Modeliranje ploče***

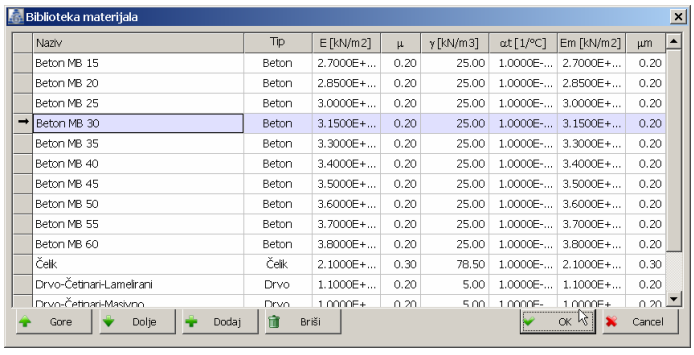
Naredba PLOČA pokreče se preko ikone ili iz padajućeg menu-a



Nakon pokretanja naredbe PLOČA na naredbenoj liniji aktivira se naredba SET pomoću koje se upisuju geometrijske karakteristike ploče (debljina d (cm) i odabire karakteristika materijala (MB 30 za C25/30).



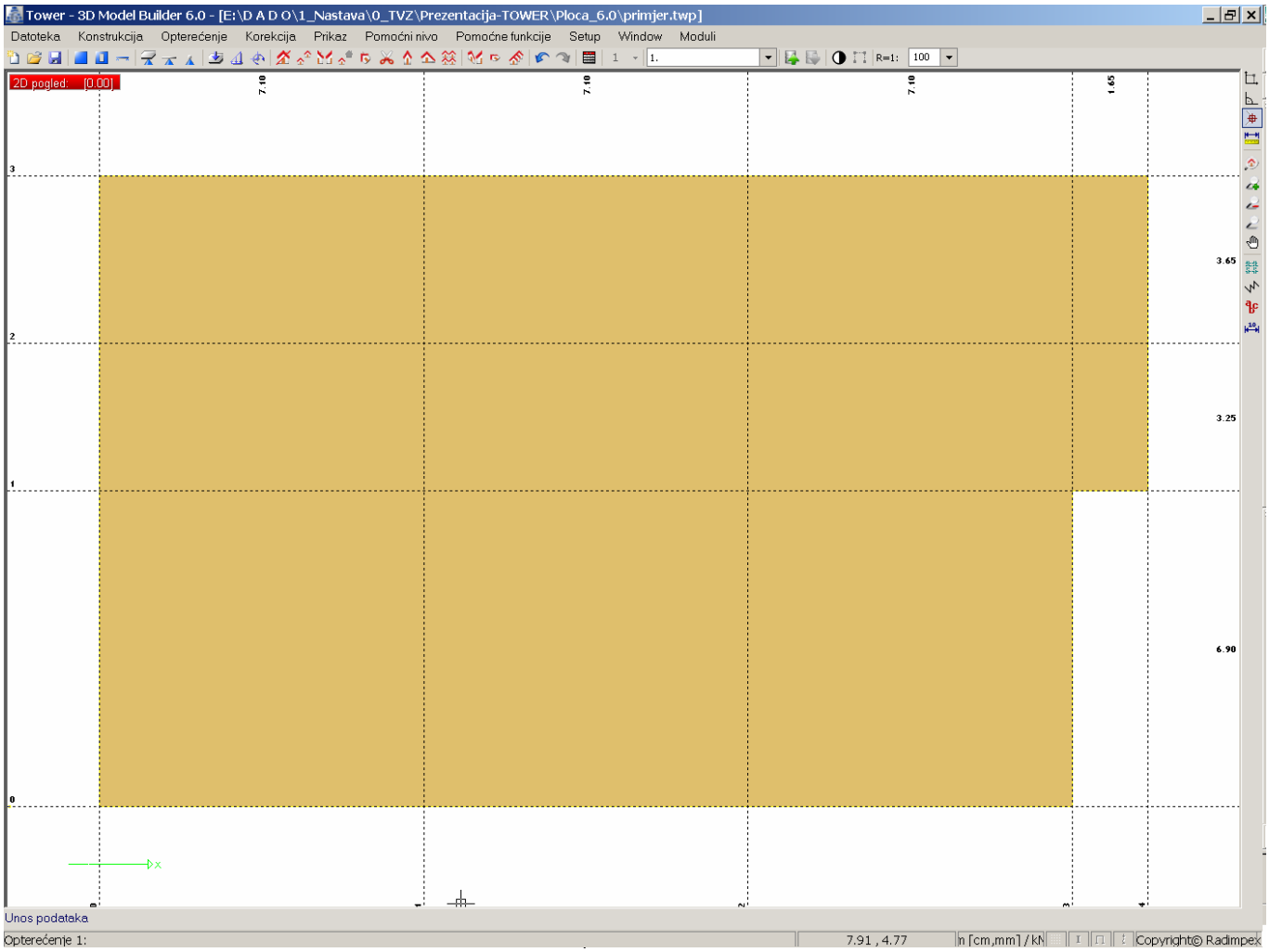




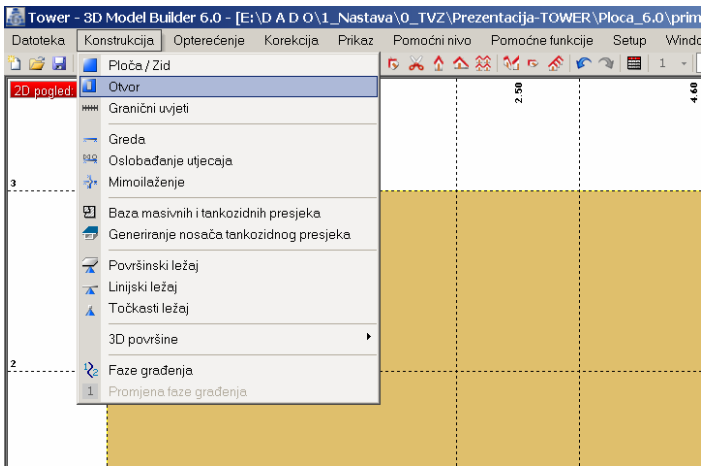
Nakon toga klikom na ikonu s desne strane odabire se „osnap“ za odabir točke koja se nalazi na sjecištu dviju linija i iscrta se kontura ploče.

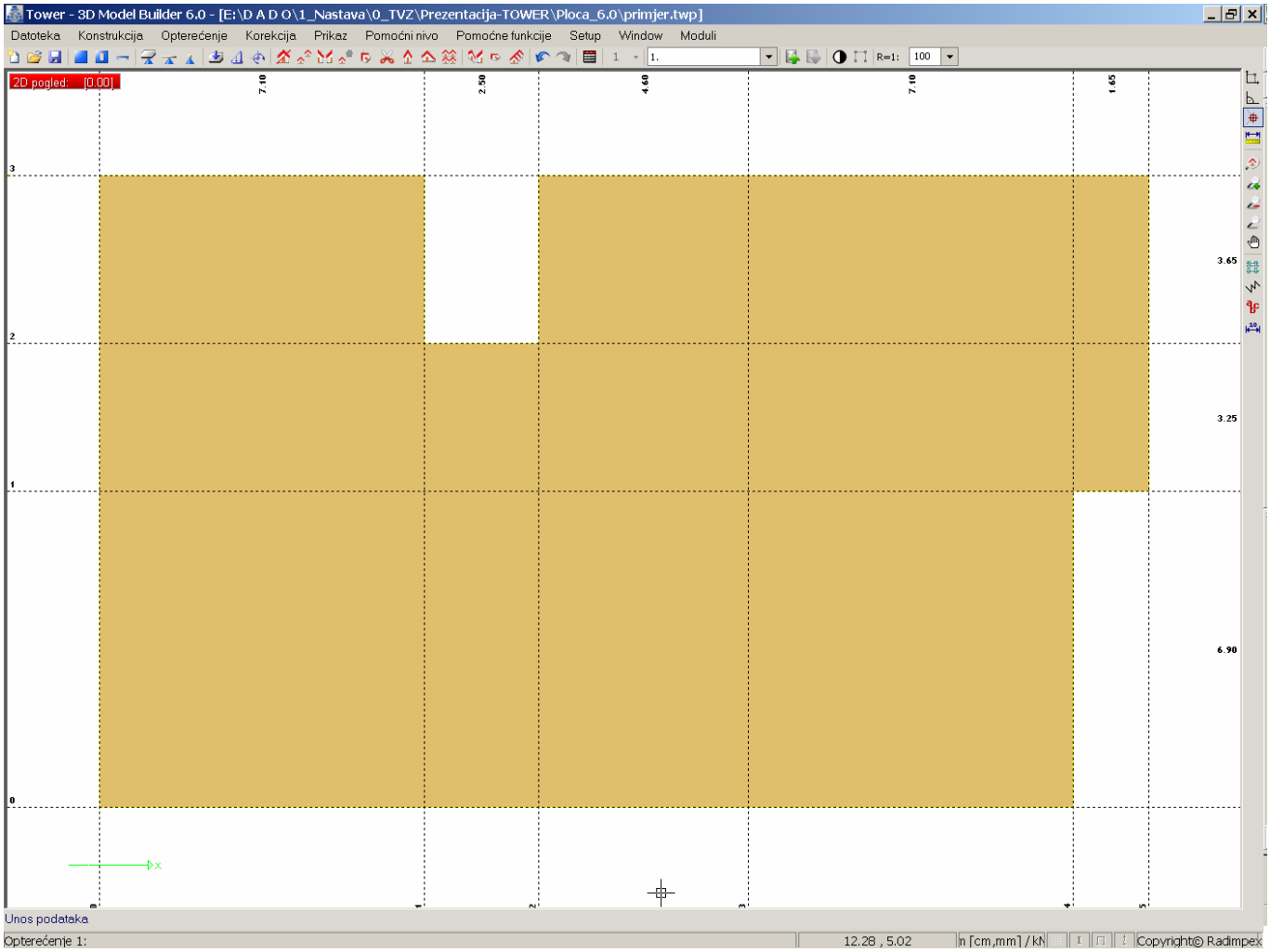
Napomena: isti postupak se provodi i kada se koristi dxf. uvoz ako ploča nije definirana nekim posebnim layerom.

Nakon provedenih operacija ekran izgleda ovako:



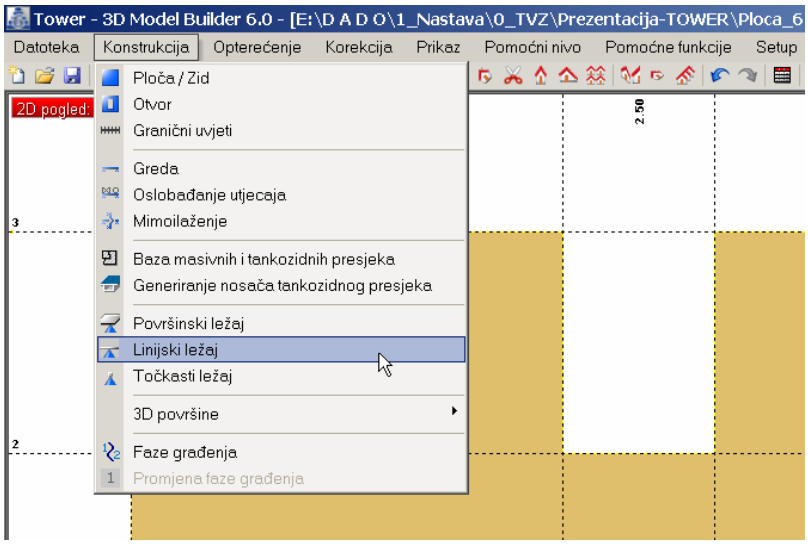
Pomoću naredbe otvor definira se otvor za stubište na isti način kao što se definira i ploča

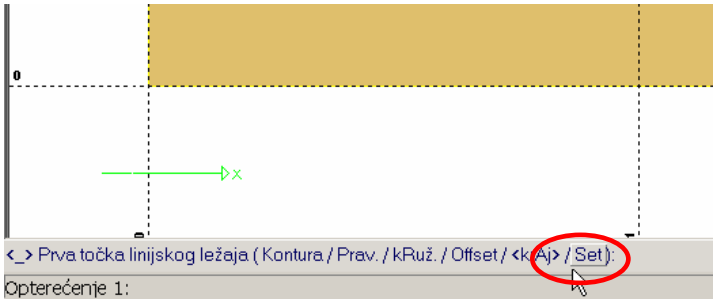




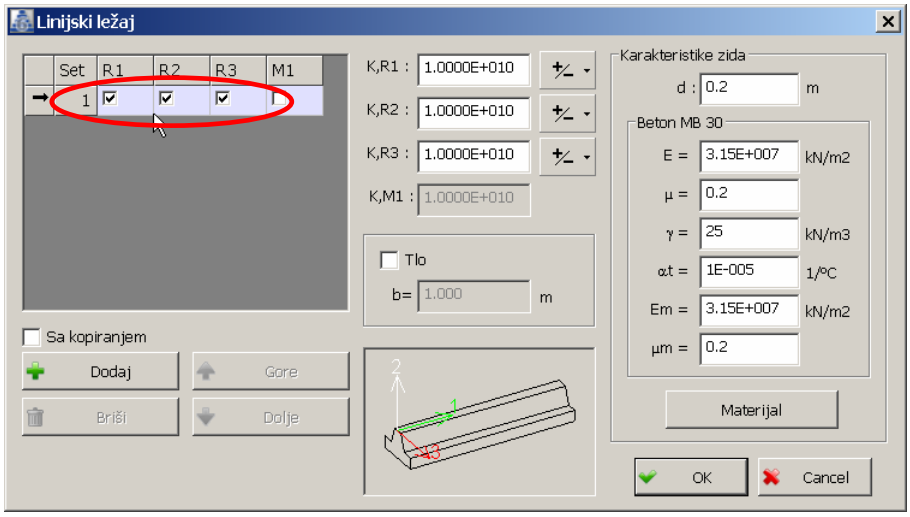
- ***Definiranja rubnih uvjeta, crtanje linijskih i točkastih ležajeva***

Potrebno je pokrenuti naredbu LINIJSKI LEŽAJ,
i zadati stupnjeva slobode te geometriju ležaja

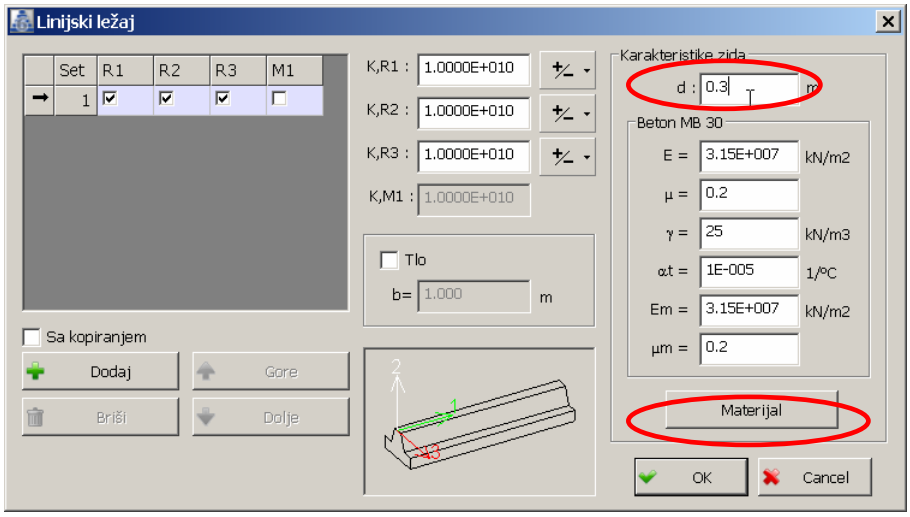




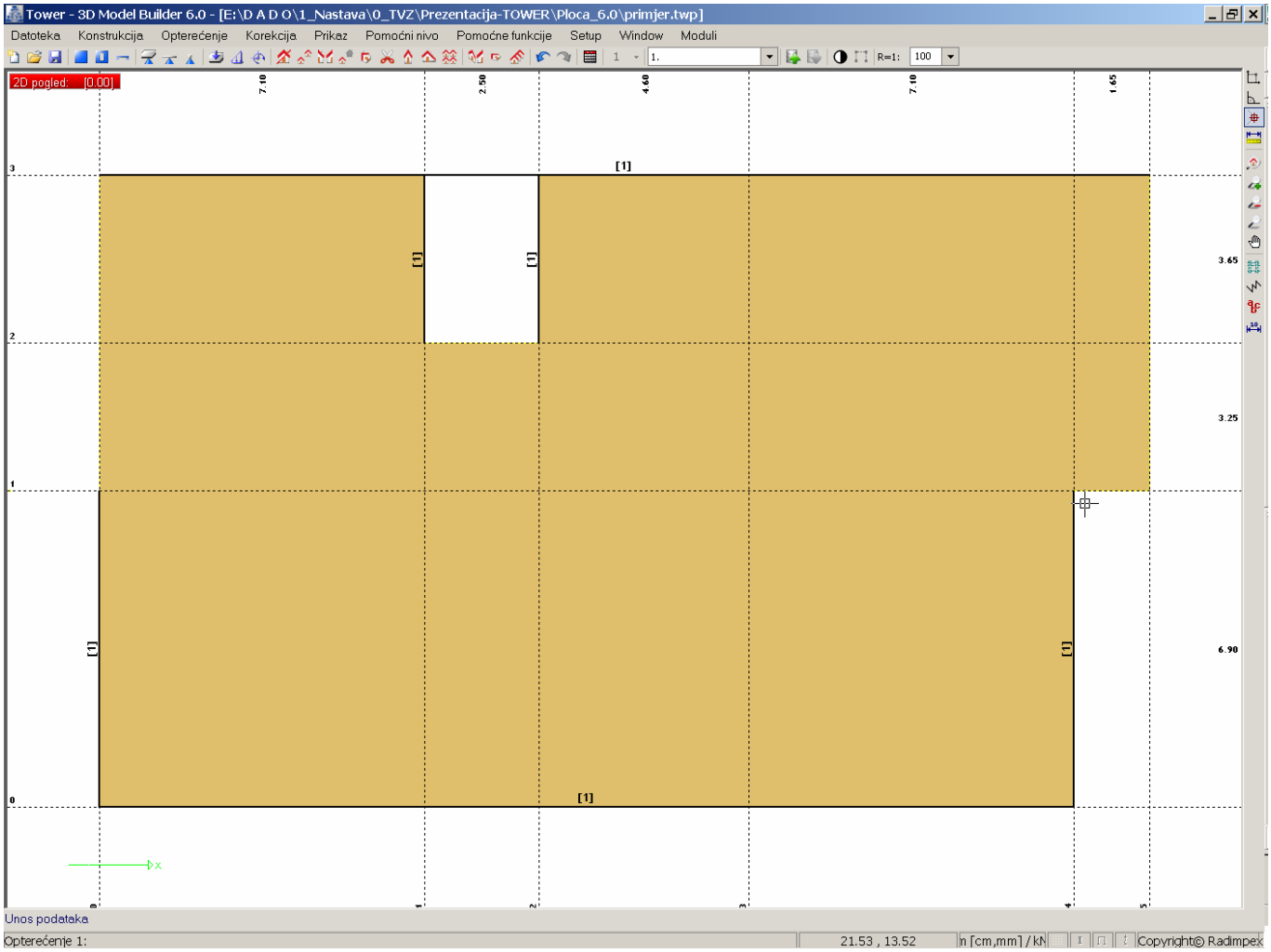
Stupnjevi slobode



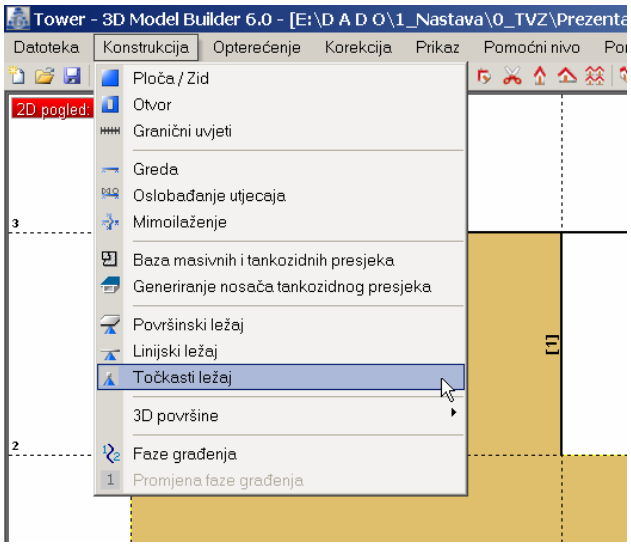
Geometrija

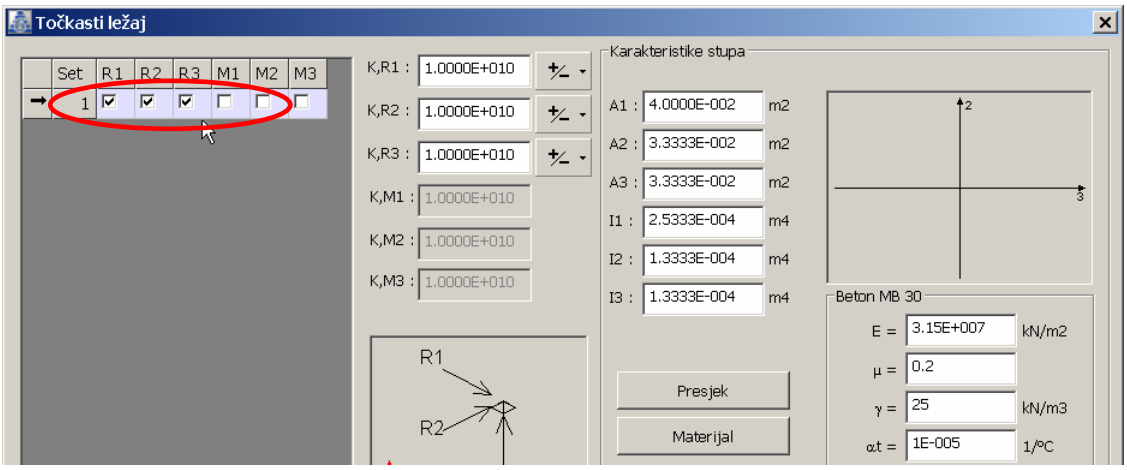


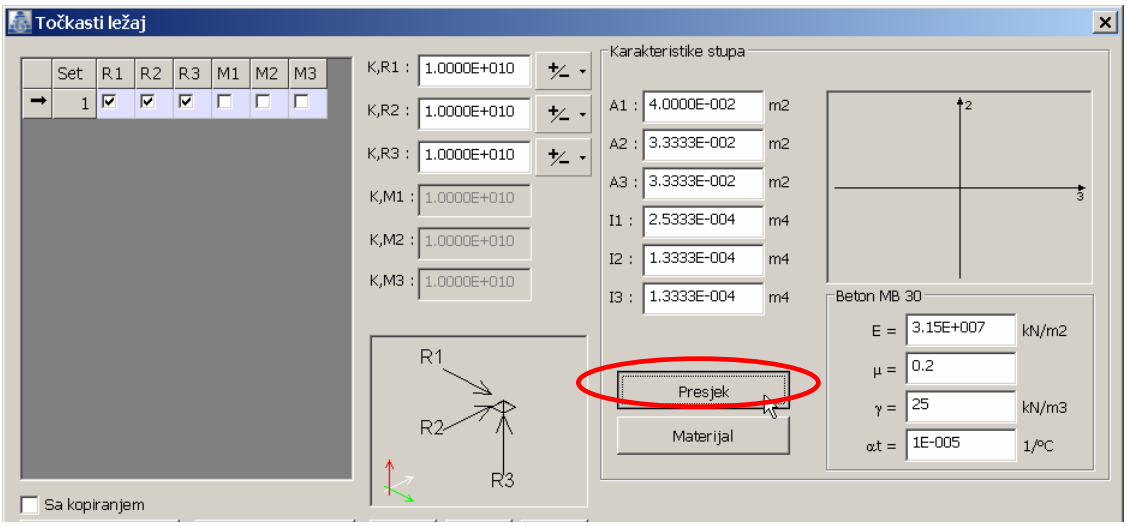
Zatim se iscrtaju linijski ležajevi

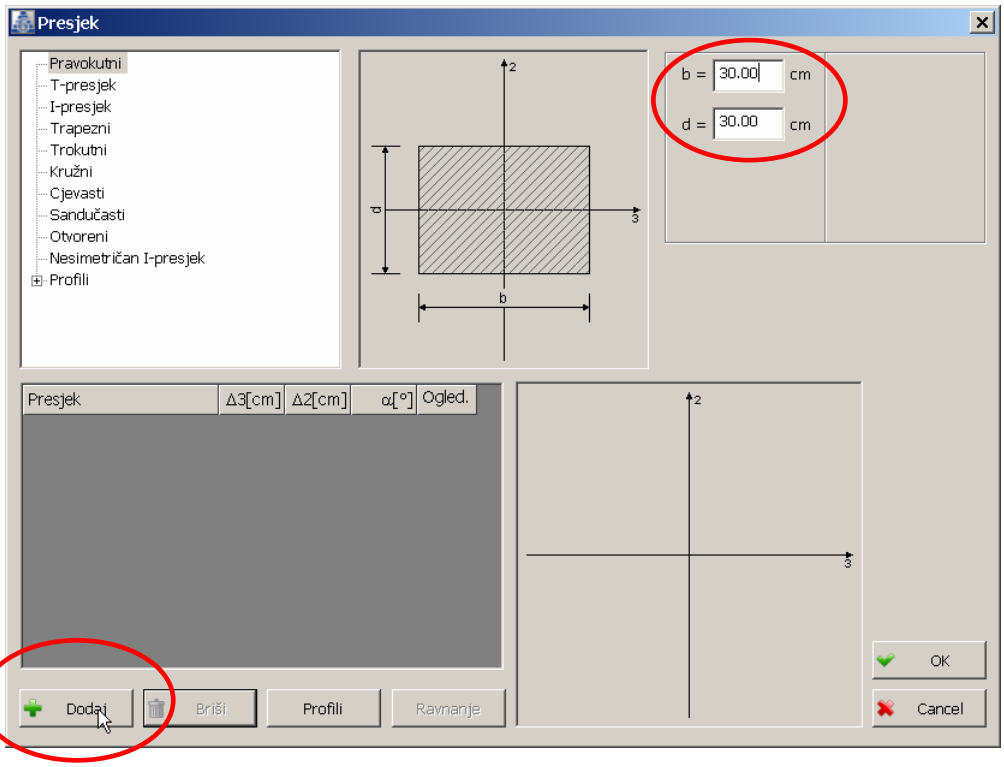


Na isti način se definiraju i točkasti ležajevi

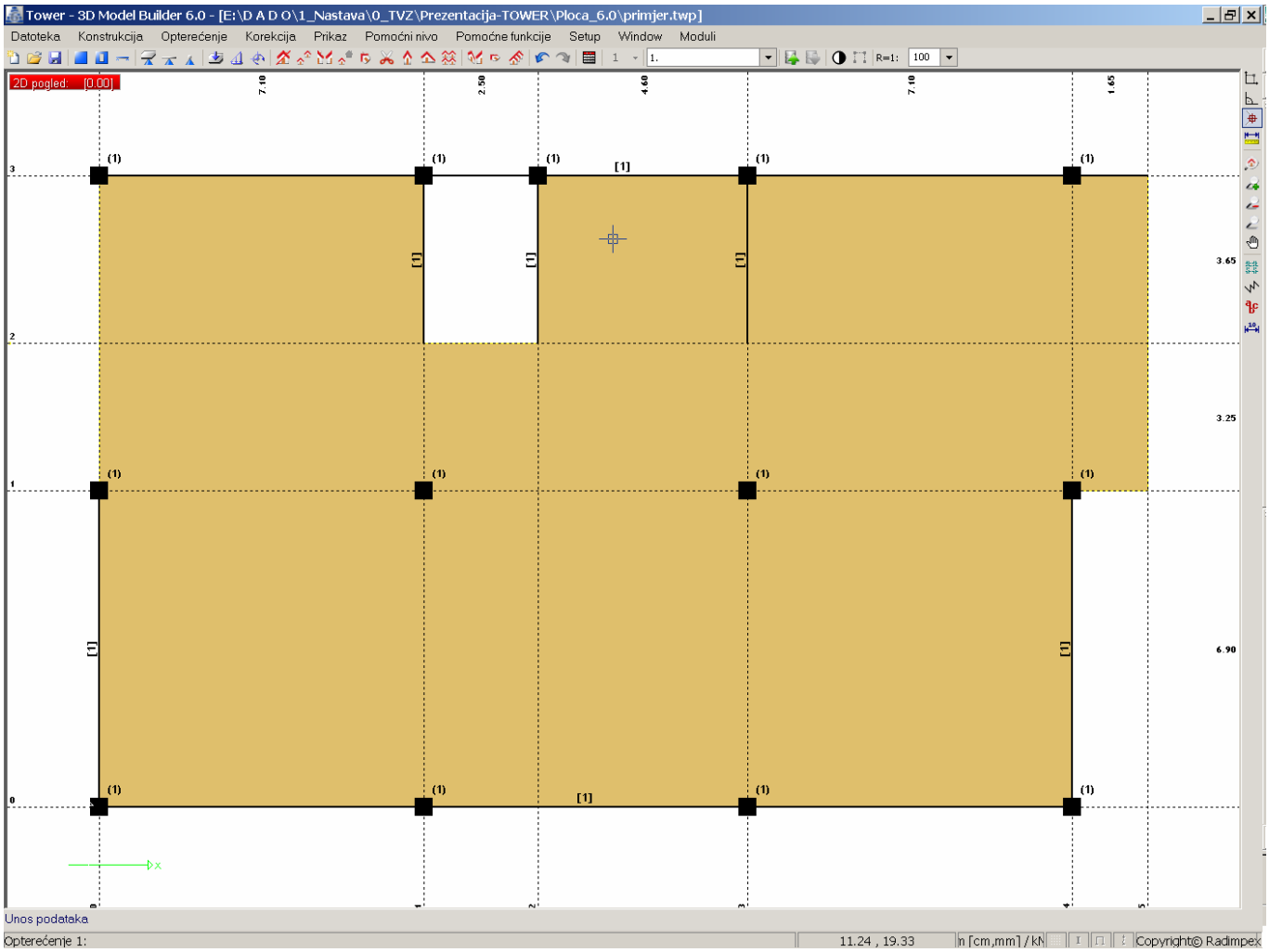



Točkasti ležaj
Set R1 R2 R3 M1 M2 M3
1
K,R1 : 1.0000E+010
K,R2 : 1.0000E+010
K,R3 : 1.0000E+010
K,M1 : 1.0000E+010
K,M2 : 1.0000E+010
K,M3 : 1.0000E+010
R1
R2
Karakteristike stupa
A1 : 4.0000E-002 m2
A2 : 3.3333E-002 m2
A3 : 3.3333E-002 m2
I1 : 2.5333E-004 m4
I2 : 1.3333E-004 m4
I3 : 1.3333E-004 m4
Presjek
Materijal
Beton MB 30
E = 3.15E+007 kN/m2
μ = 0.2
γ = 25 kN/m3
αt = 1E-005 1/°C

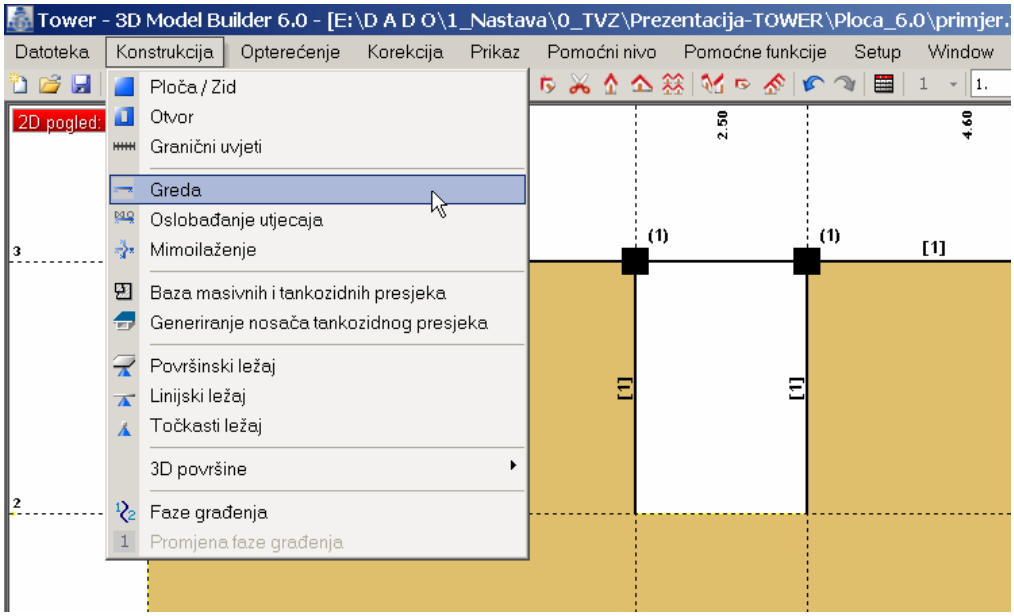

Točkasti ležaj
Set R1 R2 R3 M1 M2 M3
1
K,R1 : 1.0000E+010
K,R2 : 1.0000E+010
K,R3 : 1.0000E+010
K,M1 : 1.0000E+010
K,M2 : 1.0000E+010
K,M3 : 1.0000E+010
R1
R2
R3
Karakteristike stupa
A1 : 4.0000E-002 m2
A2 : 3.3333E-002 m2
A3 : 3.3333E-002 m2
I1 : 2.5333E-004 m4
I2 : 1.3333E-004 m4
I3 : 1.3333E-004 m4
Presjek
Materijal
Beton MB 30
E = 3.15E+007 kN/m2
μ = 0.2
γ = 25 kN/m3
αt = 1E-005 1/°C
Sa kopiranjem


Presjek
Pravokutni
T-presjek
I-presjek
Trapezni
Trokutni
Kružni
Cjevasti
Sandučasti
Otvoreni
Nesimetričan I-presjek
Profili
b = 30.00 cm
d = 30.00 cm
Presjek
Δ3[cm]
Δ2[cm]
α[°]
Ogled.
Dodaj
Briši
Profili
Ravnanje
OK
Cancel

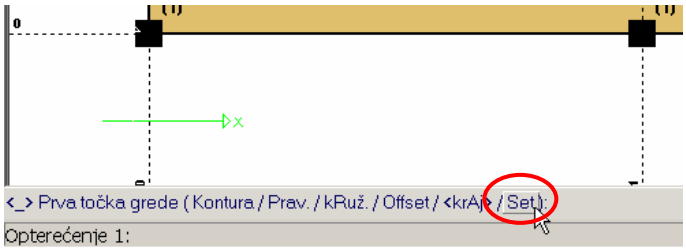
Zatim se iscrtaju točkasti ležajevi

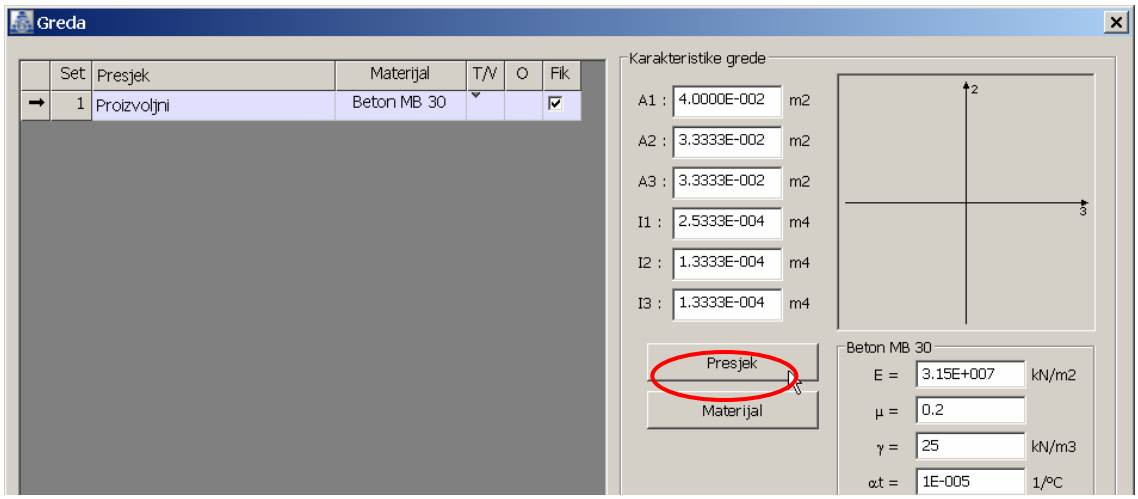


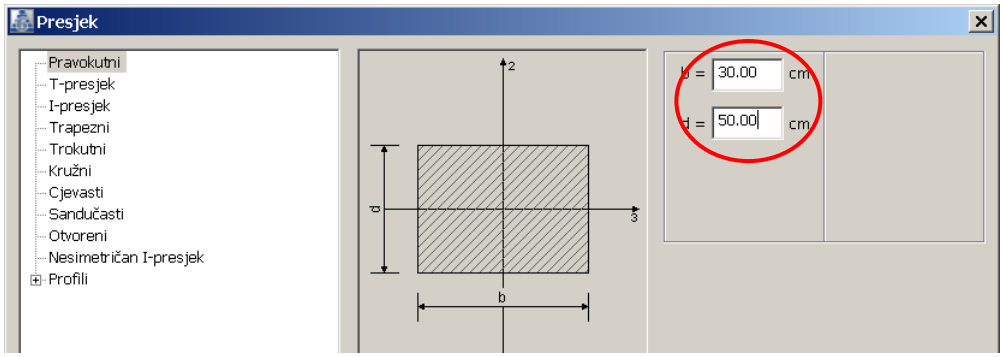
- ***Definiranje greda***

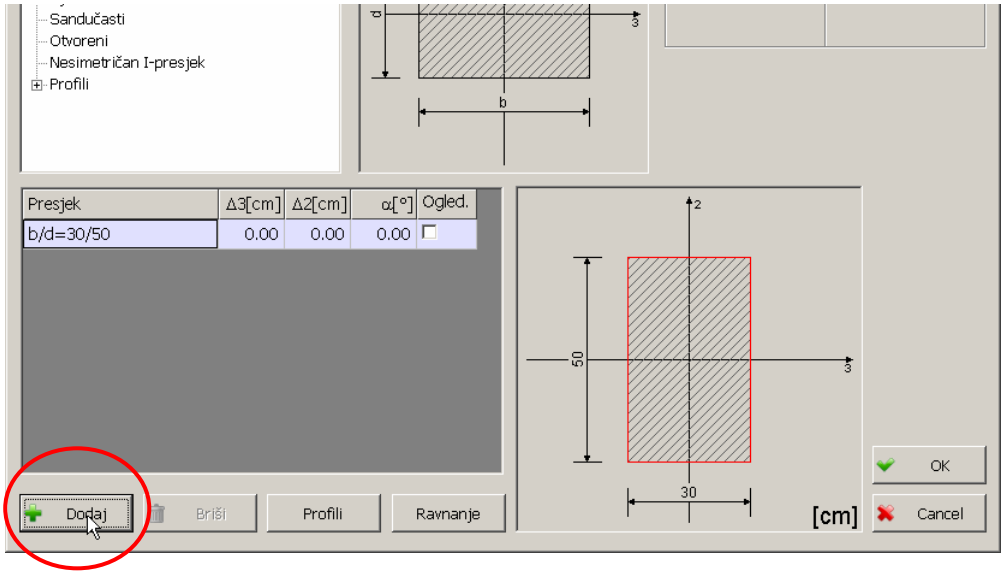


Zadavanje karakteristika grede

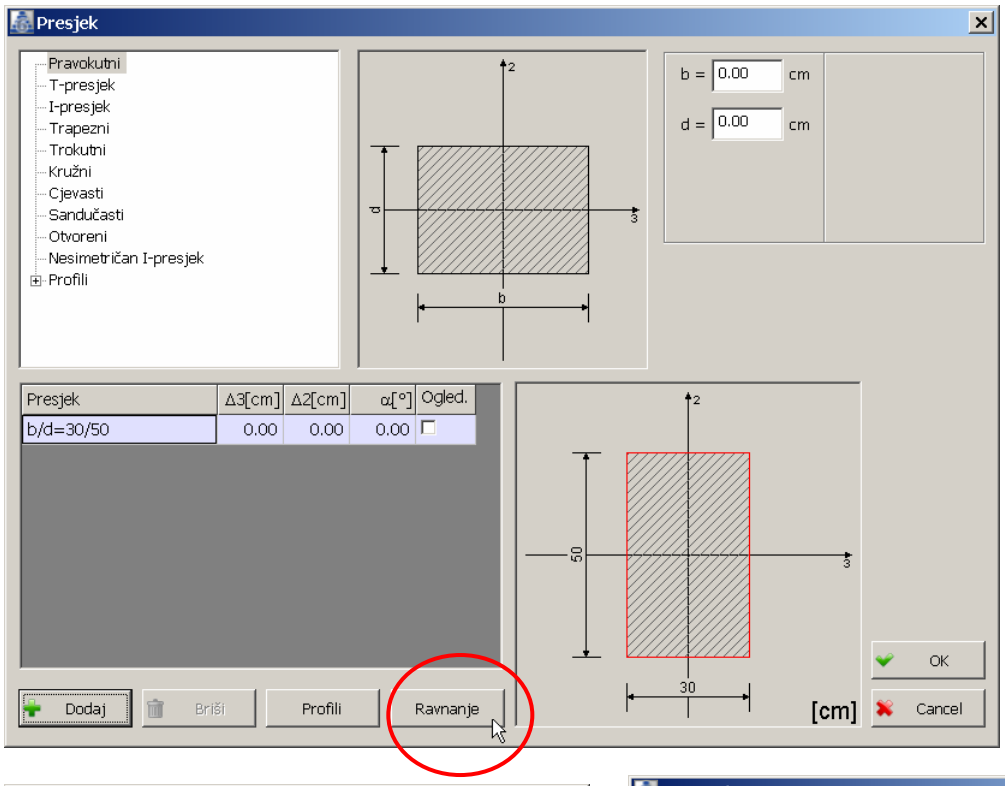


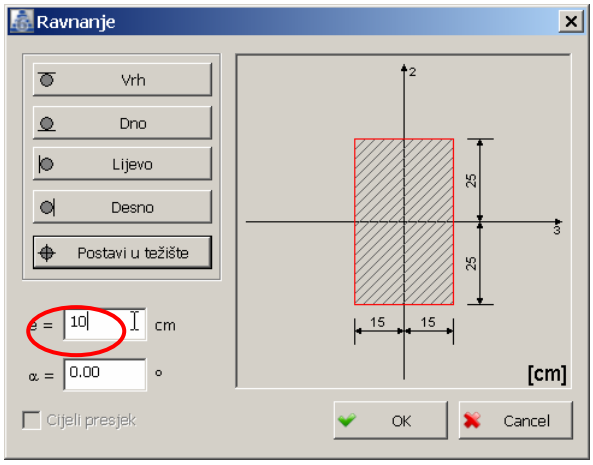


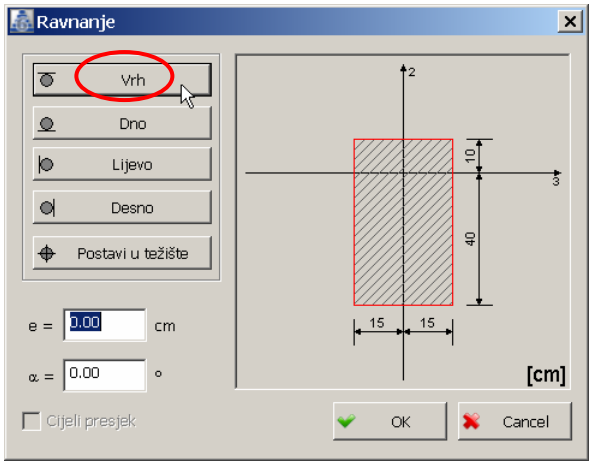




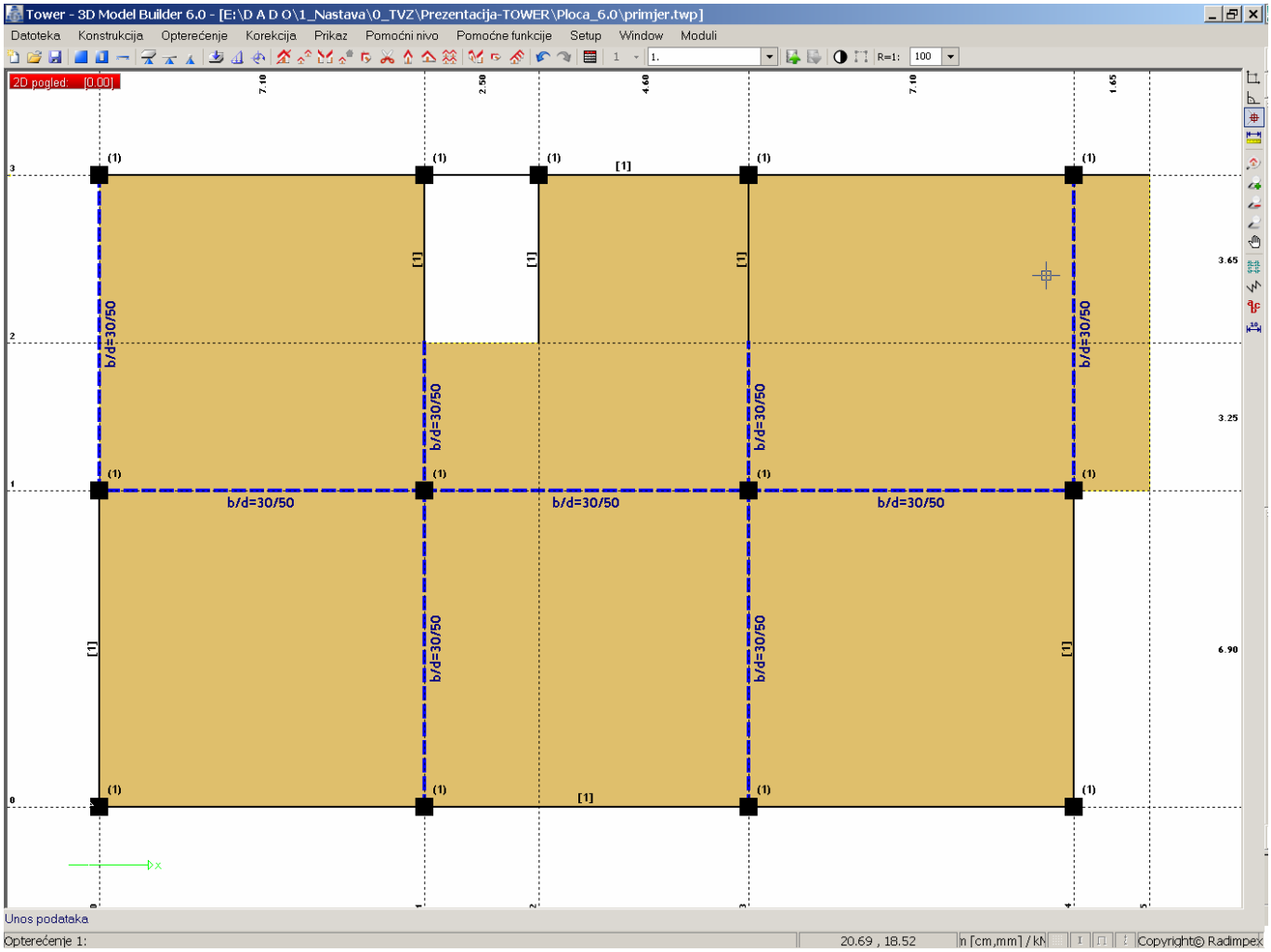
Sada je gredu potrebno poravnati sa gornjim rubom ploče







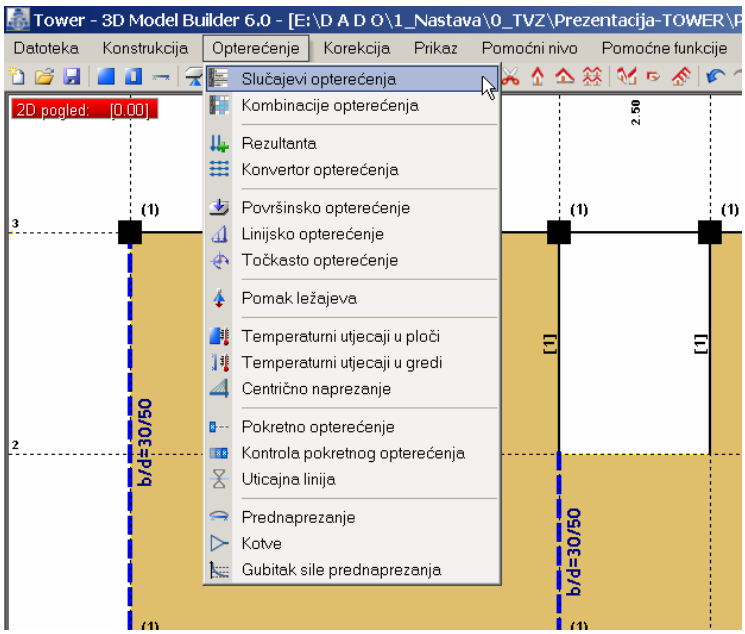
Nakon definiranja geometrijskih karakteristika iscrtaju se grede pa model izgleda ovako



Napomena: Za modele koji su uvezeni u tower kao dxf iz ACAD-a potrebno je samo provesti zadavanje geometrijskih karakteristika pojedinih elemenata konstrukcije.

- ***Opterećenje konstrukcije***

Prvo se definiraju slučajevi opterećenja

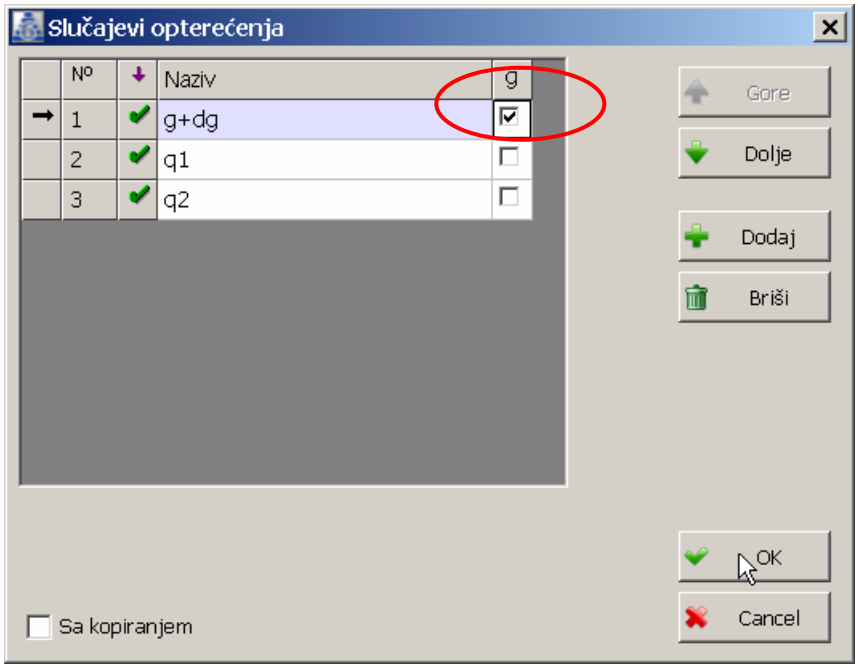


Definiraju se slijedeće kombinacije opterećenja:

Stalno opterećenje: - vlastita težina (program uzima automatski, uključiti zastavicu u okviru kraj opterećenja)

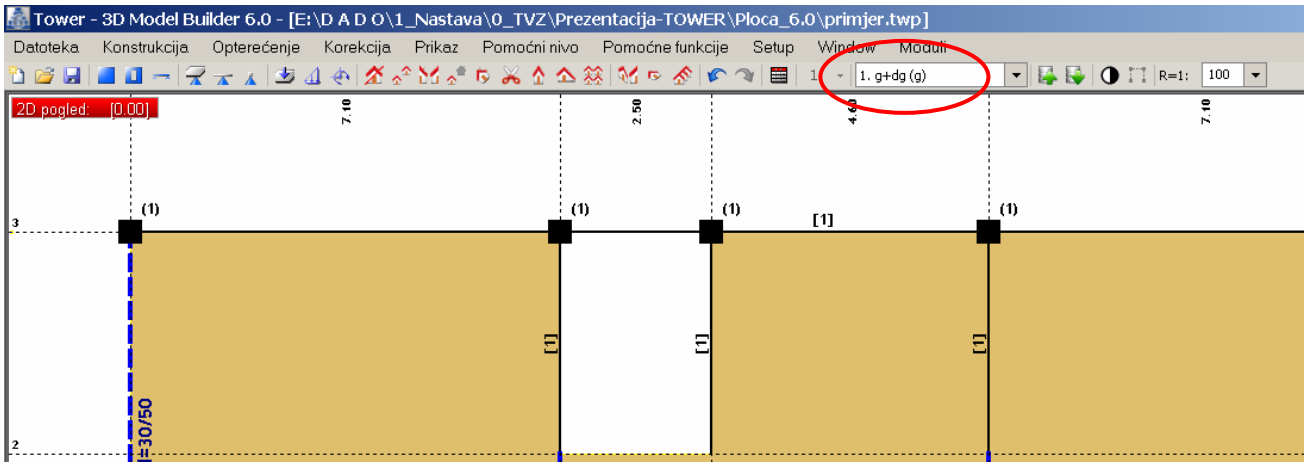
- dodatno stalno Δg

Korisno opterećenje q kao šahovsko opterećenje q_1 do q_n

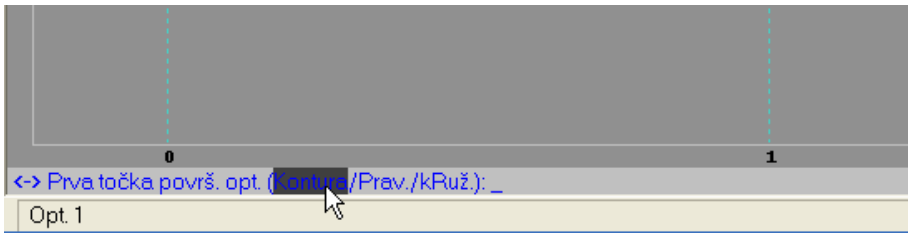


Nakon toga definira se samo površinsko opterećenje ali prije toga se mora aktivirati željeni slučaj opterećenja (crna strelica)

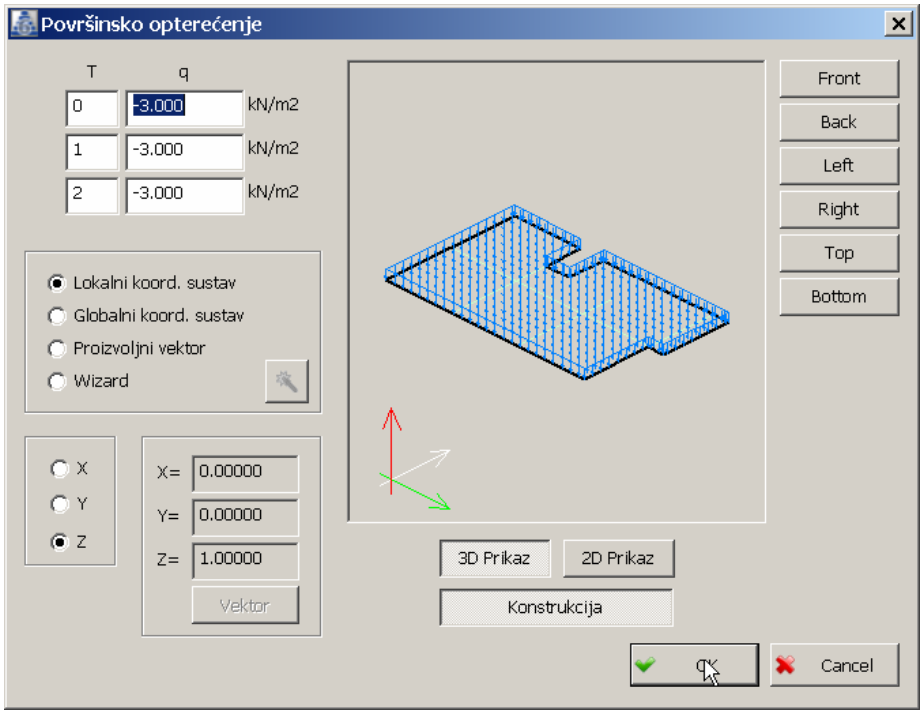
Stalno + dodatno stalno opterećenje



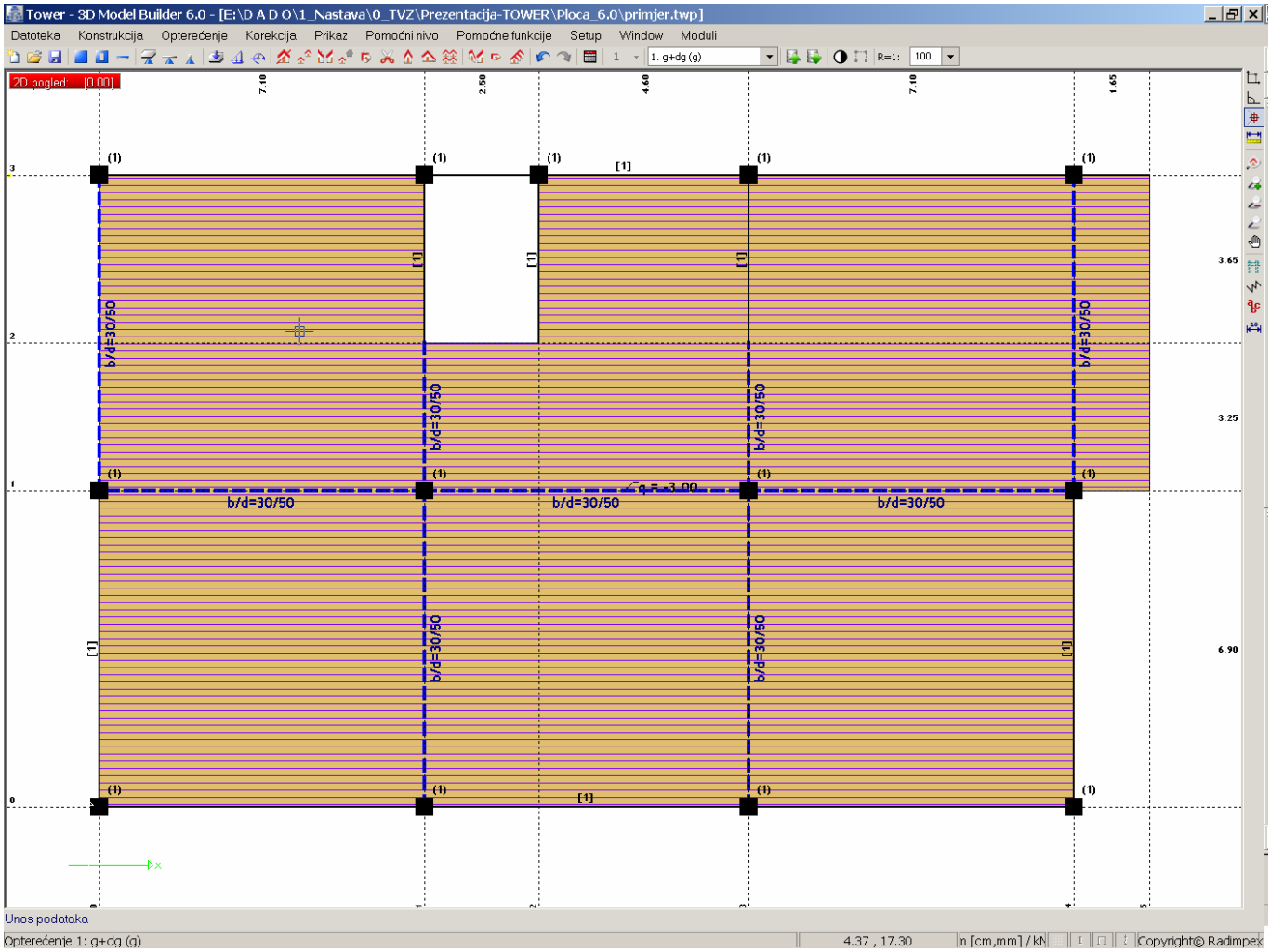
na naredbenoj liniji odabere se „KONTURA“



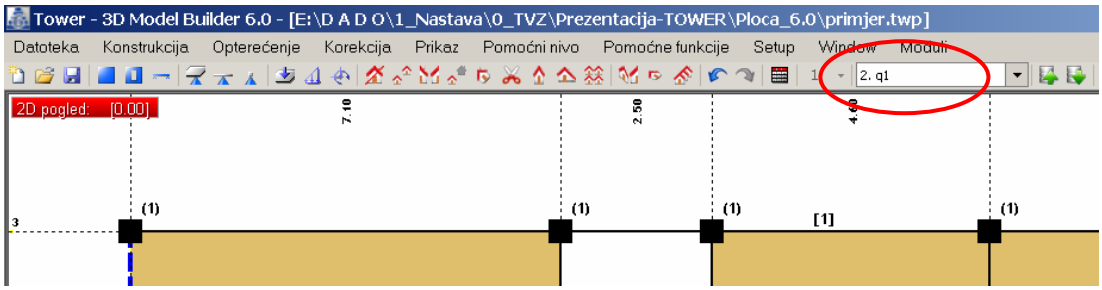
Selektira se kontura ploče i u okviru koji se pojavio nakon selektiranja konture upiše se željeni intenzitet sa predznakom „-„



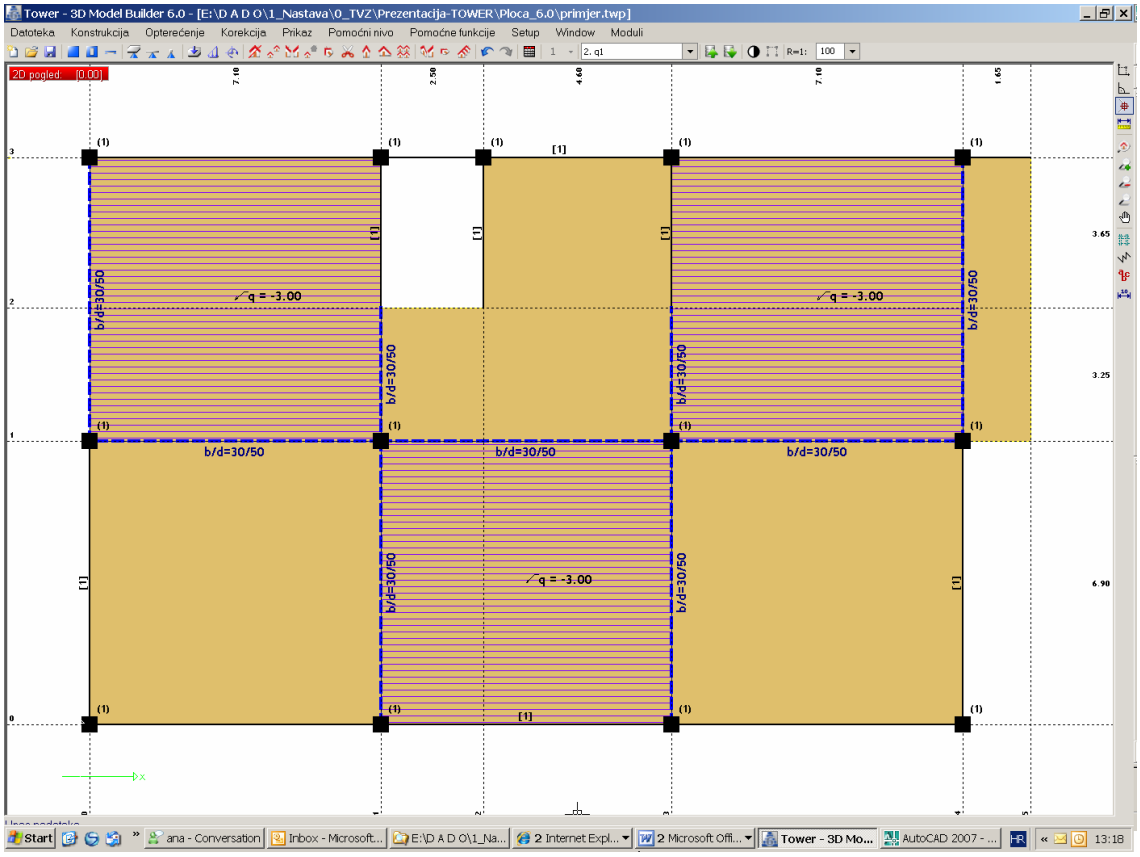
Definirano opterećenje izgleda na modelu na ovaj način



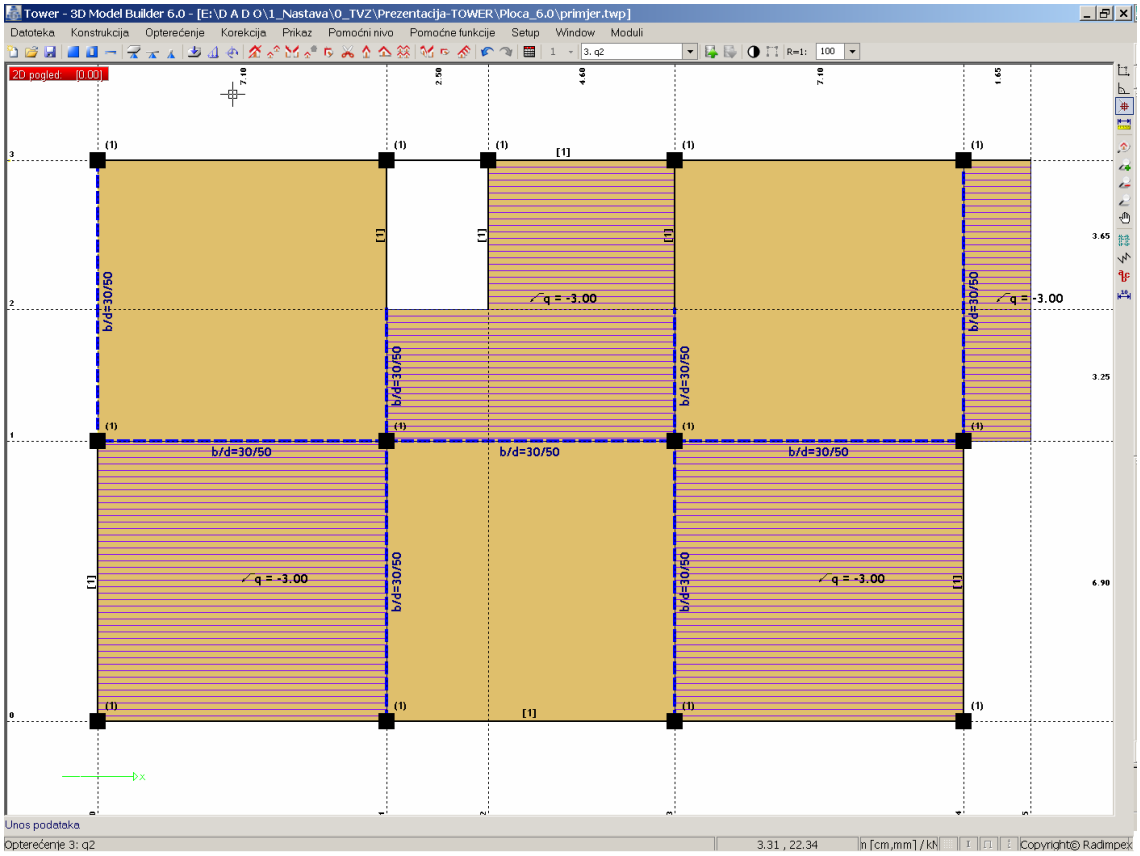
Isto se ponovi za slučaj opterećenja q jedina je razlika što sada više ne koristimo pod-naredbu „KONTURA“ budući da je potrebno zadati šahovski raspored opterećenja već se pomoću „osnapa „ crta zadano opterećenje.



Zadano opterećenje izgleda na ovaj način



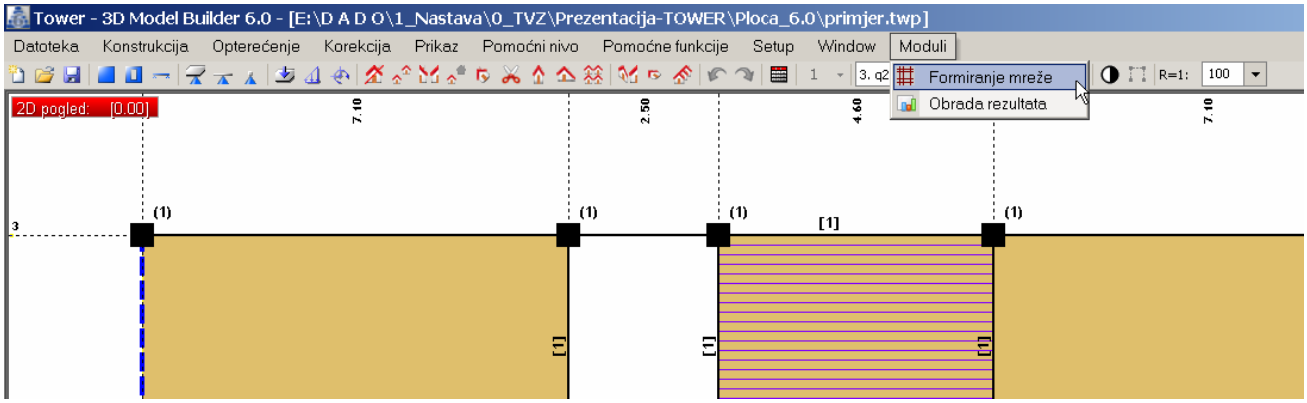
Na isti način se definira i opterećenje q2

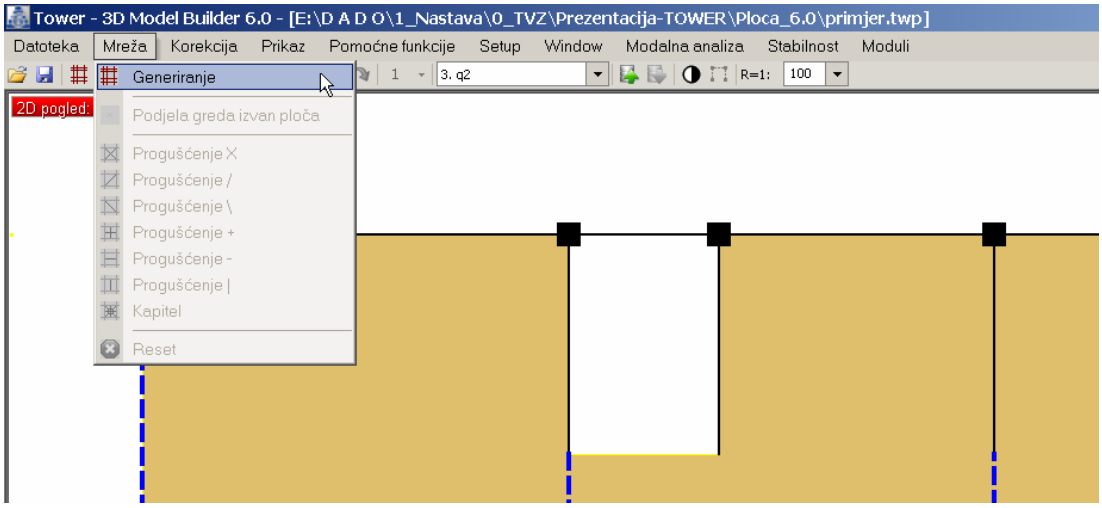


3. GENERIRANJE MREŽE KONAČNIH ELEMENATA I PRORAČUN MODELA

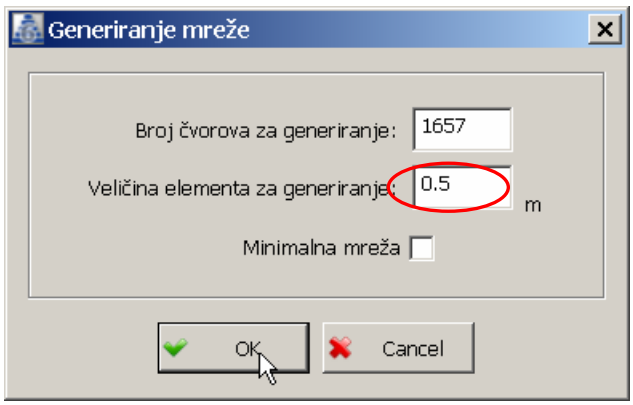
- ***Generiranje MKE***

Naredbom MODULI – FORMIRANJE MREŽE, pristupa se modulu u kojem se generira MKE

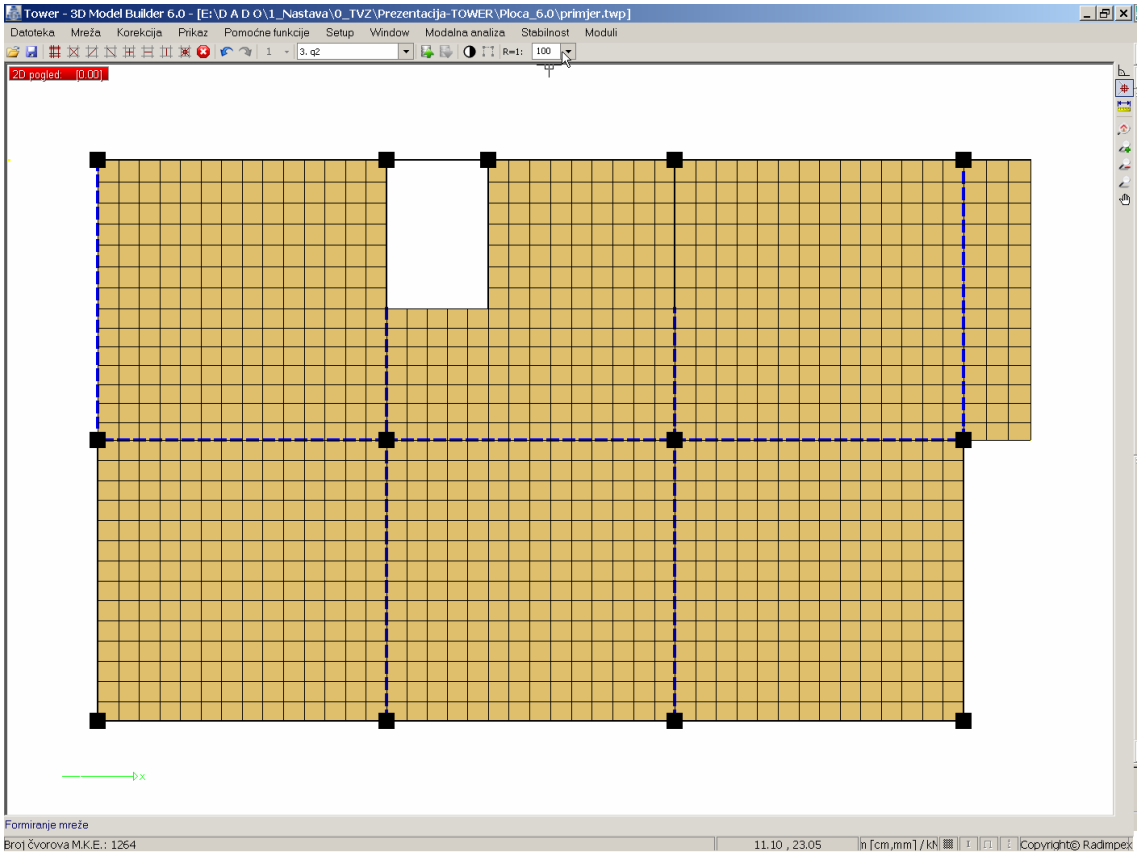




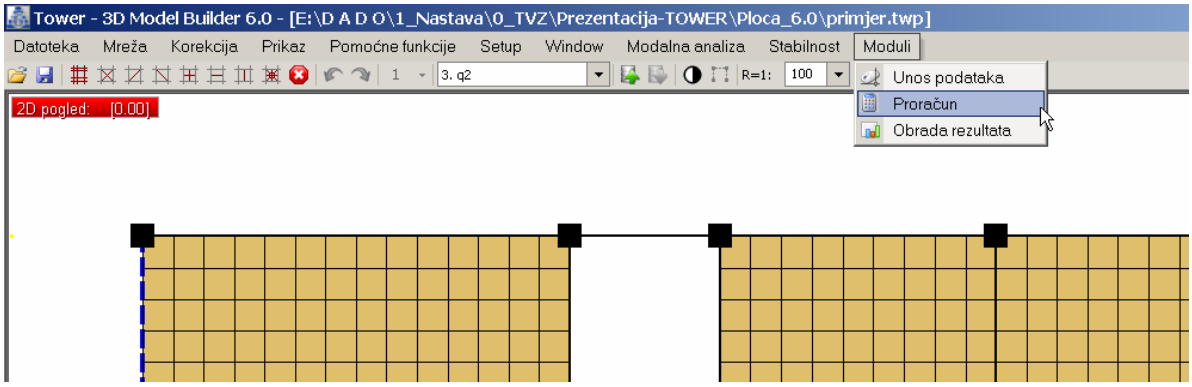
Za ploču ovih dimenzija uzima se veličina konačnog elementa 0.5×0.5 m

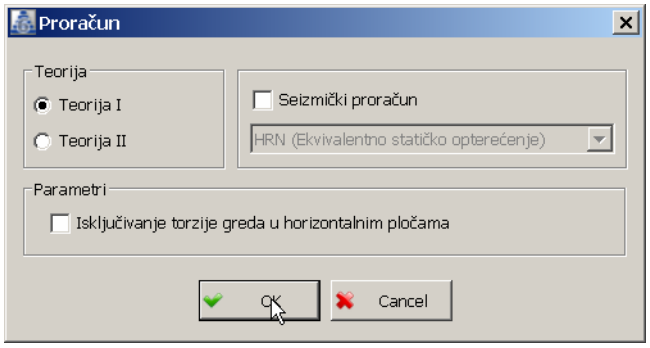


Generirana mreža izgleda na ovaj način

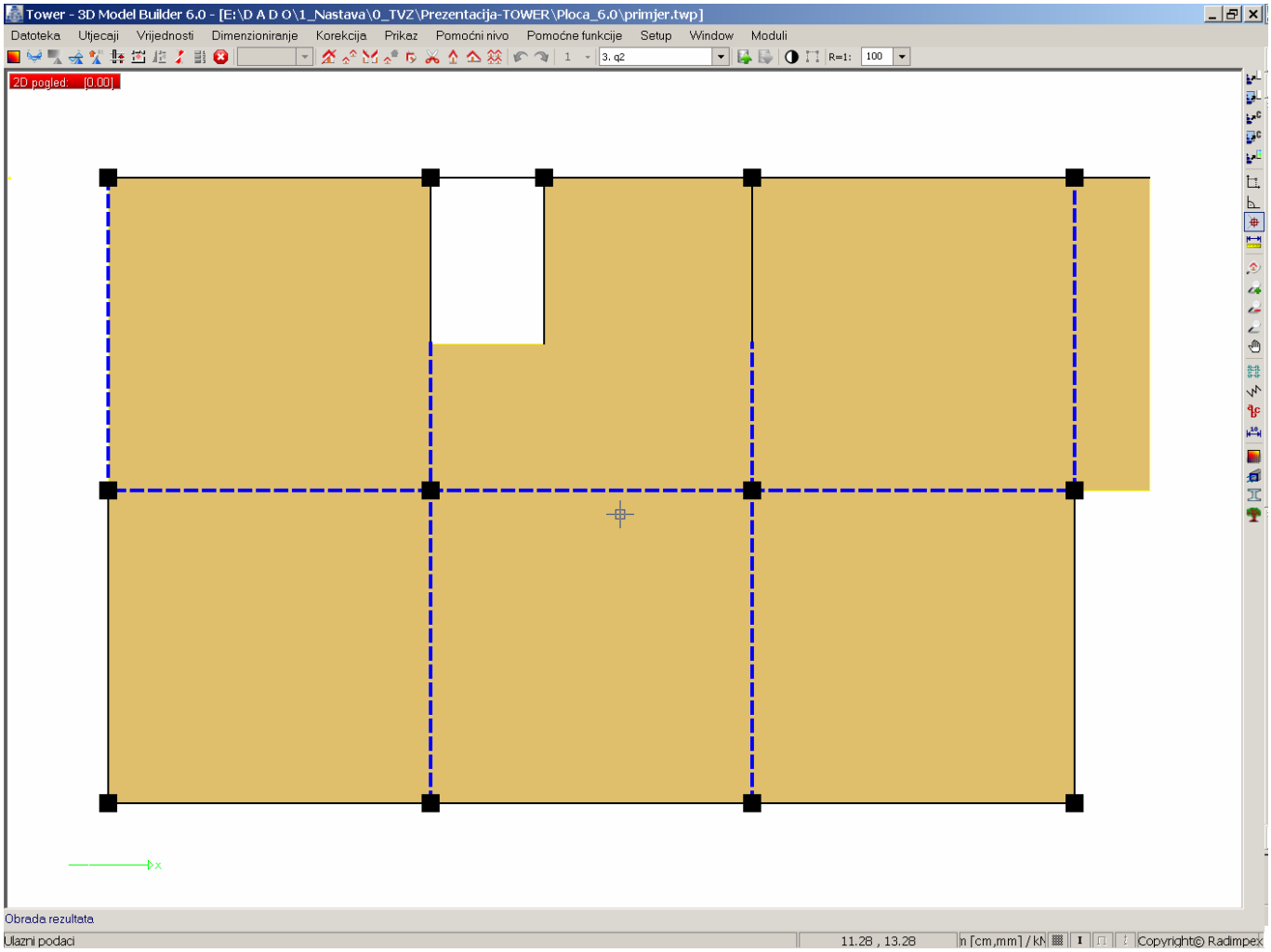


Nakon provedenog postupka generiranja MKE provodi se postupak proračuna

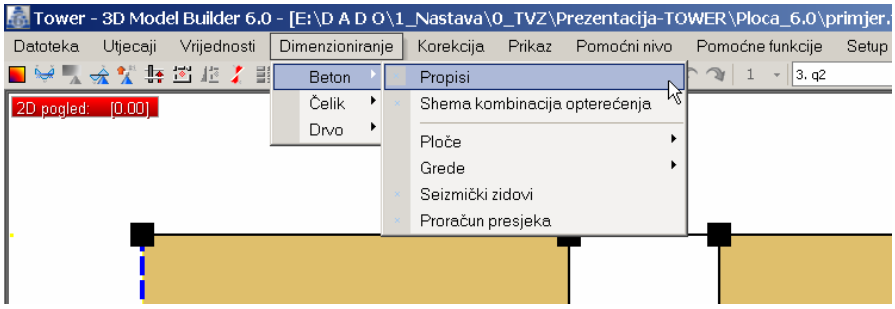




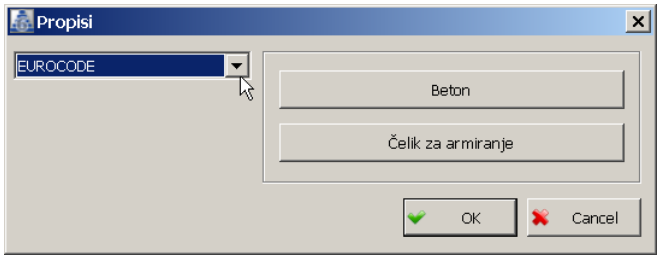
Nakon provedenog proračuna, otvara se modul za obradu rezultata i dimenzioniranje



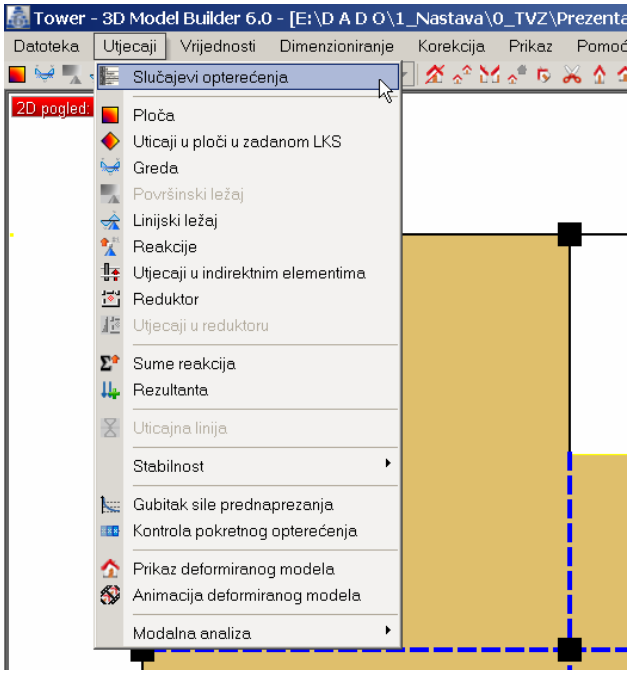
- ***Dimenzioniranje i obrada rezultata***

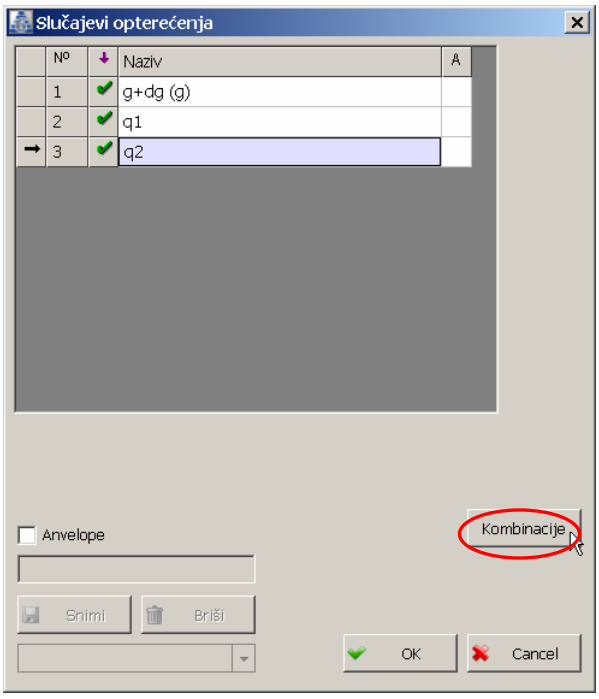


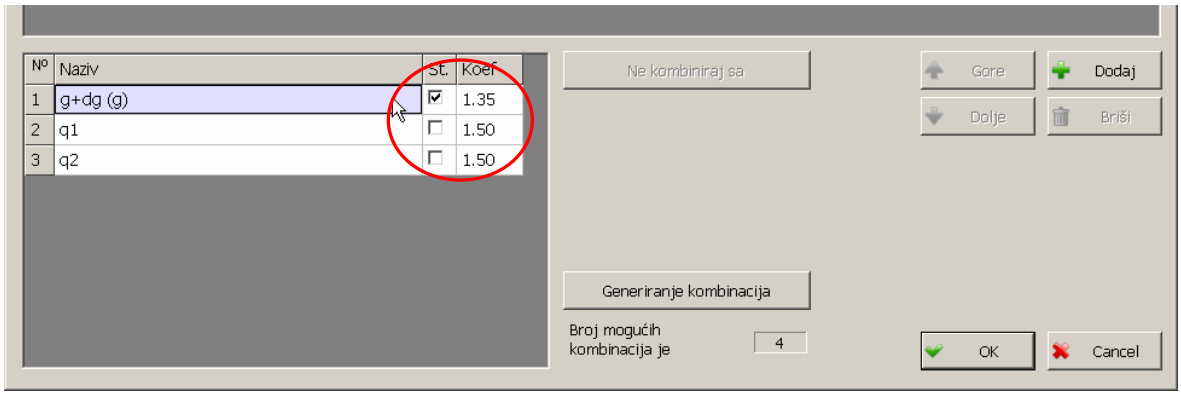
Prvo se moraju odabrati propisi po kojima će se konstrukcija dimenzionirati

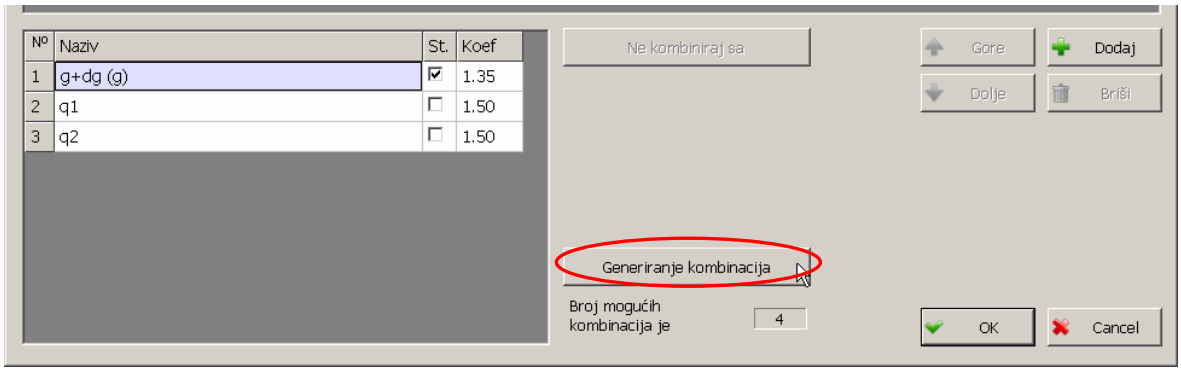


Nakon odabira propisa potrebno je generirati slučajeve opterećenja za koje će se provoditi dimenzioniranje (ova operacija može se na isti način provesti i u modulu za unos podataka)

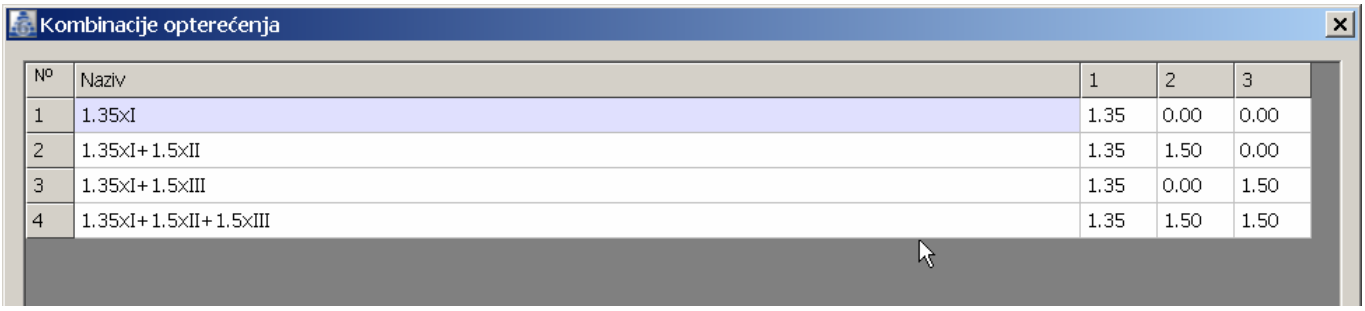






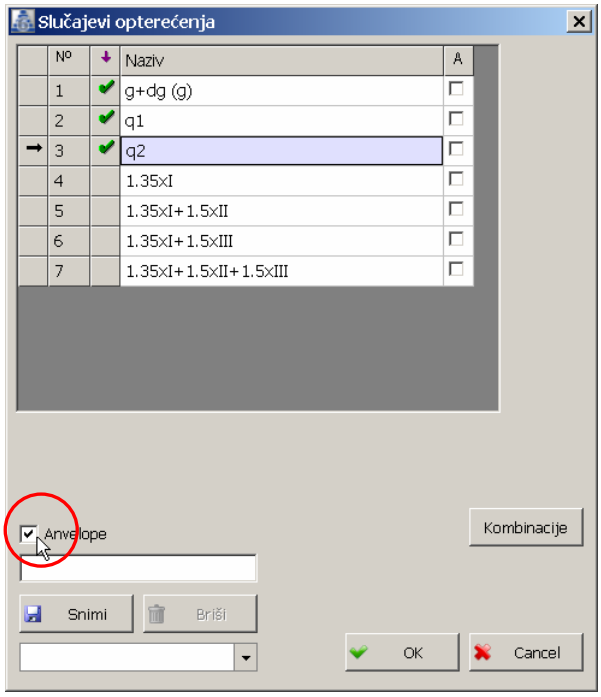


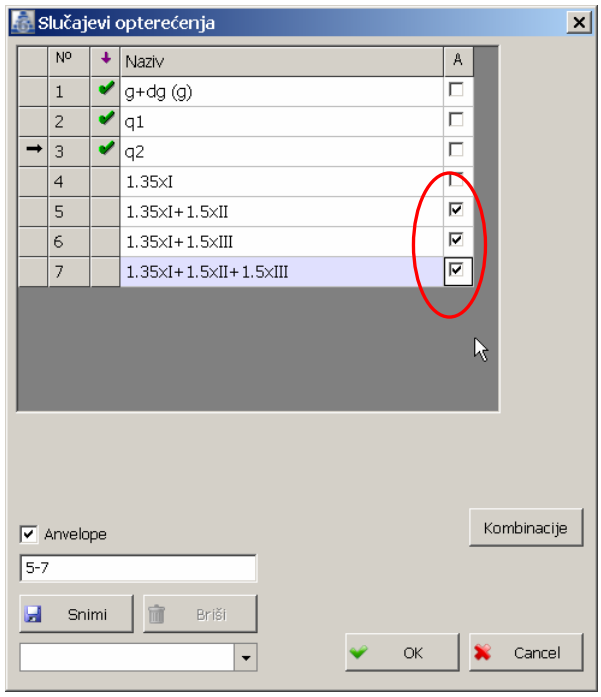
Provedenim postupkom definiranja kombinacija opterećenja dobili smo 4 kombinacije opterećenja za koje ćemo definirati anvelope u kojima tražimo maximume djelovanja vanjskih sila.



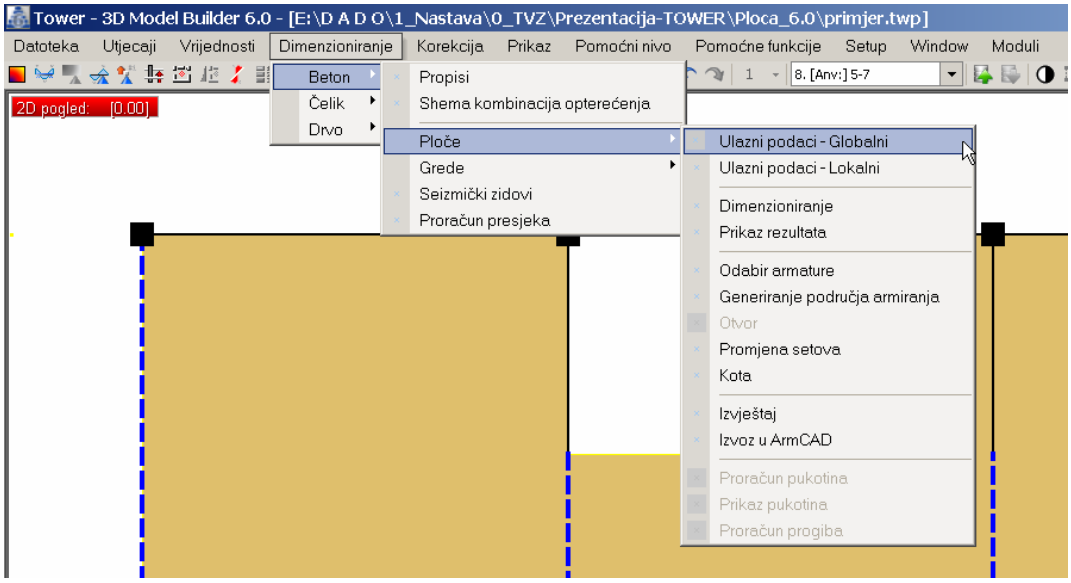
No	Naziv	1	2	3
1	1.35xI	1.35	0.00	0.00
2	1.35xI+1.5xII	1.35	1.50	0.00
3	1.35xI+1.5xIII	1.35	0.00	1.50
4	1.35xI+1.5xII+1.5xIII	1.35	1.50	1.50

Definiranje anvelopa opterećenja

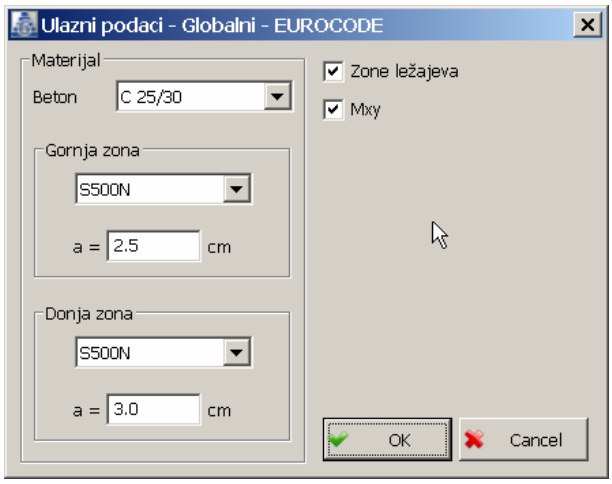


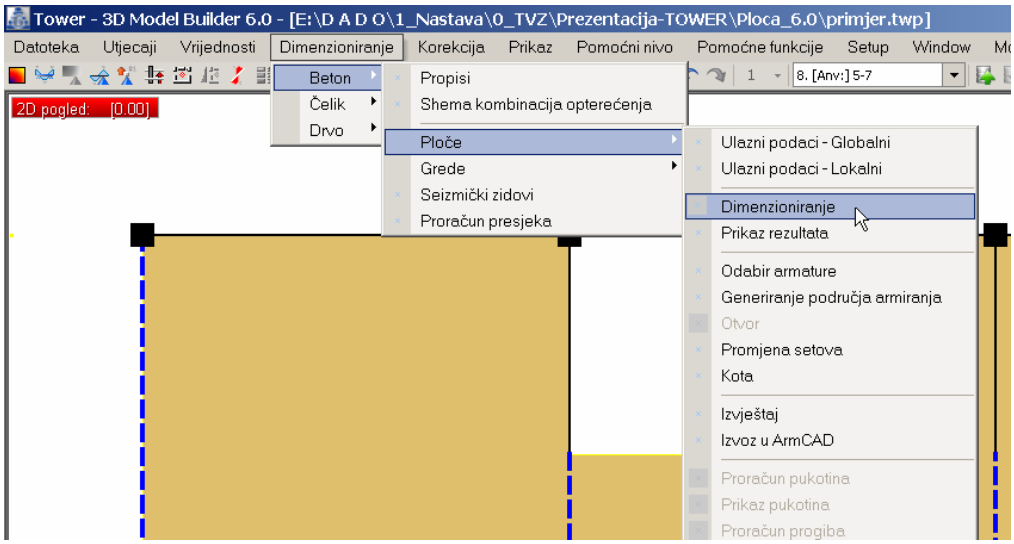


- ***Dimenzioniranje ploča***

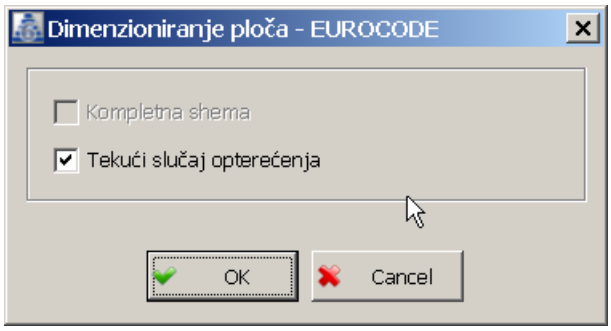


Definiranje globalnih karakteristika ploče za dimenzioniranje, materijal betona i čelika, statička visina

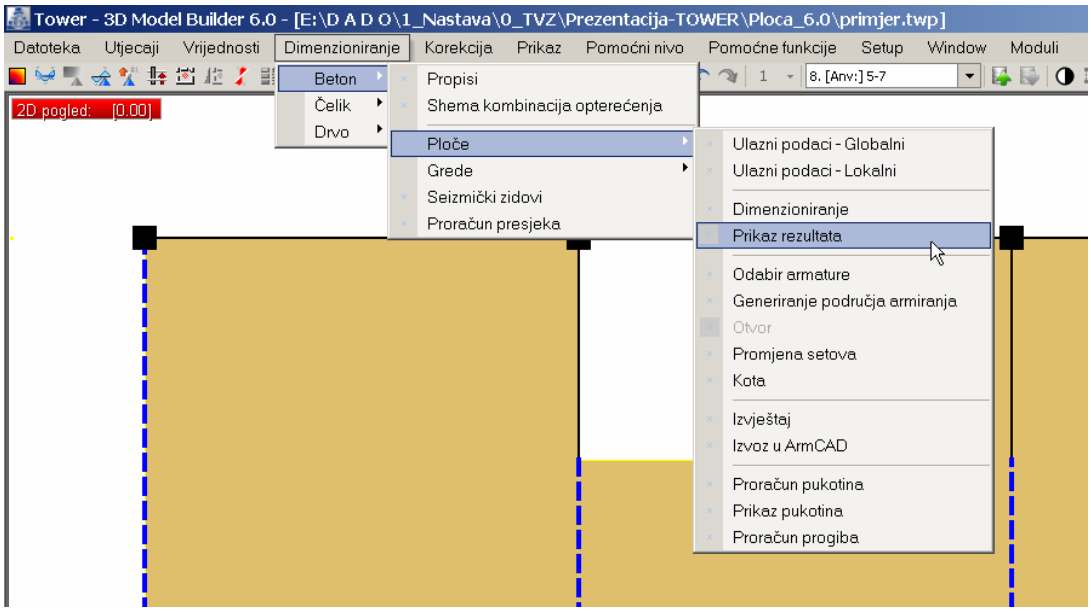




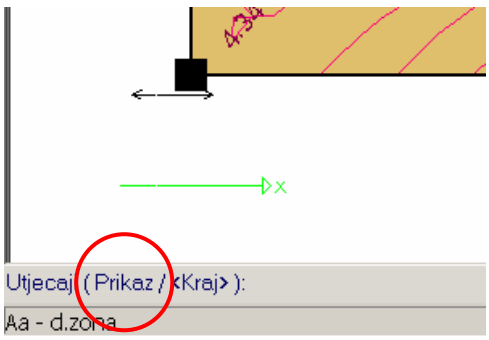
Selektira se tekući slučaj opterećenja jer dimenzioniramo na anvelope opterećenja

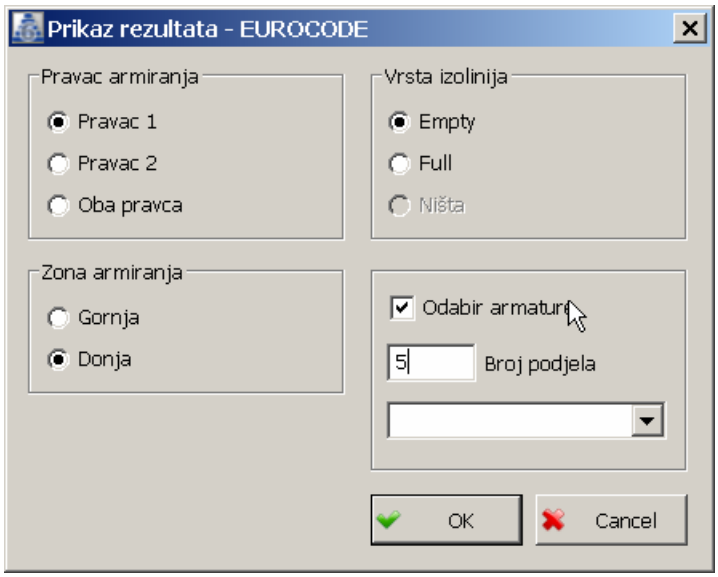


Prikaz rezultata dimenzioniranja.



Armatura donje zone smjer X, pravac 1, (na naredbenoj liniji potrebno je selektirati PRIKAZ)



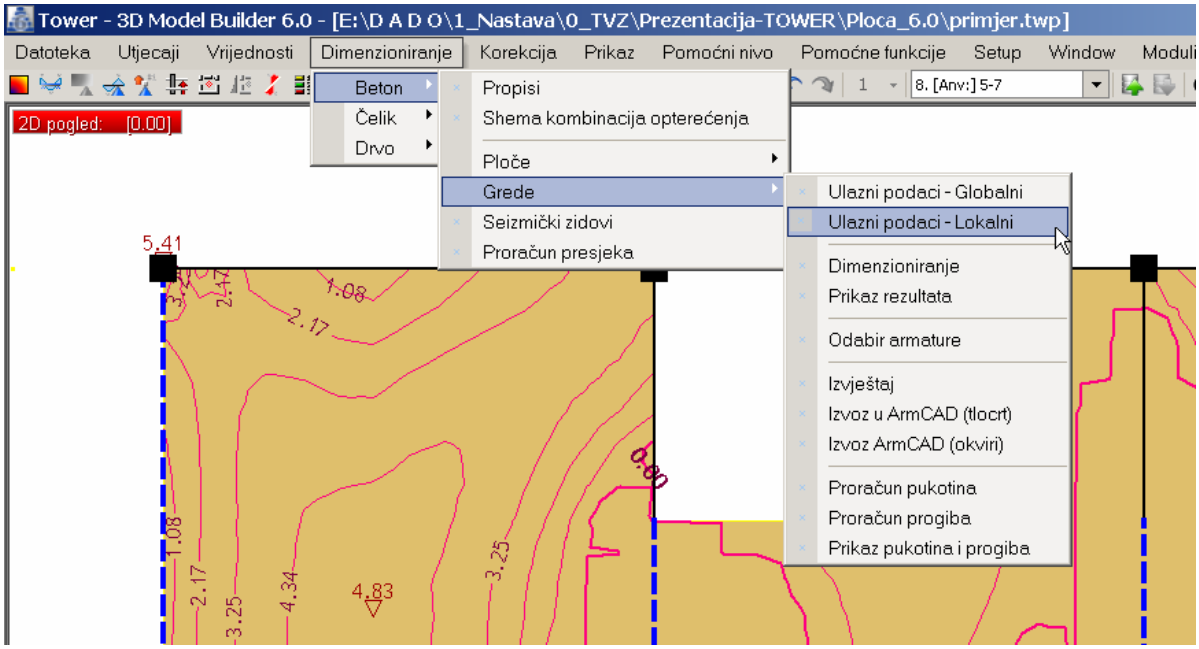


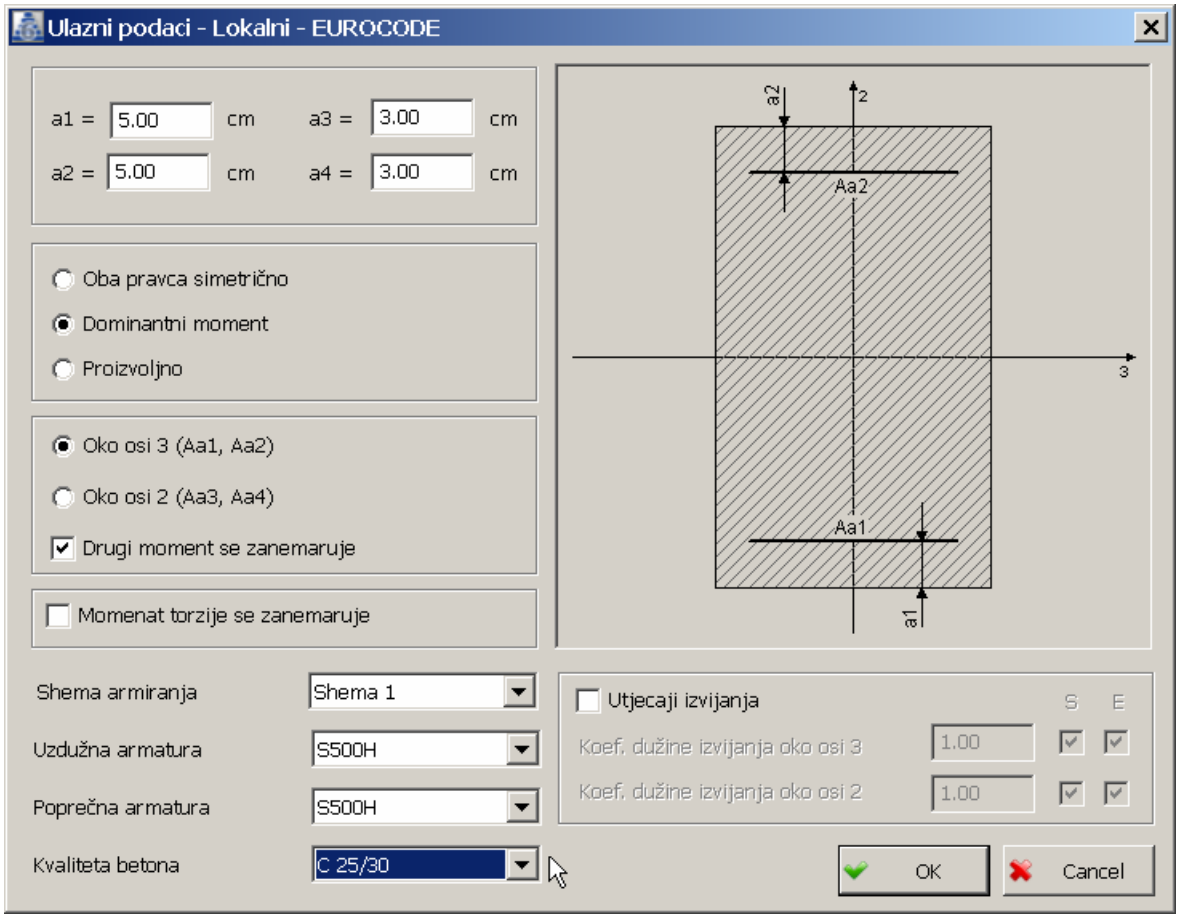
Isti postupak se provodi i za smjer 2. te za gornju zonu.

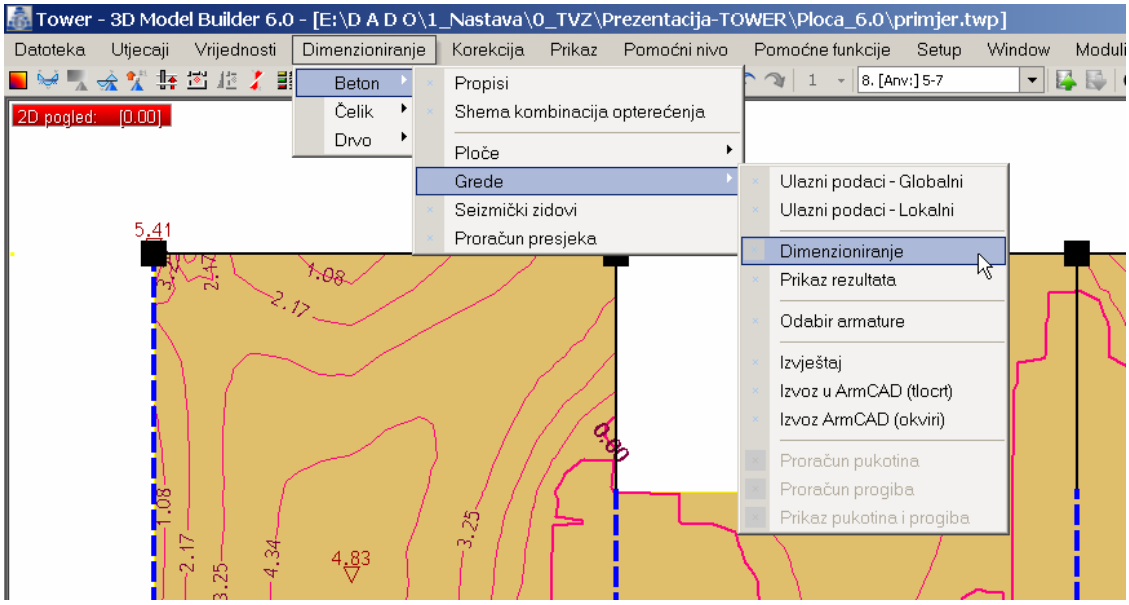
Svaka slika armature ispisuje se u izvještaj sa funkcijskom tipkom F2.

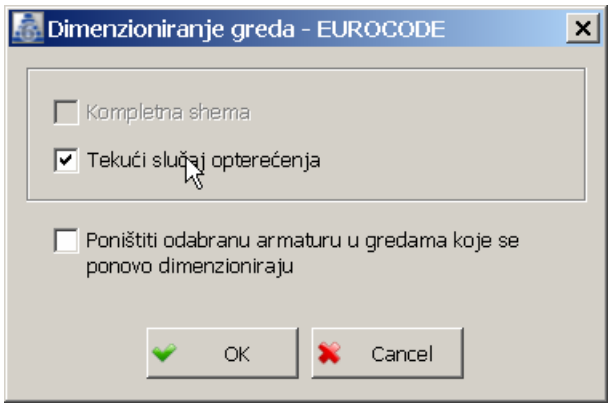
- ***Dimenzioniranje greda***

Kao i u pločama prvo se definiraju ulazni parametri

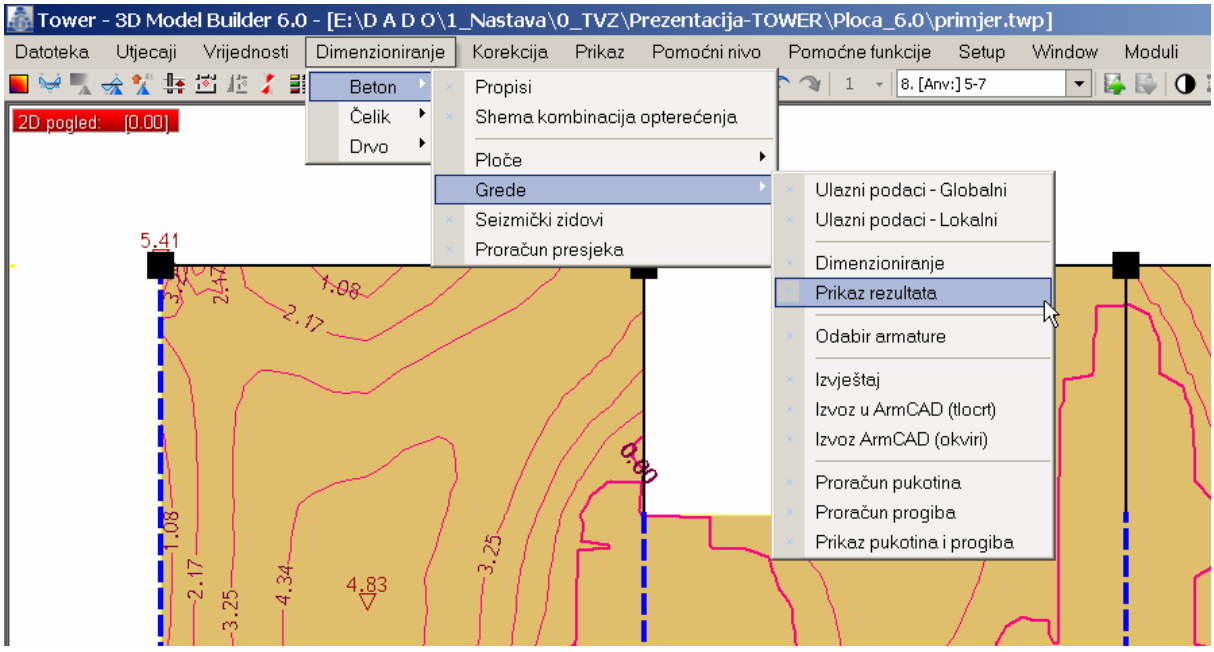




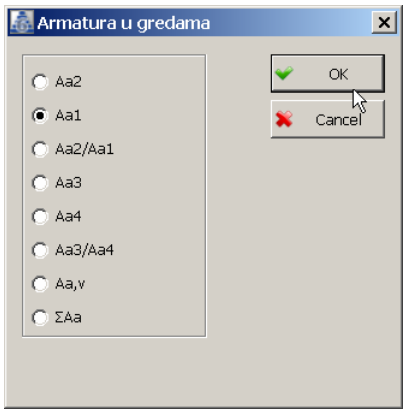


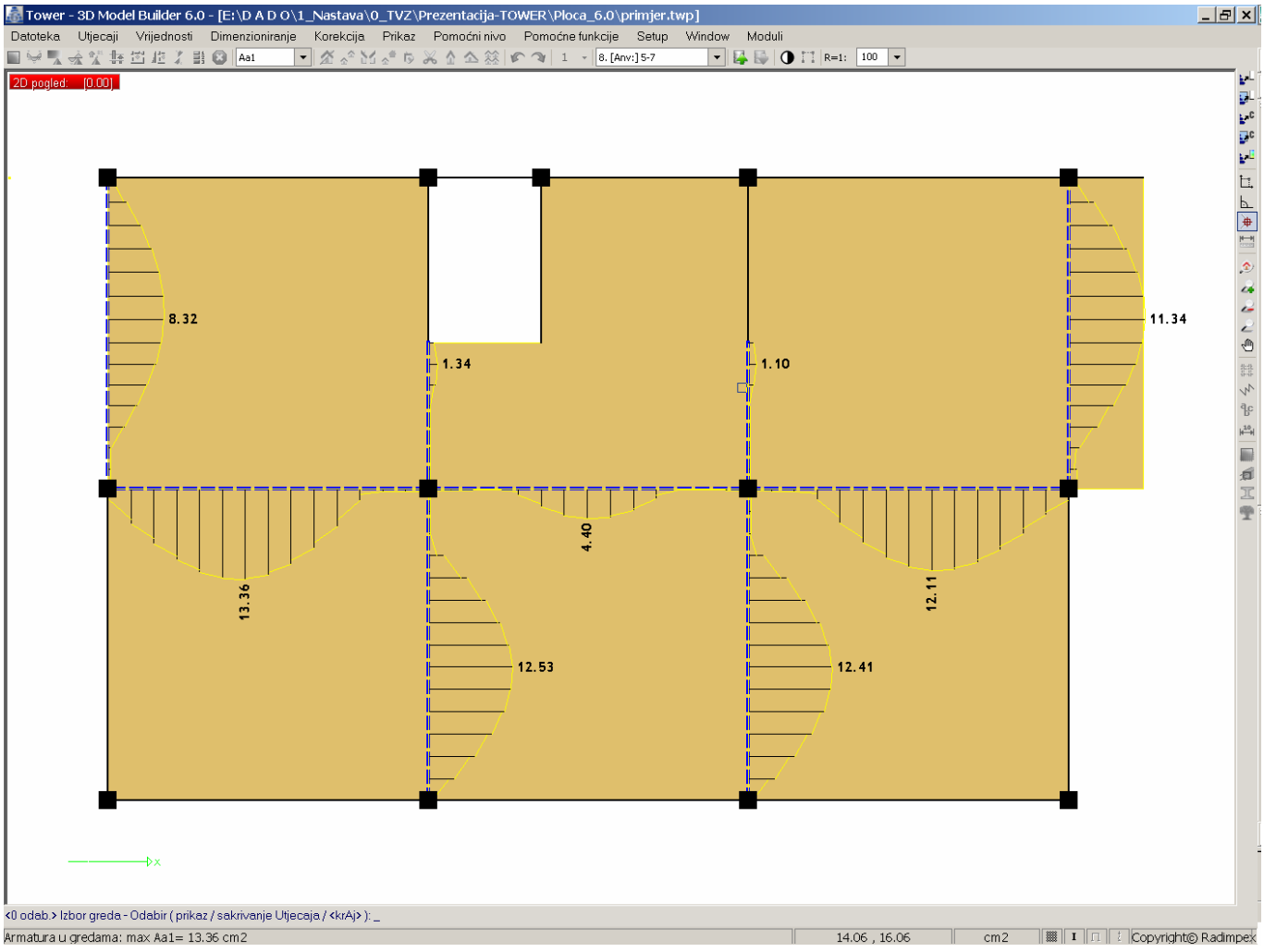


Ispis rezultata dimenzioniranja greda

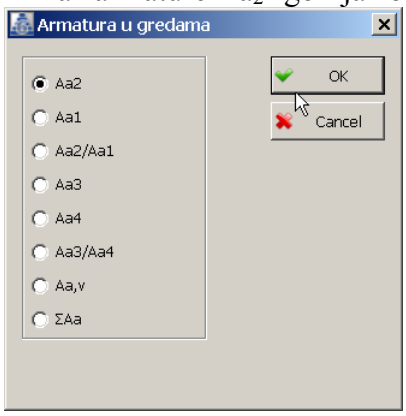


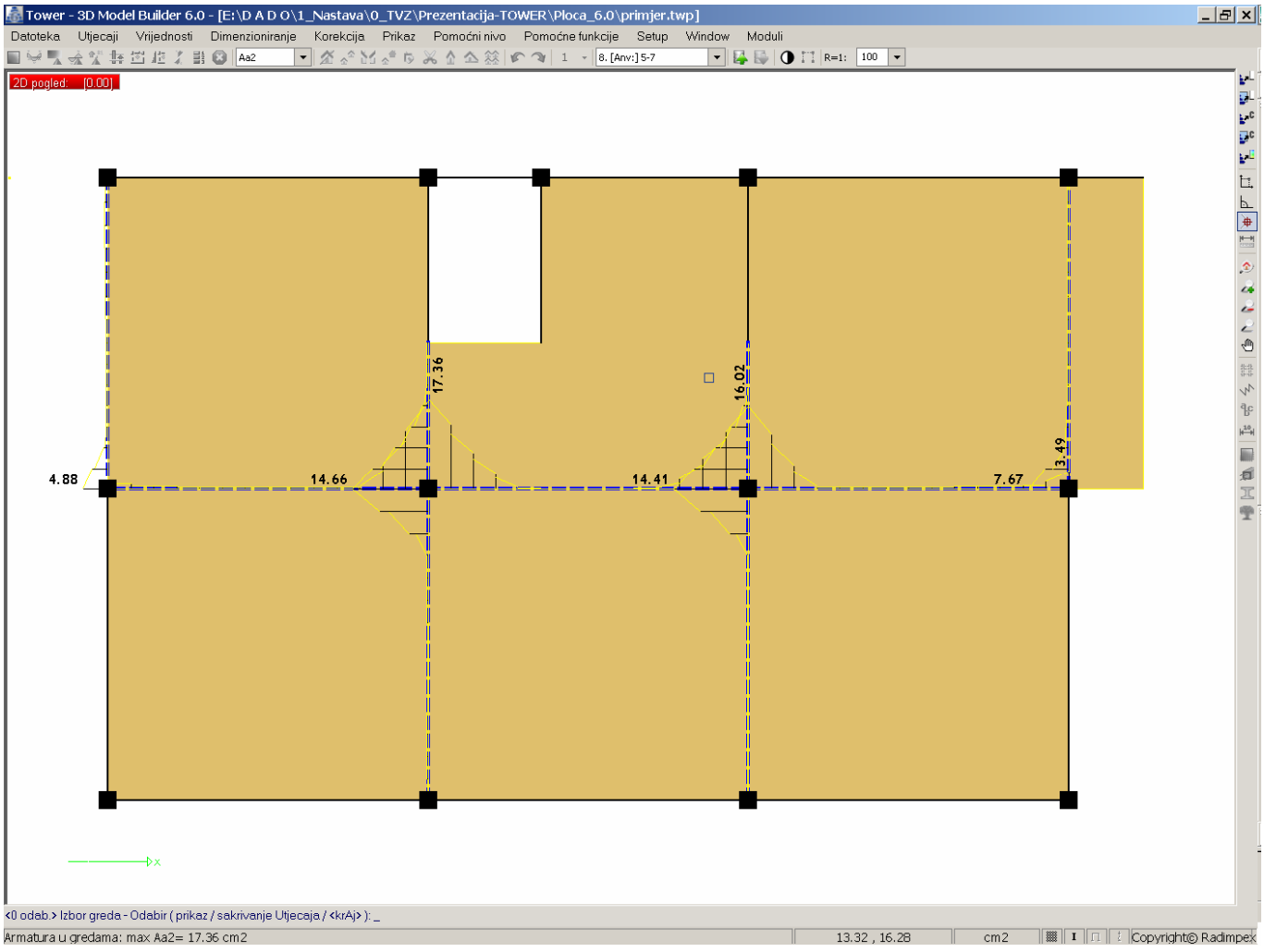
Prikaz armature donje zone Aa_1 (cm^2)



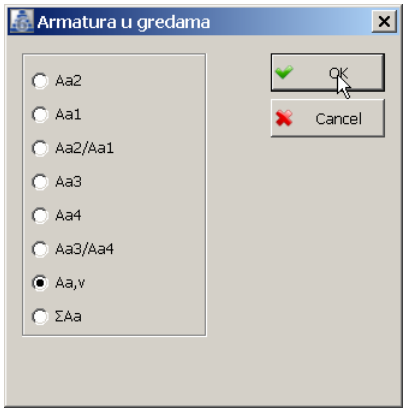


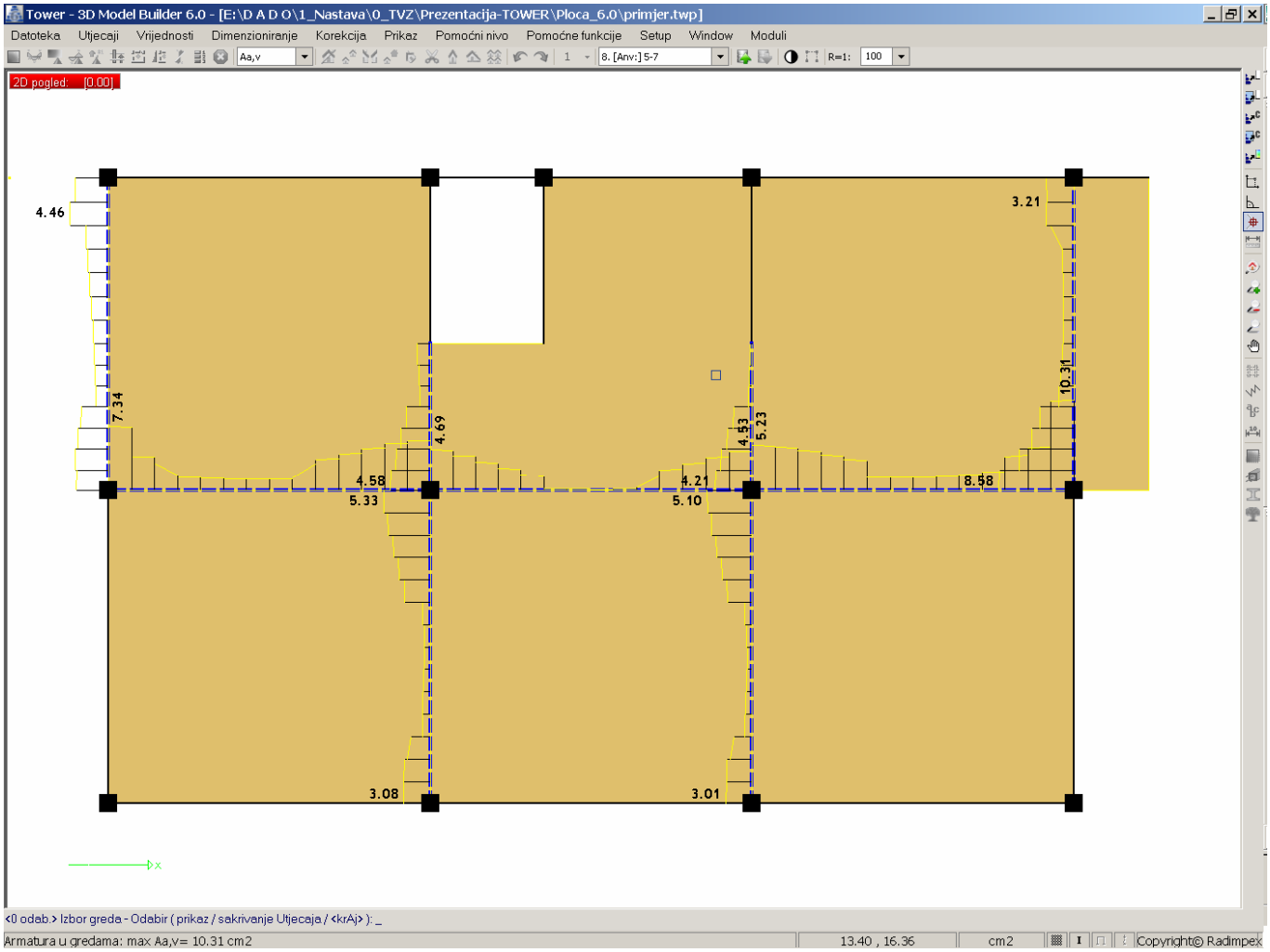
Prikaz armature Aa_2 - gornja zona





Prikaz armature vilica Aa_v

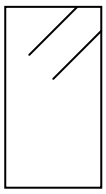




U ovoj verziji program rezultate dimenzioniranja za vilice ispisuje po jednoj strani grede (automatski uzima dvorezne vilice m=2) tj. ukupna površina poprečne armature je dvostruko veća od ispisane vrijednosti.

Primjer odabira vilica:

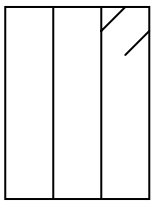
Program ispisuje površinu 5.0 cm2/m' po jednoj strani grede, pa se iz tablica direktno očita odabrano ∅8-10, A_{od}= 5.0 cm2/m' – po jednoj strani grede.



Dvorezna vilica, m = 2

Ako bi se recimo pokazala potreba za m=4, tj. četveroreznim vilicama proračun bi bio slijedeći

As = 5.0×2/4 = 2.5 cm2/m' -> odabrano iz tablica ∅8-20, A_{od}= 2.51 cm2/m' – po jednoj strani grede.



Četverorezna vilica, m = 4

3. KREIRANJE IZLAZNOG IZVJEŠTAJA (PRINT VERZIJA)

Ispis je moguć direktno na printer, PDF ili izvoz u RTF datoteku.

Više o kreiranju izlaznog izvještaja na slijedećim web stranicama:

http://www.plan-b.hr/download/Tower5.pdf

http://www.plan-b.hr/download/Tower%206_Hrv.pdf

http://www.radimpex.co.yu/lessons.php?id=1 → online lekcije i tutorijali