

Univerzitet Crne Gore  
GRAĐEVINSKI FAKULTET U PODGORICI

**BETONSKE KONSTRUKCIJE  
INŽENJERSKIH OBJEKATA**

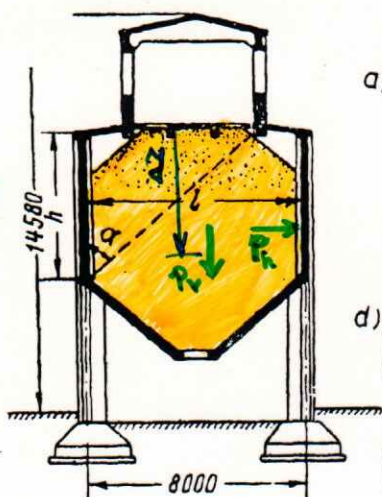
*Mladen Ulićević*

**OBJEKTI ZA SMJEŠTAJ RASutih MATERIJALA  
- SILOSI -**

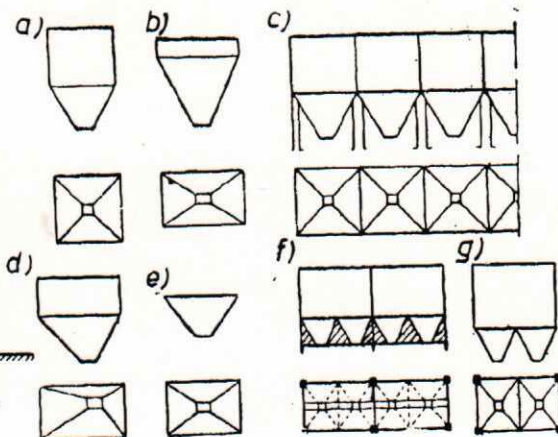
# OBJEKTI ZA ŠMJEŠTAJ RASUTIH MATERIJALA

## A. BUNKERI

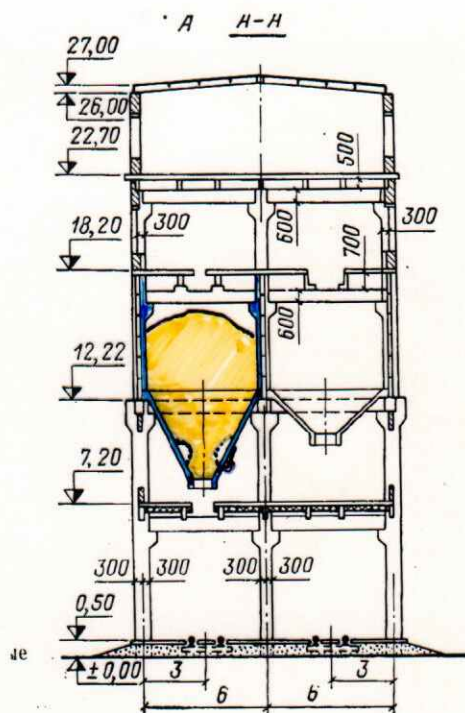
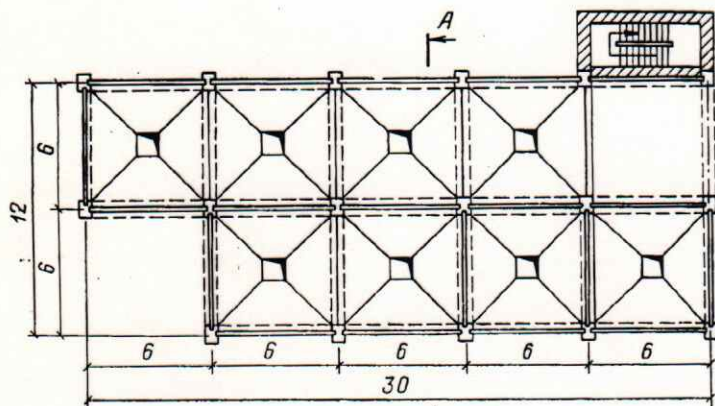
$h \cdot \tan \alpha < 1$   
 $h \leq 1.5 a(d)$



SI. XX. 33. Poprečni presek bunkera



SI. XX. 34. Sheme bunkera



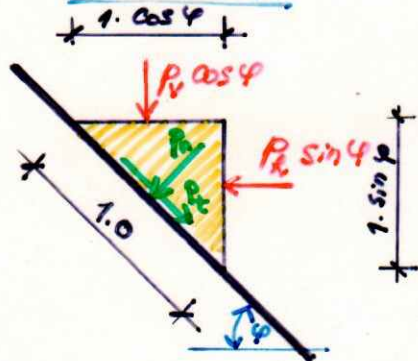
Opterećenje zidova:

$P_h = \gamma \cdot \gamma \cdot \tan^2(45^\circ - \varphi/2)$  ( $\varphi = 30 - 45^\circ$ )

$P_v = \gamma \cdot \gamma$

$P_t = 0$

LIJEVAK:



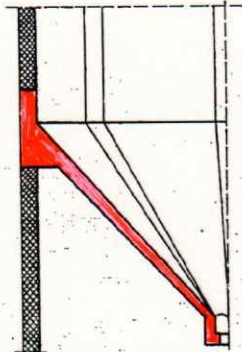
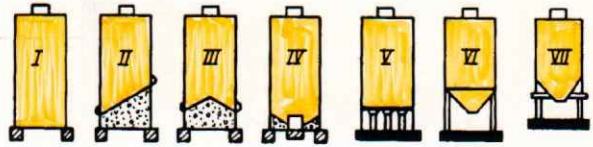
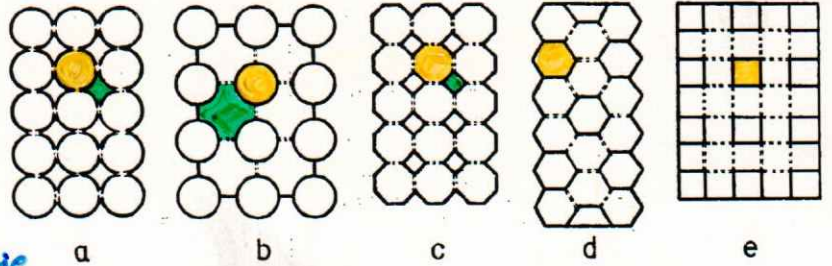
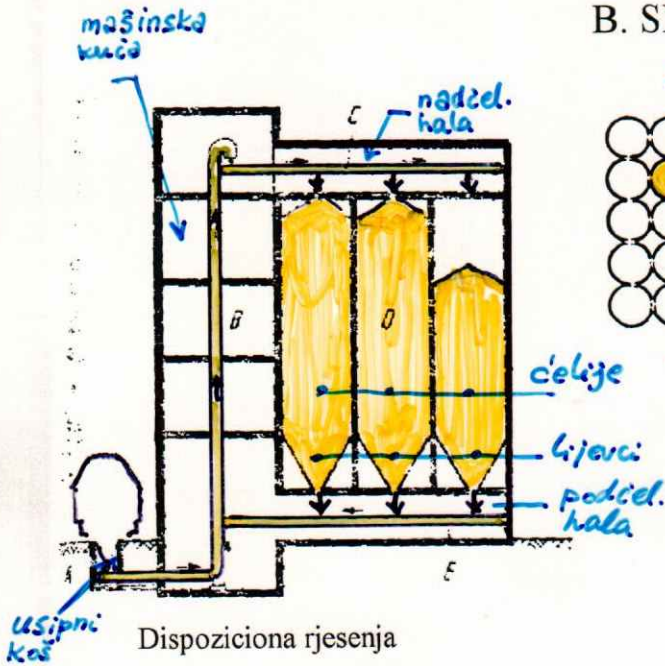
$P_n = P_v \cos^2 \varphi + P_h \sin^2 \varphi$

$P_t = (P_v - P_n) \sin \varphi \cos \varphi$

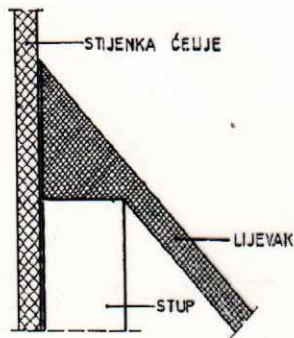
## B. SILOSI

$d = 6-8\text{ m}$

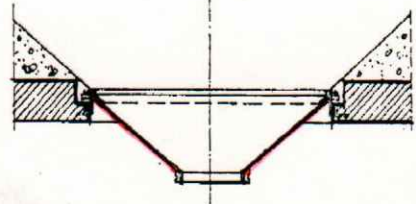
$a = 3-4\text{ m}$



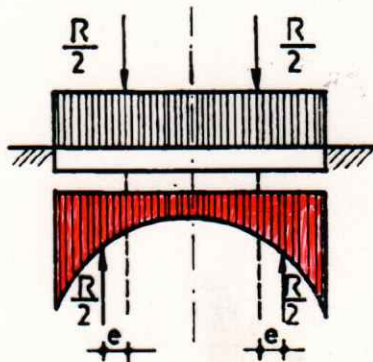
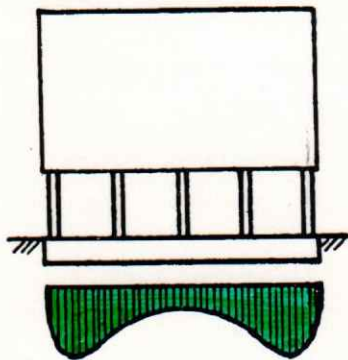
Slika 5. Lijevak oslonjen na silovsku čeližu



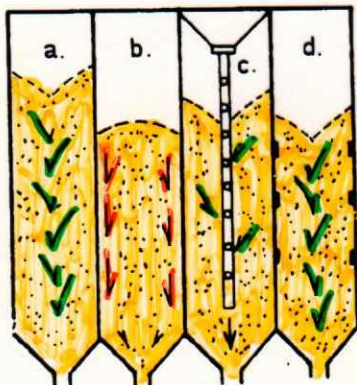
Slika 7. Lijevak oslonjen na posebni stup



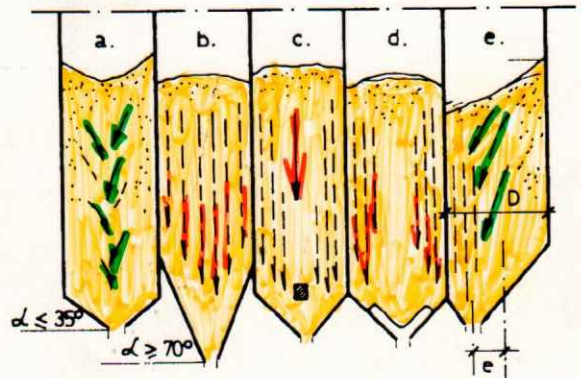
Slika 8. Lijevak kao betonska ispuna na ravnoj armiranobetonskoj ploči s obježenim željeznim dnom



Rjesenje fundiranja: raspodjela napona u tlu za **krutu** i **fleksibilnu** temeljnu konstrukciju

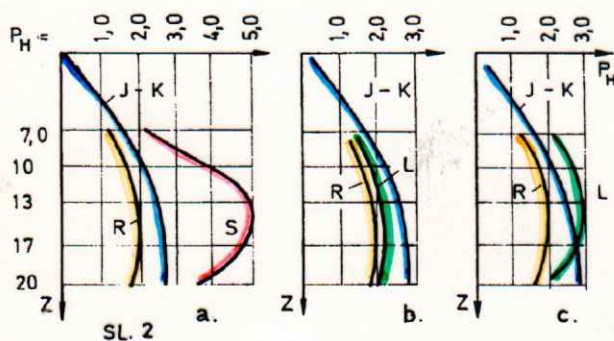
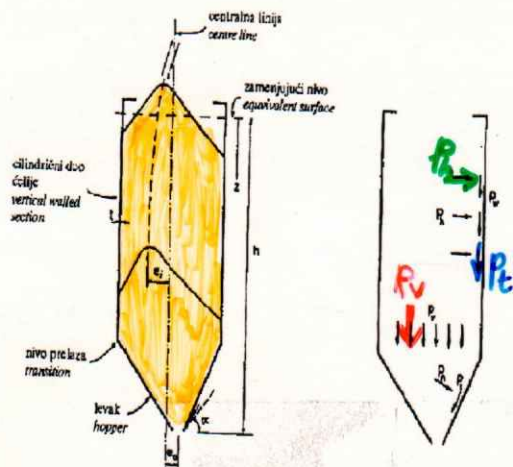


SL 1 - Oblici isticanja žita u čeliji pod raznim uslovima.



SL 4 - Uticaj konstrukcije levka i uređaja na način isticanja žita:

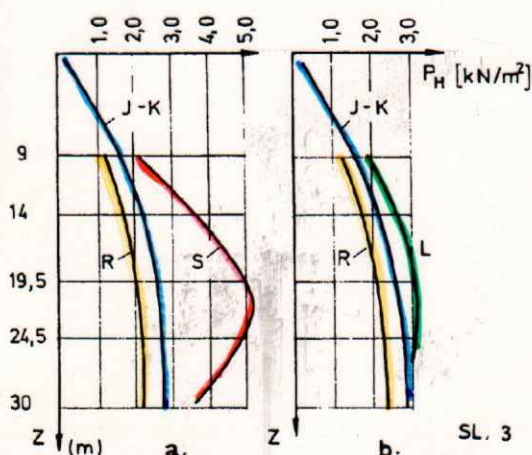
# OPTEREĆENJE U SILOSIMA



HORIZ OPTEREĆENJA PREMA IZVRŠENIM MERENJIMA

ČELIJA  $\phi = 6,50$  H = 21,0m

- PRI ISTICANJU STUBOM (LINIJA - S)
- PRI ISTICANJU LEVKOM KOD UGRAĐENIH PRSTENOVA (LINIJA - L)
- PRI ISTICANJU LEVKOM KOD UGRAĐENE CEVKE (LINIJA - L)



ČELIJA  $\phi = 5,30$  H = 33,0

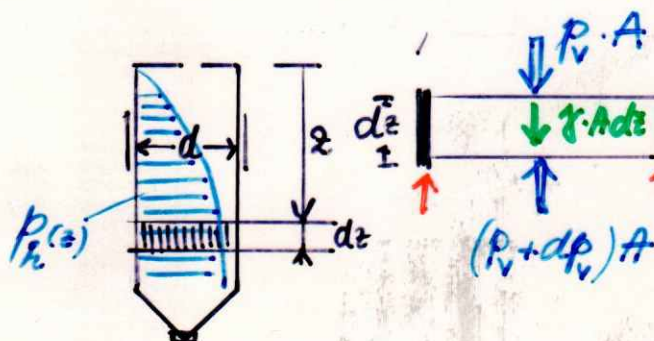
- ISTICANJE STUBOM (S)
- ISTICANJE LEVKOM KOD UGRAĐENE CEVKE (L)

R-LINIJA PRI PUNJENJU ZA SVE SLUČAJEVE

J-K-LINIJA JANSEN - KENENA DATA RADI POREĐENJA

SL. 2 i 3 - Linije pritiska žita prema dokumentaciji V.S. Kima. Urtane su srednje vrednosti iz niza merenja u označenim nivoima Z.

## JANSEN-KENANOVA TEORIJA :



$$\gamma \cdot A \cdot dz = A \cdot dp_v + P_h \tan \delta \cdot O \cdot dz$$

$$P_h / P_v = k_0, \tan \delta = f$$

$$dz = \frac{dp_v}{\gamma - f k_0 O P_v / A}$$

$$P_v = \frac{\gamma A}{f O k_0} (1 - e^{-\frac{O}{A} f k_0 z})$$

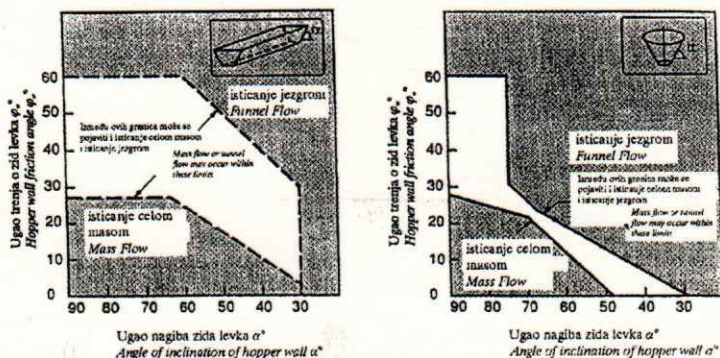
$$P_h = \frac{\gamma \cdot A}{f \cdot O} (1 - e^{-\frac{O}{A} f k_0 z})$$

$$k_0 = \tan^2(45^\circ - \varphi/2)$$

$$f = 0,4 \text{ za beton : žito}$$

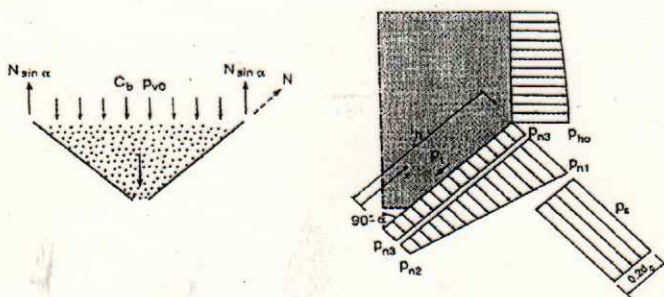
# OPTEREĆENJE SILOSA PREMA EC1 - dio 4

## - Način isticanja

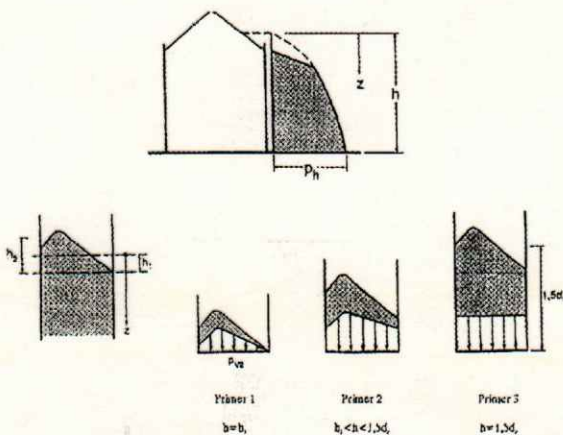


Slika 5.1 Granice između isticanja celom masom i isticanja jezgrom za kornjaste i konusne levkove

- Vitki i zdepasti silosi
- Opterećenja nakon punjenja i pri pražnjenju
- Opterećenja zidova i lijevka



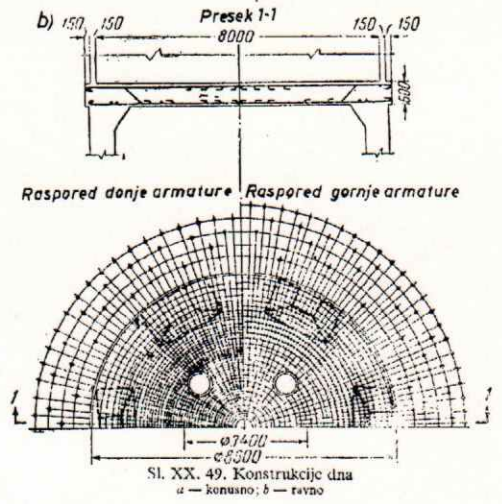
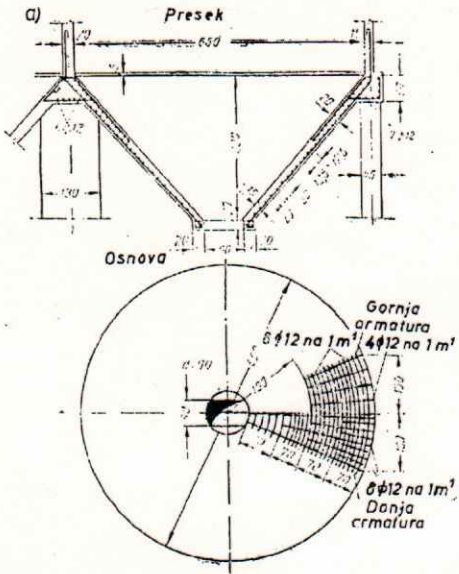
Slika 5.3 Opterećenja na levak i zatežuća sila na vrhu levka



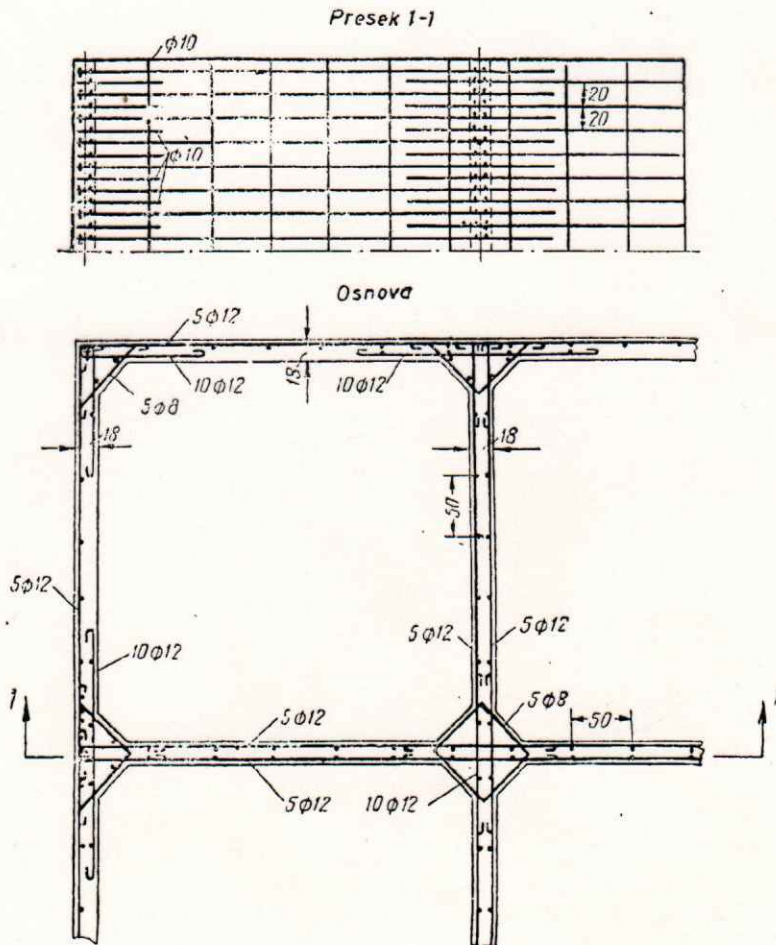
Slika 5.4 Opterećenja na zidove i ravno dno zdepastih silosa

# DETALJI ARMATURE SILOSA

## a) KRUZNE CELIJE

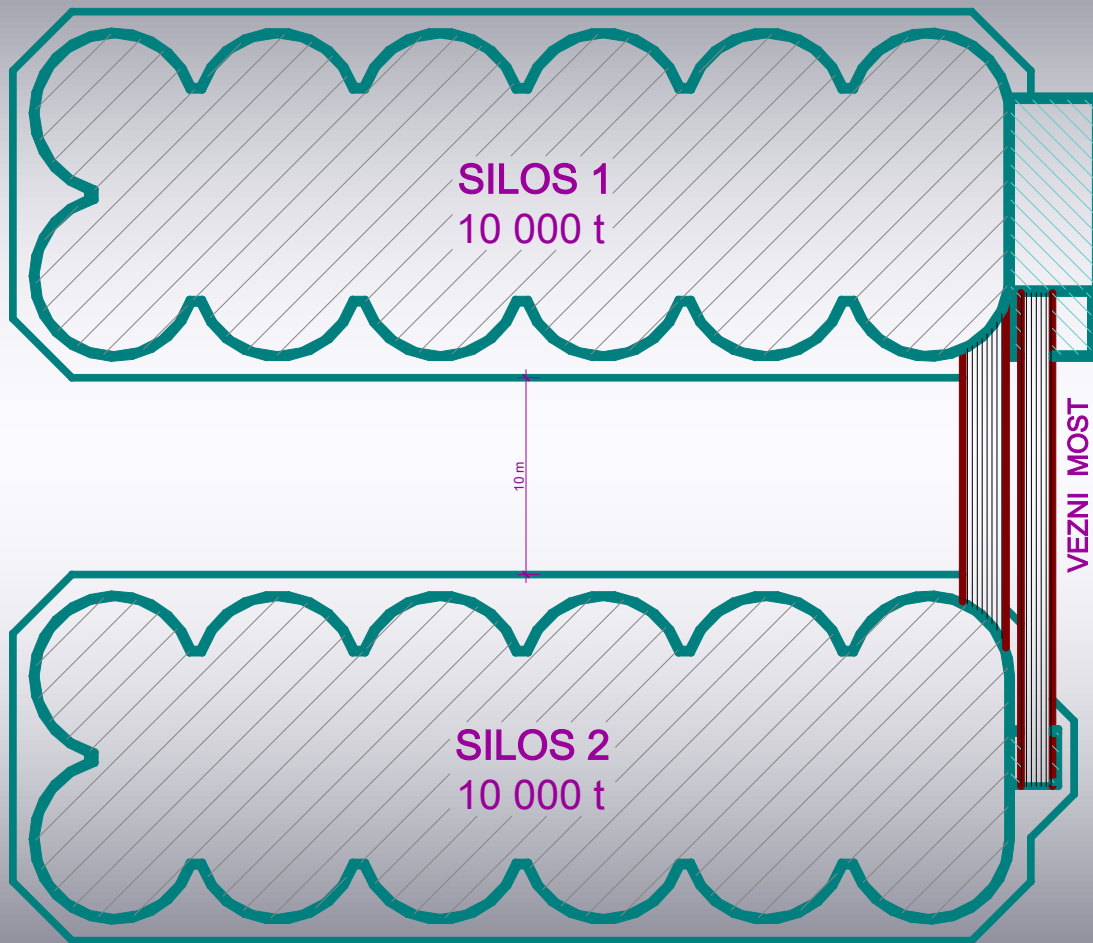


## b) KVADRATNE CELIJE

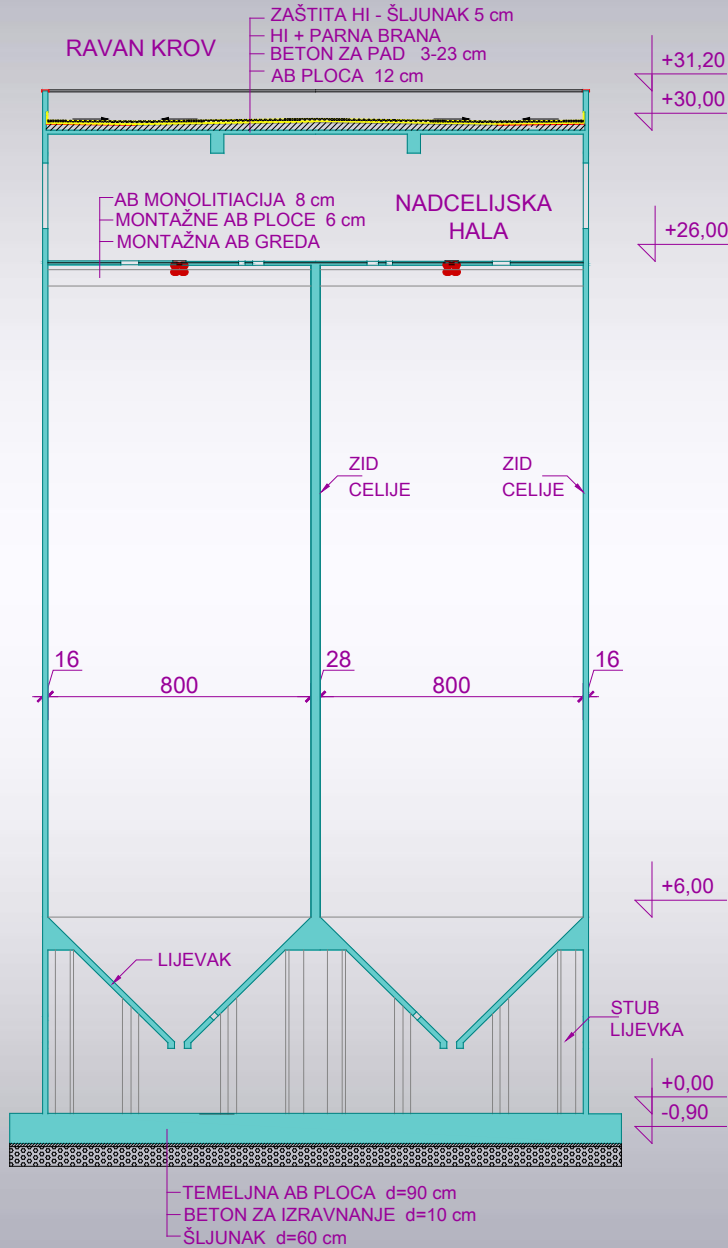


Sl. XX. 51. Armiranje kvadratnih silosa

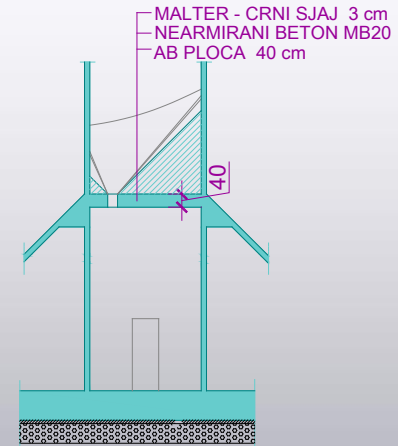
# SILOSI U SPUŽU - PROJEKTOVANJE I IZGRADNJA SITUACIONI PLAN



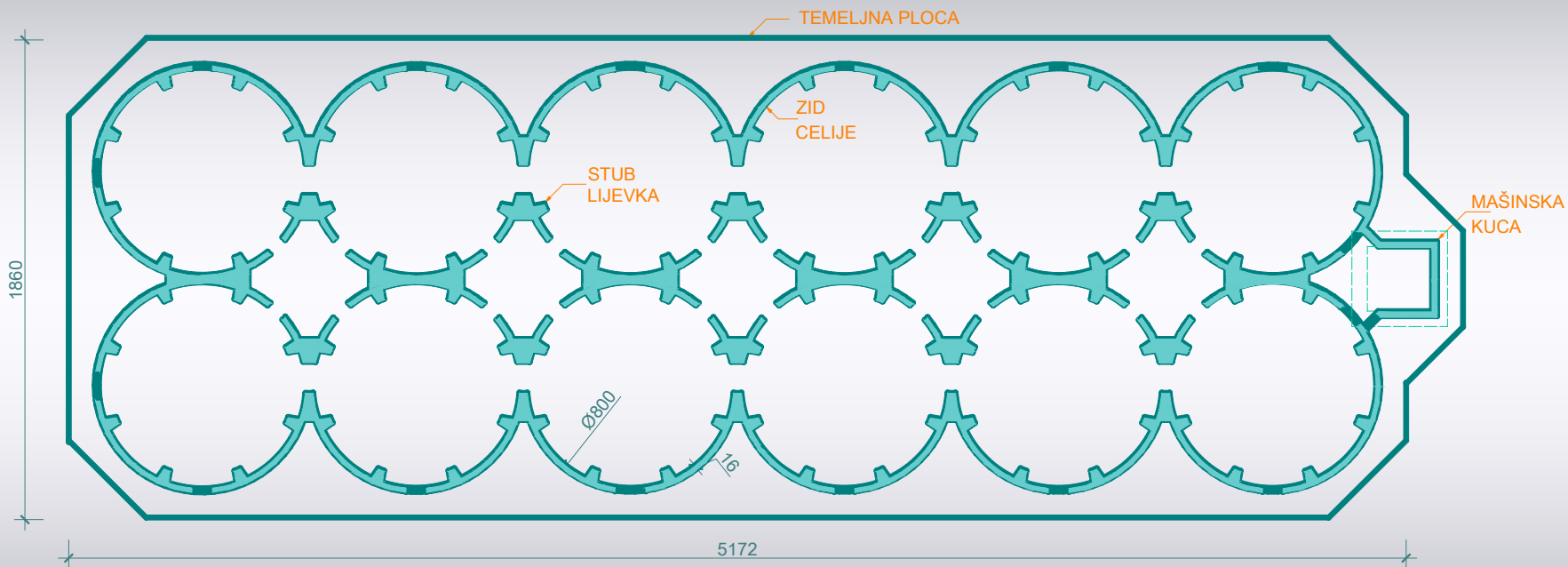
# POPREČNI PRESJEK



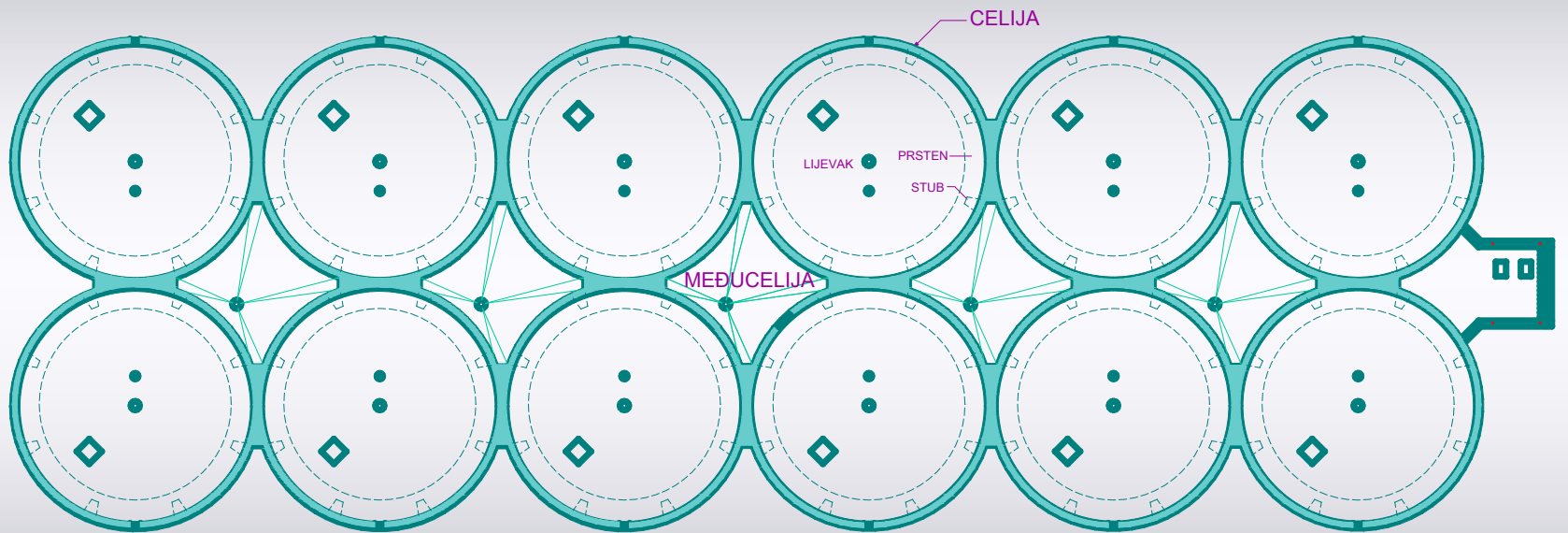
## PRESJEK KROZ MEĐUCELIJU



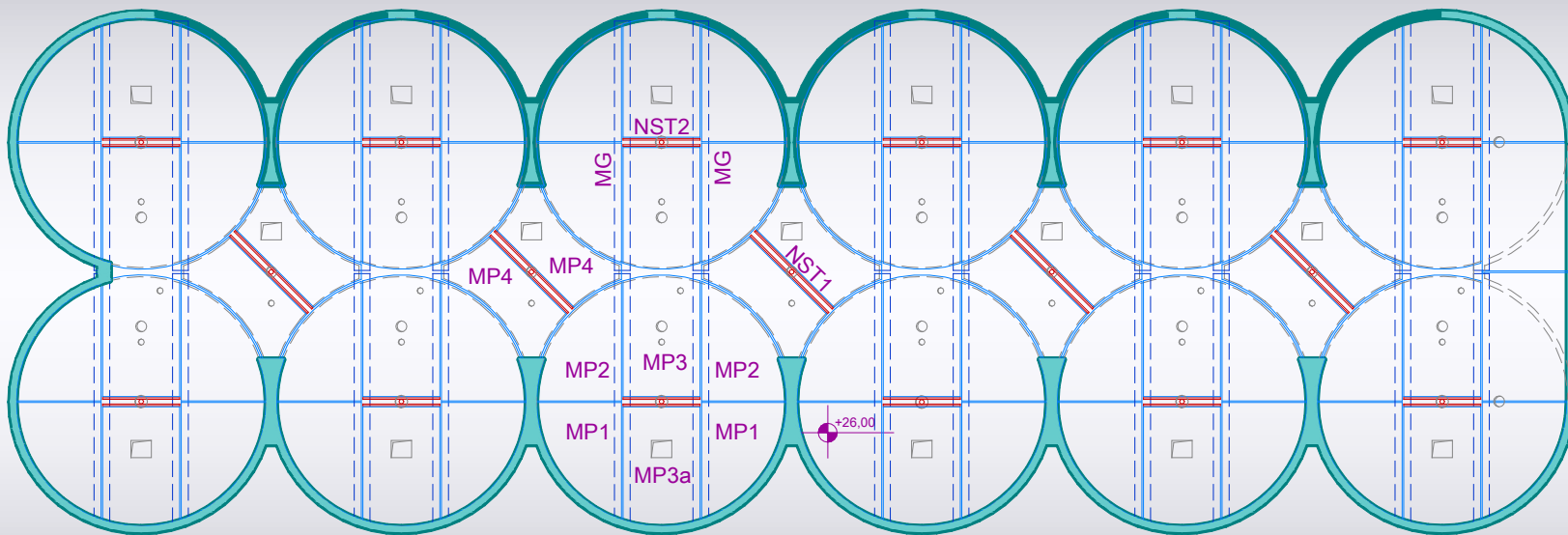




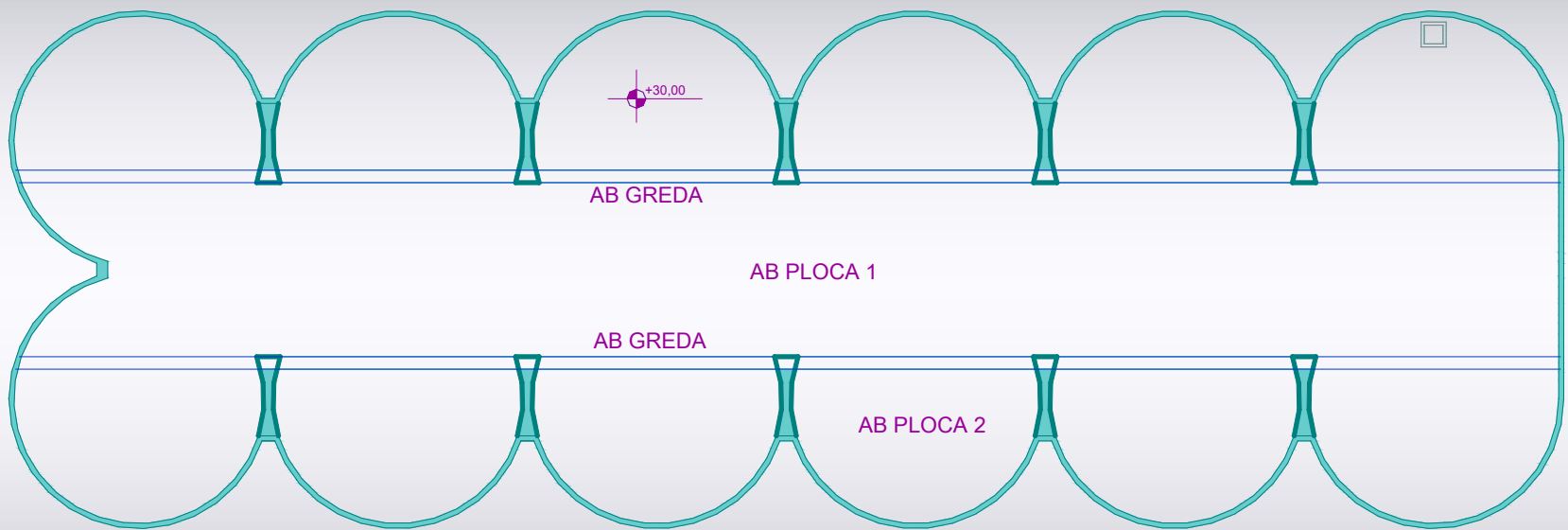
OSNOVA NA KOTI  $\pm 0,00$



OSNOVA NA KOTI +6,00



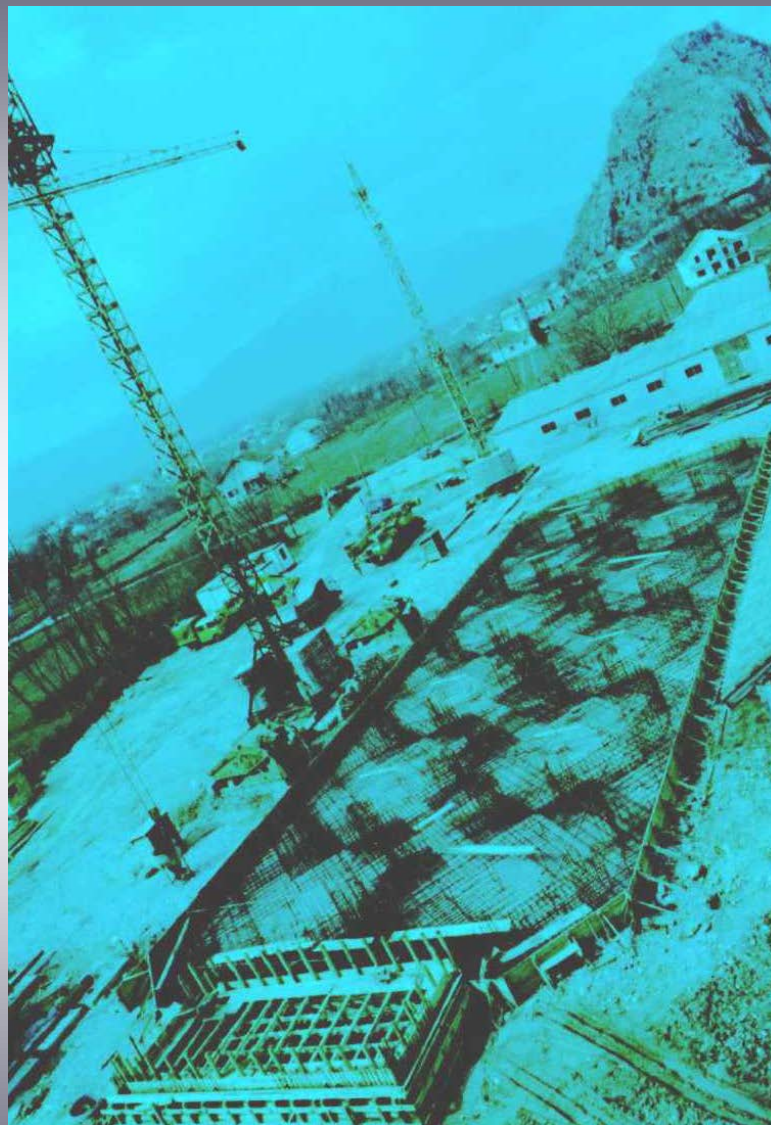
**POD NADČELIJSKE HALE  
OSNOVA NA KOTI +26,00**



**KROVNA KONSTRUKCIJA  
OSNOVA NA KOTI +30.00**

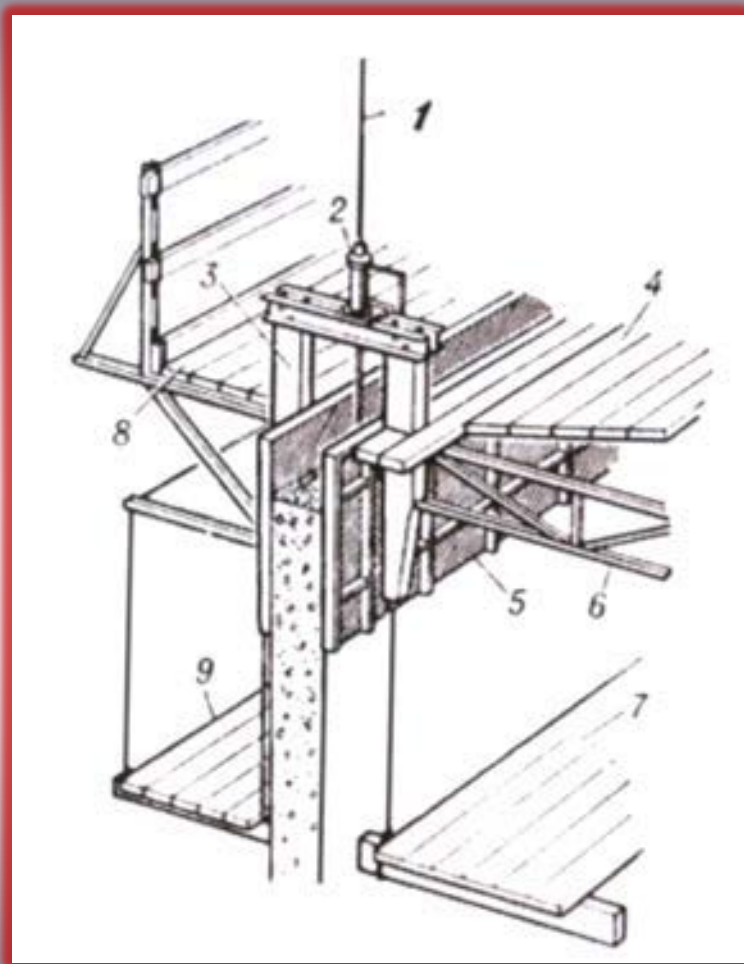
# IZGRADNJA





IZGRADNJA TEMELJNE PLOČE

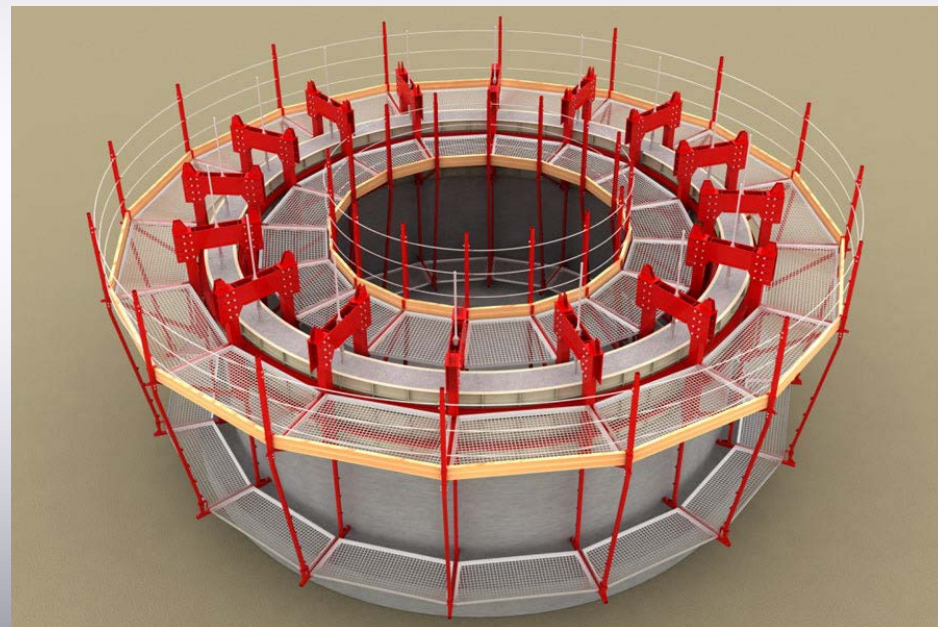
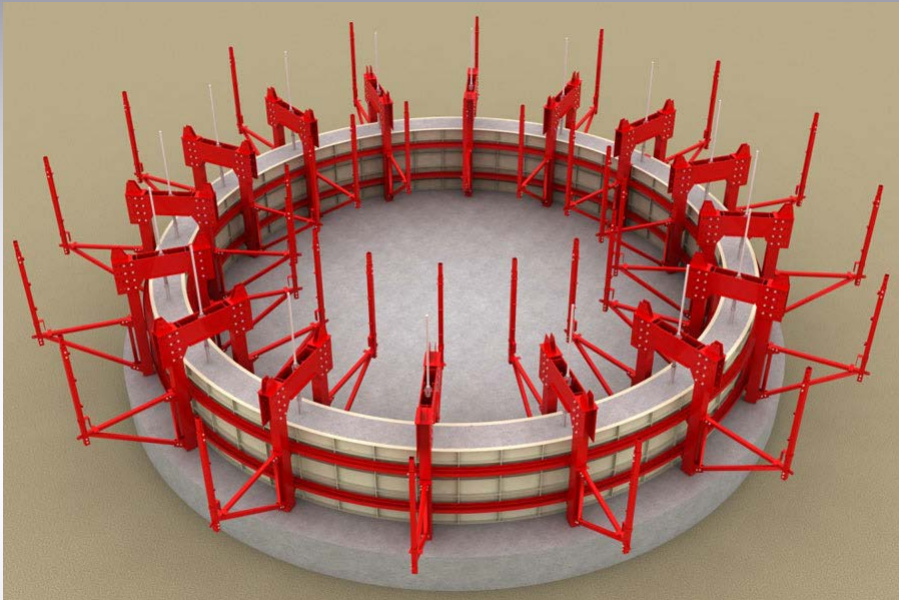
# KLIZNA OPLATA ZA SILOSE



Osnovni dijelovi klizne oplate:

1. Šipka – “kleter-štangla”
2. Hidraulička dizalica
3. Čelični nosač (ram)
4. Unutrašnja gornja platforma
5. Unutrašnja oplata
6. Konzolni nosač platforme
7. Unutrašnja donja platforma
8. Spoljna gornja platforma
9. Spoljna donja platforma

## POČETNA FAZA



## KOMPLETIRANJE





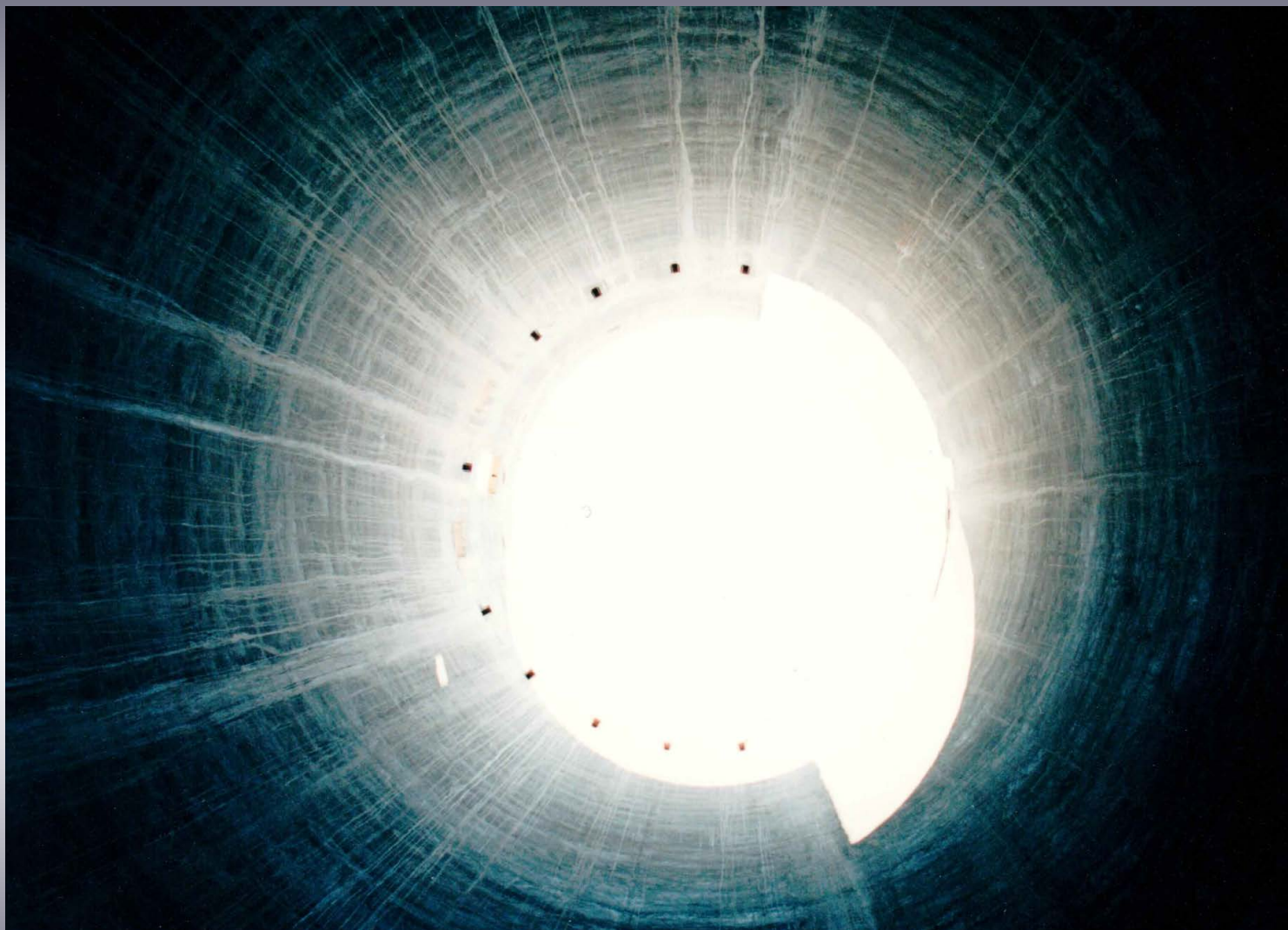
IZGRADNJA ČELIJA U KLIZNOJ OPLATI



**BETONIRANJE U KLIZNOJ OPLATI**



ĆELIJE SILOSA U TOKU "KLIZANJA"



ZAVRŠENA ČELIJA - POGLED ODOZDO



IZRADA MONTAŽNIH  
ELEMENTA PODA  
NADĆELIJSKE HALE

# MONTAŽA PODA NADĆELIJSKE HALE





NADĆELIJSKA HALA U UPOTREBI



PODĆELIJSKA HALA I  
IZGRADNJA LIJEVKA