PREDNAPREGNUTE ŠUPLJE PLOČE

PRESTRESSED HOLLOW CORE SLABS

MOBECO

MONTAŽNE
BETONSKE
KONSTRUKCIJE

SADRŽAJ
CONTENT

UVOD / INTRODUCTION

Jedna desetina svetske privrede obuhvata izgradnju i organizaciju stambenih i komercijalnih objekata. Ovaj sektor troši više materijala za izgradnju, minerala, vode i struje nego preostalih 90% privrede. Upravo zbog toga, tokom svih faza izgradnje, neophodan je nov pristup koji će zadovoljiti sve veće ljudske potrebe, a pritom očuvati i zaštititi životnu sredinu i prirodne resurse.
Projektovanje za potrebe održivog razvoja uključuje upotrebu građevinskog materijala koji ispunjavaju nove zahteve fleksibilnosti i prilagodljivosti, štednju energije tokom gradnje i upotrebe objekata, ekološku demontažu i recikliranje umesto rušenja uz prisustvo buke i prašine .

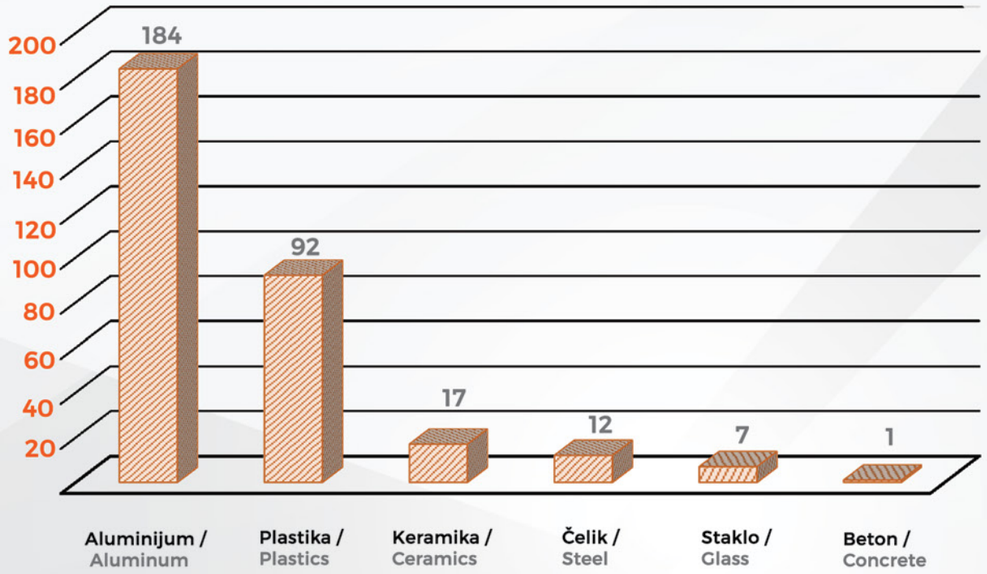
One tenth of the world's economy goes towards building and managing housing and commercial property. This sector accounts for more wood, minerals, water and electricity than the remaining 90 percent of the economy. Therefore new approaches in all life stages of buildings are needed, which will meet the challenges of satisfying the growing human needs while conserving and protecting the environmental quality and natural resources.
Designing for sustainable development involves the use of building materials that meet new requirements of flexibility and adaptability, energy conservation during construction and use of facilities, environmental disassembly and recycling instead of demolition in the presence of noise and dust.

KARAKTERISTIKE MONTAŽNIH ELEMENATA / OPPORTUNITIES FOR PREFABRICATION

Betonske konstrukcije, a posebno montažni elementi, imaju odlične performanse koje mogu da zadovolje sadašnje i buduće zahteve koji se tiču očuvanja životne sredine. Proizvodnja montažnih betonskih elemenata se odvija u kontrolisanim klimatskim uslovima u zatvorenim fabrikama. Na taj način je kontrola otpada, emisije i nivoa buke lako uporediva sa istim procesom koji se odvija na gradilištu. Upravo zbog toga je nelagodnost znatno smanjena u poređenju sa klasičnim graditeljskim metodama.
Pri fabričkoj proizvodnji, okruženje u kojima radnici rade se lako kontroliše. Takođe, recikliranje materijala je neuporedivo jednostavnije u fabričkim uslovima.

Concrete structures in general and prefabrication in particular have excellent opportunities to respond to the present and future environmental demands. The production of precast concrete elements takes place under controlled climatic conditions in enclosed factories. This makes control with waste, emissions and noise levels easy compared to the same processes at the building site. Consequently the inconvenience to the public is greatly reduced in comparison with traditional building methods.
With factory production, the environment for the workers is easily controlled. Also recycling of all materials is comparatively simple to achieve in a closed factory environment.

Beton ima karakteristike koje imaju mnogo ekoloških prednosti. Izdržljiv je, te ne zahteva toksične prezervative koji sprečavaju njegovo propadanje. U industrijalizovanim zemljama, korozija čelika košta oko 4% bruto nacionalnog proizvoda, a polovina svetske godišnje proizvodnje čelika se koristi da bi se zamenile korodirane konstrukcije. Energija koju troši beton je izuzetno mala u poređenju sa drugim materijalima (Grafikon 1.). Iskorišćenje termalne mase betona će uštedeti do 35% energije koja je neophodna za hlađenje ili grejanje zgrada. Osim toga, betonska masa ima izvanrednu sposobnost zvučne izolacije.



Grafikon 1. - Potrošnja energije za proizvodnju građevinskih materijala /
Chart 1. - Energy consumption for the production of building materials

Concrete has properties that at the outset are ecologically advantageous. Concrete is durable, and requires no toxic preservatives in order to prevent its deterioration. In industrialized countries corrosion of steel is costing about 4% of the gross national product, and half of the annual steel production in the world is used to replace corroded structures. In addition, the energy consumption of concrete is extremely low, compared to other construction materials (Graphic 1). The utilization of the thermal mass of the concrete will save up to 35% of the energy required to heat or cool buildings. Furthermore, the mass of concrete provides excellent sound insulating properties.

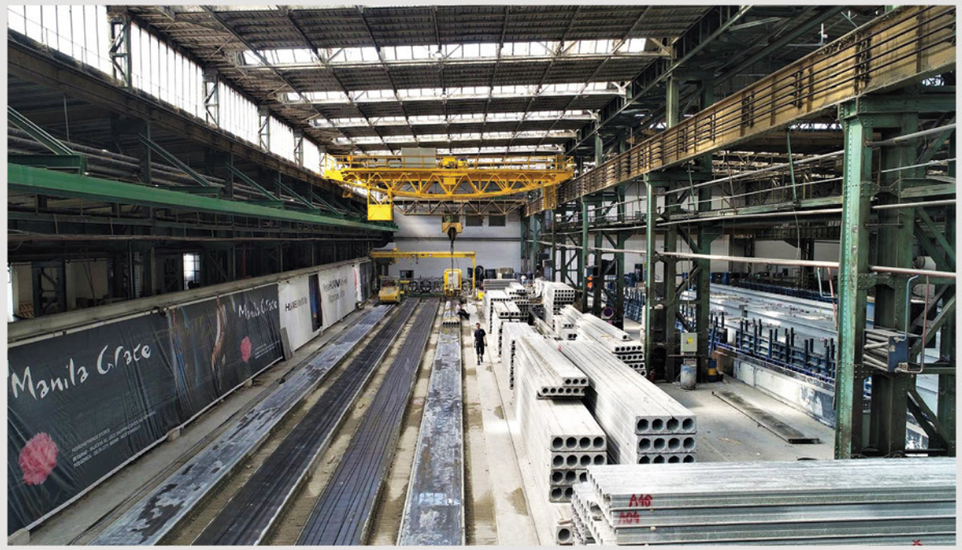
ŠUPLJE PLOČE - OPŠTE KARAKTERISTIKE / HOLLOW-CORE SLABS - GENERAL CHARACTERISTICS

Industrija montažnih betonskih elemenata je stalno u potrazi za novim proizvodima i građevinskim sistemima koji će zadovoljiti novonastale potrebe i zahteve modernog društva: nedostatak radne snage, konstruktivna efikasnost, otpornost na požar, brzina gradnje, kvalitet izvođenja i održiva gradnja. U tom smislu, jedno od najuspešnijih rešenja su prednapregnute šuplje ploče. One daju odgovor na sadašnje zahteve tržišta i izazove građevinske industrije. Poseduju konstruktivnu efikasnost, malu potrošnju materijala, visoko automatizovani proces proizvodnje koji je bezbedan po okolinu, visoku čvrstoću betona, kao i mogućnost ponovnog korišćenja i recikliranja na kraju upotrebnog veka.

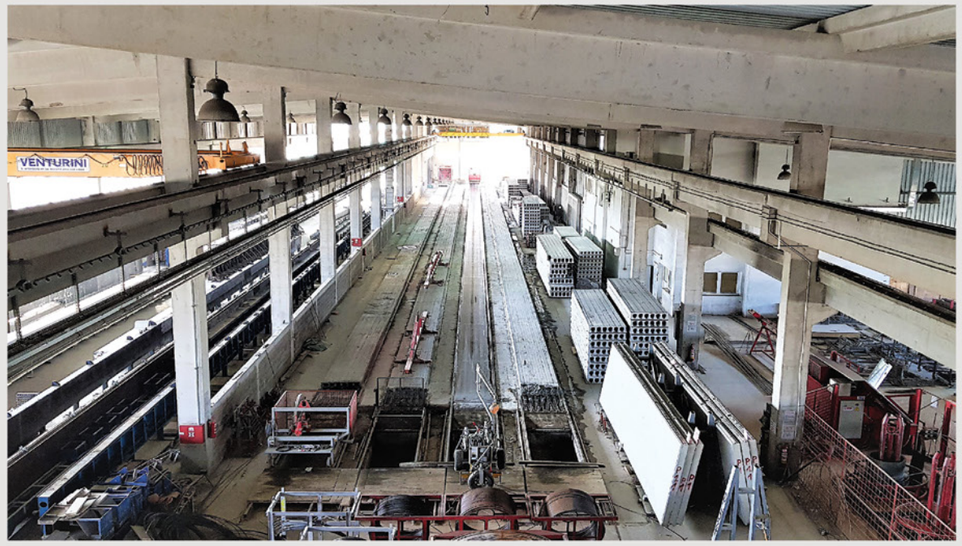
The precast concrete industry is constantly searching for new products and building systems to satisfy the coming needs and demands of our modern society: shortage of labour force, structural efficiency, fire resistance, speed of construction, quality of execution, and last but not least sustainable construction. One of the most remarkable and successfull developments in this context is the prestressed hollow core slab. It provides an answer to most of the present market demands and challenges for the building industry: structural efficiency, low material consumption, highly automated and environmentally friendly production process, high concrete strength, slender floor thickness, and possibilities for reuse and recycling at the end of the life cycle.

Proizvodnja šupljih ploča odvija se na pistama, metodom ekstrudovanja ili vibriranja specijalnog betona uz pomoć kliznih finišera koji formiraju presek ploča sa kontinuiranim unutrašnjim šupljinama. Proizvodna širina ploča je 120cm, dužina je promenljiva, a debljina direktno zavisi od opterećenja i raspona ploča.

The production of hollow-core slabs takes place on standard production beds by the method of extrusion or vibrations of special concrete with the help of slipform pavers which form slab section with continual interior holes. The production width of slabs is 120cm, the length is variable, whereby thickness depends on load and the span of slabs.



Slika 1. - Pogon za livenje šupljih ploča - Beograd / Image 1. - Section for casting hollow plates - Belgrade



Slika 2. - Pogon za livenje šupljih ploča - Niš / Image 2. - Section for casting hollow plates - Niš

- **Za proizvodnju šupljih ploča primenjujemo dve tehnologije:**

  1.ECHO - ošupljene ploče se liju SLIP FORMER mašinom
  2. ELEMATIC - izlivanje ploča mašinom EXTRUDER.

  Prva tehnologija se primenjuje u Niškom pogonu, a druga u Beogradu.

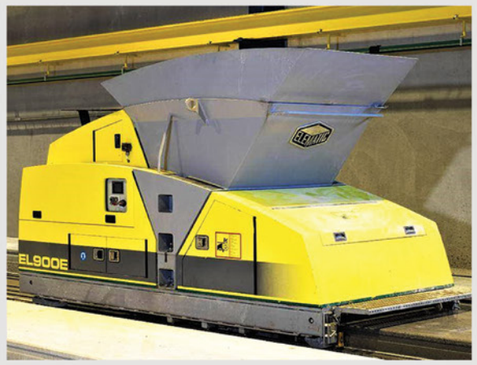
- We use two technologies for the production of hollow-core slabs:

  1. ECHO - scraped slabs are bled with SLIP FORMER machines
  2. ELEMATIC - casting of slabs with machine EXTRUDER.

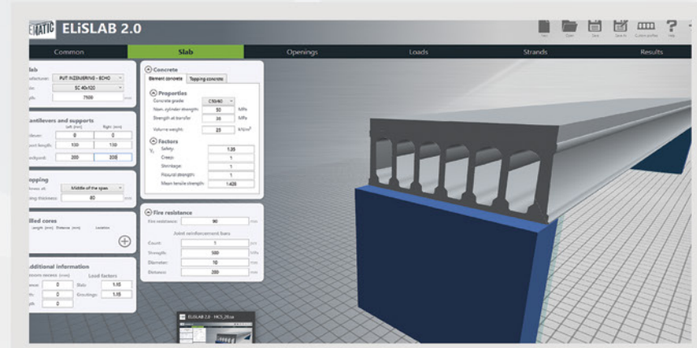
  The first technology is applied in the section in Niš, and the other in Belgrade.

SLIP FORMER - ECHO

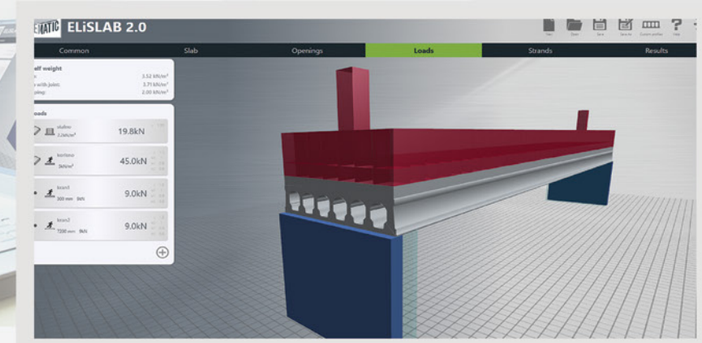
EXTRUDER - ELEMATIC EL900E



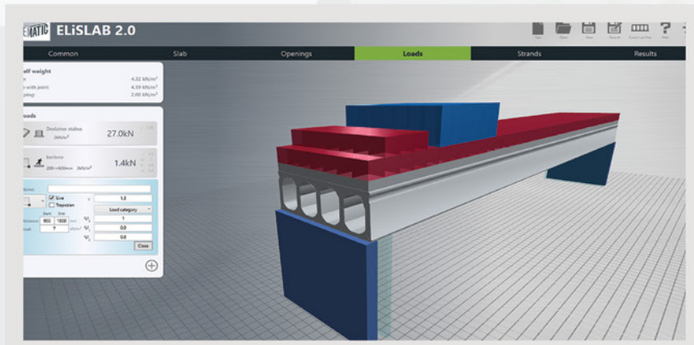
Kao softversku podršku za statički proračun nosivosti i vatrootpornosti šupljih ploča, koristimo program Elematic ELiSLAB 2.0.



ECHO



As software support for static calculation of load capacity and fire resistance of hollow plates, we use the Elematic ELiSLAB 2.0 program.



ELEMATIC

Glavne prednosti prednapregnutih šupljih ploča /
Main advantages of prestressed hollow-core slabs

Smanjena težina
Postiže se unutrašnjim šupljinama čitavom dužinom ploče. Smanjuje troškove gradnje: za proizvodnju je potrebno 40 do 50% manje sirovina u odnosu na metodu livenja na licu mesta.

Reduced weight
Attained by interior hollow cores along the entire length of slabs reduces the cost of building: production requires 40 to 50% less raw materials in comparison with the method of casting in situ.

Velika nosivost
Omogućava primenu prednapregnutih šupljih ploča u izgradnji proizvodnih pogona i objekata za skladištenje.

Great bearing capacity
Enables the application of prestressed hollow core slabs in building production plants and storage facilities.

Fleksibilnost
Fleksibilnost postižemo sečenjem ploča na bilo koju dužinu i pod različitim uglovima.

Flexibility
Is achieved by cutting slabs to any length and under different angles.

Brza gradnja
Proizvodnja prednapregnutih šupljih ploča je automatizovana i brza. Tokom montaže nije potrebna nosiva skela i najčešće se montaža vrši direktno sa vozila na nosivi zid ili gredu što smanjuje vreme i utrošak energije. Procesi koji slede nakon montaže mogu da otpočnu odmah nakon montaže.

Speedy construction
The production of prestressed hollow core slabs is automated and speedy; mounting does not require scaffolding and often it is performed directly from the vehicle to the retaining wall or beam which reduces time nad energy consumption; mounting follow-up processes can start immediately after mounting.

Smanjenje broja radnika
Automatizacija procesa u fabrici smanjuje potreban broj radnika u proizvodnom pogonu i pri montaži na gradilištu.

Number of site personnel reduction
The automation of processes in the factory reduces the required number of members of the site personnel in the production plant and on the construction site in the course of mounting.

Široko polje primene
Prednapregnute šuplje ploče obezbeđuju duge, čiste raspone i veliku nosivost, što je pogodno za izgradnju stambenih objekata, bolnica, škola, sportskih objekata, industrijskih postrojenja, skladišta, komercijalnih objekata, višespratnih garaža.

Wide scope of applications
Prestressed hollow core slabs ensure long clear spans and great bearing capacities, which is good for building residential buildings, hospitals, schools, sports facilities, industrial plants, depots, commercial facilities,multi-floor garages.

Prilagodljivost svakom sistemu gradnje
Prednapregnute šuplje ploče mogu se kombinovati sa montažnom AB konstrukcijom, monolitnom AB konstrukcijom i čeličnom konstrukcijom.

Adaptability to every system of building
Prestressed hollow core slabs can be combined with the precast prefabricated AB construction, monolyth AB construction and steel construction.

Odlična akustička izolacija i toplotne karakteristike
Njihova masa i stepen amortizacije redukuju vibracije zgrada za koje je to potrebno.

Excellent acoustic insulation and thermal characteristics
Their mass and the level of amortization reduce vibrations of buildings for which this is advisable.

Otpornost na požar

Rezultati ispitivanja pokazuju da međuspratne i krovne konstrukcije od prednapregnutih šupljih ploča mogu biti otporne na požar i do 120 minuta.

Fire resistance

Testing results show that interfloor and roof constructions from prestressed hollow core slabs can resist fire for 120 minutes.

Ekonomično rešenje

Upotrebom prednapregnutih šupljih ploča smanjuju se troškovi izgradnje, ekspoloatacije, kao i adaptacije i demontaže (rušenja).

Economical solution

Prestressed hollow core slabs reduce building costs, exploitation costs, as well as costs of renovation and dismounting (demolition).

Ekološki proizvod

Proizvodnja i montaža prednapregnutih šupljih ploča su bezbedni po životnu sredinu iz više razloga: smanjena upotreba sirovina i energije, smanjenje buke, prašine i emisije opasnih materija, olakšan i kontrolisan tretman otpadnih materijala.

Ecological product

The production and mounting of prestressed hollow core slabs are environmentally safe for several reasons: reduced use of raw materials and energy, noise reduction, reduction of dust and hazardous substances emission, facilitated and controlled treatment of waste materials.

Mogućnost ponovnog korišćenja i recikliranja

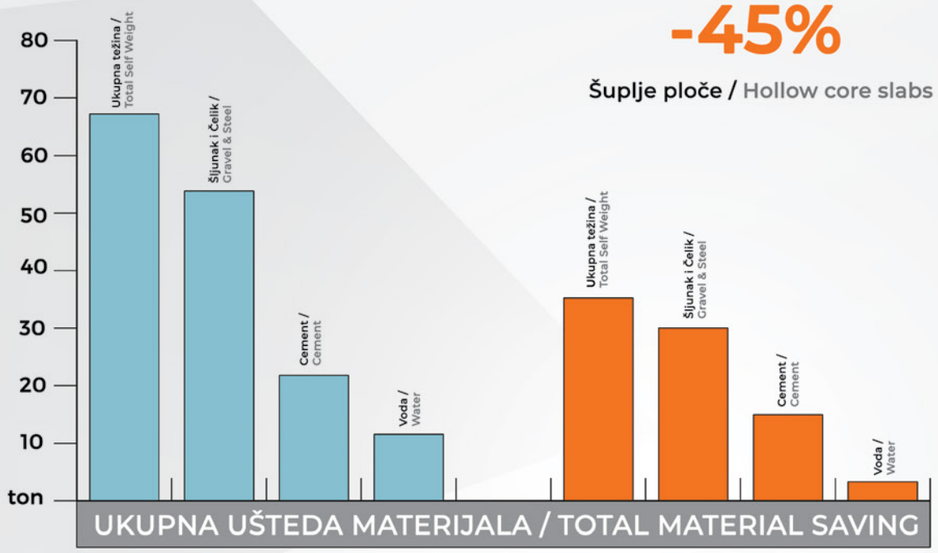
Bitna prednost montažne gradnje je mogućnost demontaže i redizajna postojećih montažnih objekata.

The possibility of recovery and recycling

The essential advantage of the precast prefabricated building is the possibility of dismounting and redesigning existing precast prefabricated facilities.

Montažni prednapregnuti podovi od šupljih ploča i armirani podovi liveni na licu mesta koji se koriste za porodičnu stambenu jedinicu-poređenje uticaja na životnu sredinu /

Comparison of the environmental effects between a precast prestressed hollow core floor and a plain cast in-situ reinforced floor for single family housing.



Grafikon 2. - Ukupno iskorišćenje materijala za šuplje ploče u poređenju sa pločama koje se liju direktno na gradilištu /
Chart 2. - Total material consumption of hollow core slabs compared to cast in-situ floors

Sledeće tabele pokazuju rezultate komparativne LCA studije koja je poredila prednapregnute šuplje ploče i ploče koje su livene na licu mesta. Cifre se odnose na jedan kvadratni metar betonskog sprata pojedinačne porodične stambene jedinice tokom perioda od 50 godina. Rezultati pokazuju da šuplje ploče imaju mnogo bolje rezultate od onih koje su livene na licu mesta, i to po skoro svim parametrima koji se odnose na bezbednost životne sredine:

- **28% manje primarnog utroška energije,**
- **40 do 50% manje sirovina,**
- **37,8% manje stvaranje otpada.**

The following tables show the results of a comparative LCA study of a prestressed concrete hollow core floor compared to a plain cast in-situ slab. The figures are related to one square meter of concrete storey floor in a single family house, over a period of 50 years. The results show that the hollow core floor scores much better than the in-situ floor, on most environmental parameters:

- 28% less primary energy consumption,
- 40 to 50% less raw material,
- 37,8% less generation of waste.

	Šuplje ploče / Hollow core floor	Livene ploče / Cast in-situ floor
Ukupno čelika (MJ) / Steel total (MJ)	119	183
Procentualno čelika (%) / Steel share (%)	25,8%	28,5%
meki čelik / mild steel	67	306
prednapregnut čelik / prestressing steel	117	
reciklirano / recycling	-65	-123
Ukupno cementa (MJ) / Cement total (MJ)	213,3	173
Procentualno cementa (%) / Cement share (%)	46,3%	26,9%
Portland B / Portland B	32,3	
Portland C / Portland C	181	
Visoka peć / Blast furnace A		173
Ukupno vezivo (MJ) / Filler total (MJ)	39,8	20,3
Procentualno vezivo (%) / Filler share (%)	8,6%	3,2%
pesak / sand	7,1	8,0
šljunak / gravel		11,9
krečnjak / lime stone	32,6	
voda / water	0,2	0,4
Ukupan transport (MJ) / Transport total (MJ)	55,1	66,3
Procentualno transport (%) / Transport share (%)	12,0%	10,3%
kamion 40t / truck 40t	32,6	
kamion 28t / truck 28t	10,6	11,4
kamion 16t + mixer / truck 16t + truck mixer	1,0	39,7
brod / ship	11,0	15,2
Kraj životnog ciklusa (MJ) / End of life cycle (MJ)	18,1	60,1
Kraj životnog ciklusa (%) / End of life cycle (%)	3,9%	9,4%
Gubitak (deponija) / Loss (dumping)	0	0
Iskorišćen visokokvalitetni beton / Reuse high quality concrete	-9,5	15,5
Iskorišćen niskokvalitetni beton / Reuse low quality concrete	27,6	44,6
Proizvodna energija (MJ) / Production energy (MJ)	15,8	139,9
Proizvodna energija (%) / Production energy (%)	3,4%	21,8%
Ukupna energija / Total energy	-1,4	
dizel / diesel	3,4	5,6
gas / gas	5,3	7,6
struja / electricity	21,1	30,9
propan / propane		95,8
Ukupno (MJ) / Total (MJ)	461	643
Ukupno (%) / Total (%)	72%	100%

Tabela 1. - Doprinos proizvodnog procesa iskorišćenju primarne energije/
Table 1. - Contribution by the production processes to the useof primary energy

	Šuplje ploče / Hollow core floor	Livene ploče / Cast in-situ floor
Eutrofikacija (kg PO43) / Eutrophication (kg PO43- eq.)	0,035	0,0410
Izduvni gasovi (* 10-12) / Exhaustion (* 10-12)	0,0468	0,0707
Ekotoksicnost (* 10^3 m^3) / Ecotoxicity (* 10^3 m^3)	2,78	5,81
Efekat staklene bašte (kg CO_2 eq) / Greenhouse effect (kg CO_2 eq)	55,2	53,4
Acidifikacija (kg CO_2) / Acidification (kg SO_2 eq.)	0,252	0,0460
Letnji smog (kg CO_2) / Summer smog (kg SO_2 eq.)	0,0297	0,0460
Ljudska toksicnost (kg) / Human toxicity (kg)	0,318	0,411
Upotreba primarne energije (MJ) / Use of primary energy (MJ)	461	643
Čvrst otpad (kg) / Solid waste (kg)	36,3	58,8

Tabela 2. - Apsolutne vrednosti uticaja na životnu sredinu;
Izvor: CREM - Consultancz and Research for Environmental Management - Amsterdam, Holandija /
Table 2. - Absolute values of the environmental effects;
Source: CREM - Consultancy and Research for Environmental management – Amsterdam, The Netherlands

Literatura
- Fib bilten 21 "Pitanja zaštite životne sredine pri montažnim radovima" - Mart 2003; Federation internationale du Beton - Lozana, Švajcarska /

Literature
- Fib bulletin 21 "Environmental issues in prefabrication" - March 2003; Fédération internationale du Béton – Lausanne, Switserland

Izdržljivost i dug životni vek / Durability and long life span

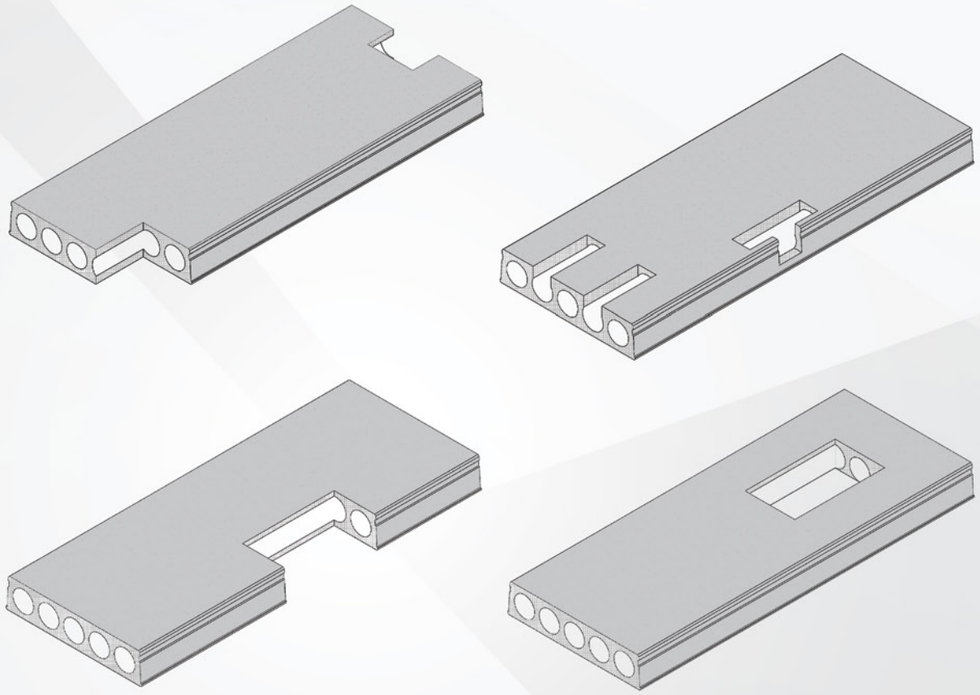
Osnovni preduslov za dug vek trajanja je izdržljiva noseća konstrukcija, uključujući i spratove. Usled velike izdržljivosti betona, niske poroznosti i dovoljnog pokrivača prednapregnute armature, spratovi od šupljih ploča će zadržati konstruktivni kapacitet 100 godina i duže. Proizvodnja mora biti usklađena sa nacionalnim standardima (na primer - Evropski propis EN 1168) i strogo kontrolisana u skladu sa sistemom samokontrole, a nadgledana od strane ovlašćenog spoljnog organa.

The prerequisite for a long life span is durable load bearing structures, including the floors. Hollow core floors will retain their structural capacity for 100 years and more because of their high concrete strength, low porosity and sufficient cover to the prestressing reinforcement. The manufacture has to respond to the national product standard (e.g. European Product Code EN 1168), and is strictly controlled according to a system of self-control, supervised by an accredited external body.

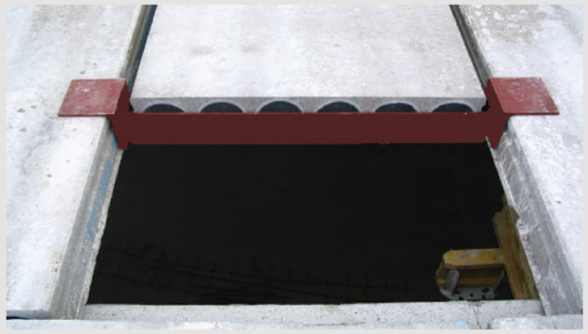
Otvori i zaseci u pločama / Opens and cuts in plates

Otvori i zaseci u prednapregnutim betonskim šupljim pločama se mogu proizvesti u pogonu prema statičkim proračunima. Rubovi zaseka su grubi zbog načina proizvodnje. Zaseci se mogu pojaviti preko čitave širine elementa, dok se veći otvori mogu realizovati i pomoću čeličnih pot-konstrukcija. Na crtežima se mogu videti primeri zaseka i otvora.

In the prestressed concrete hollow-core slabs, openings and cuts can be produced according to the static calculations. The edges of the cuts are rough due to the production method. Cuts can appear over the entire width of the element, while larger openings can also be realized using steel substructures. The drawings show examples of cuts and openings.

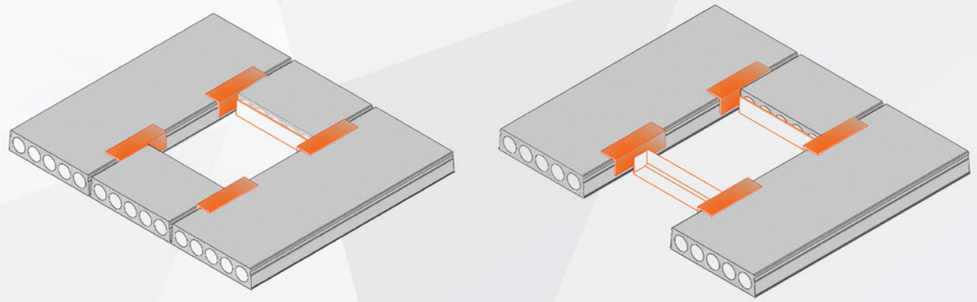


Otvori i zaseci u pločama - primeri / Opens and cuts in plates - examples



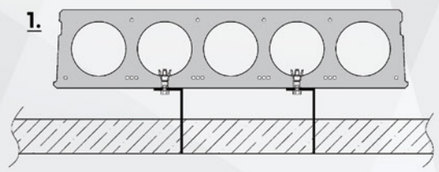
Otvori za stepenice, kamine, krovne prozore, kao i otvori za različite vrste instalacija. Ako nema druge potpore, mogu se napraviti konstrukcijom zamenskih nosača (vekslom).

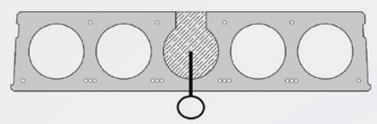
Openings for stairs, fireplaces roof windows, and opens for different types of instalation. If there is no other support, can be made by the construction of replacement girders.

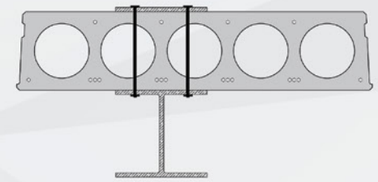


Upotreba zamenskih nosača - veksli / Use of replacement girders

Načini kačenja visećih tereta / Ways of hanging loads



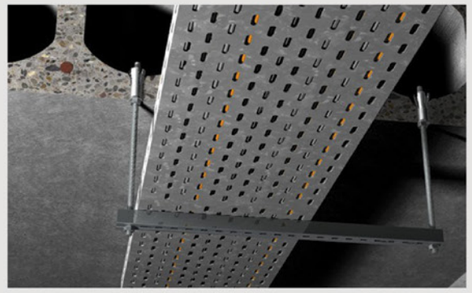




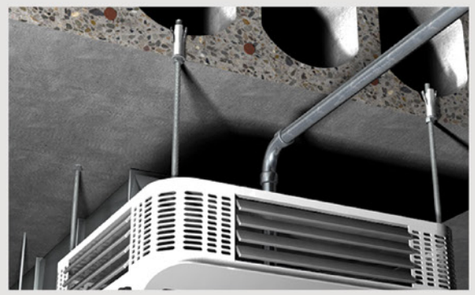
U zavisnosti od težine tereta moguća su tri načina kačenja tereta (1.-3. crteži od najlakšeg do najtežeg tereta). Jako je bitno voditi računa o mestu bušenja i striktno je zabranjeno bušiti na mestima užadi. Koriste se za kačenje cevovoda, nosača kablova, ventilacionih sistema, sprinkler sistema, spuštenih plafona, raznoraznih konzola, čeličnih i drvenih konstrukcija.

Depending on the weight of cargo, there are three ways to load loads (1.-3. drawings from the easiest to the most difficult load). It is very important to take care of the drilling site and it is strictly forbidden to drill at the rope sites.They are used for pipelines, cable trays, ventilation systems, sprinkler systems, suspended ceilings, consoles, steel constructions, timber constructions.

Načini kačenja tereta / Methods of loading cargo



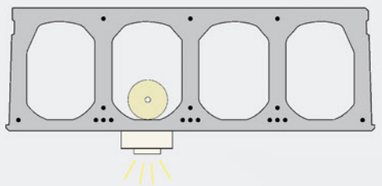
Kačenje nosača kablova /
Hanging the cable tray



Kačenje ventilacionog sistema /
Hanging ventilation system

Ugradnja rasvete u šuplje ploče postaje sve zastupljenija. Troškovi postavljanja su znatno niži, i samo postavljanje je jednostavnije i brže. Transformatori se mogu postaviti dan nakon montaže ploča, dok kod tradicionalnih metoda dve do tri nedelje nakon uklanjanja oplata i skela.

Kačenje cevi / Hanging pipes



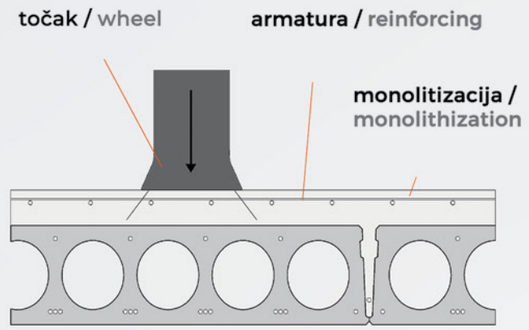
Prikaz ugradne rasvete /
Preview embedded lighting

The installation of lighting in the hollow plates becomes more and more common. Installation costs are much lower, and the setup is simpler and faster. Transformers can be installed the day after assembly of panels, while in the traditional methods two to three weeks after the removal of formwork and scaffolding.

Završna obrada šupljih ploča i zalivanje betonom / Finishing of hollow-core slabs and concrete sealing

U zavisnosti od tipa i namene prostorije, vrste opterećenja i drugih uticaja vrši se proračun potrebne debljine sloja monolitizacije. Najčešće usvajamo debljinu 5-6cm, dok po potrebi može biti i veća. U posebnim slučajevima šuplje ploče nije potrebno zalivati betonom. Kod tačkastog i neravnomernog opterećenja sloj monolitizacije se dodatno ojačava ugrađivanjem mrežaste armature.

Depending on the type and purpose of the room, types of loads and other influences, the calculation of the required thickness of the monolith layer is carried out. Usually we adopt a thickness of 5-6cm, while if necessary it can be even larger. In special cases, hollow-core slabs need not be flooded with concrete. In the case of point and uneven loading, the monolithic layer is additionally reinforced by the installation of reticulate reinforcement.



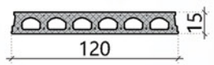
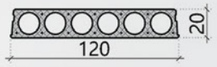
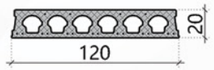
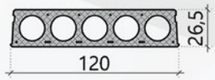
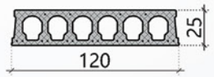
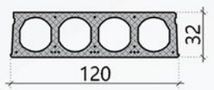
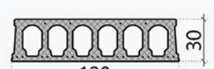
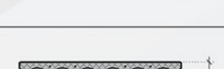
Završna obrada gornje strane ploče takođe zavisi od vrste i namene prostorije. Može biti glatka, ukoliko ne postoji monolitni sloj, odnosno hrapava, radi boljeg vezivanja sa monolitnim slojem betona.

Final treatment at the top layer of the slab also depends on the type and purpose of the room. It can be smooth, if there is no monolithic layer, that is, rough, for better bonding with the monolithic layer of concrete.

TIPOVI ŠUPLJIH PLOČA /
TYPE OF HOLLOW-CORE SLABS

U našoj ponudi postoje dva tipa šupljih ploča, ECHO i ELEMATIC, koje se međusobno razlikuju po obliku poprečnog preseka, tj. po različitoj tehnologiji izrade. ECHO ploče se izrađuju slipformerom i proizvodimo ih u pogonu u Nišu, dok se ELEMATIC ploče izrađuju uz pomoć extrudera u Beogradu.

In our offer there are two types of hollow-core slabs, ECHO and ELEMATIC, which differ from one another in the form of a cross-section, i.e. the molds in which they come out. ECHO boards are made with slipformer and we manufacture them in the factory in Niš, while the ELEMATIC boards are made with the help of extruders in Belgrade.

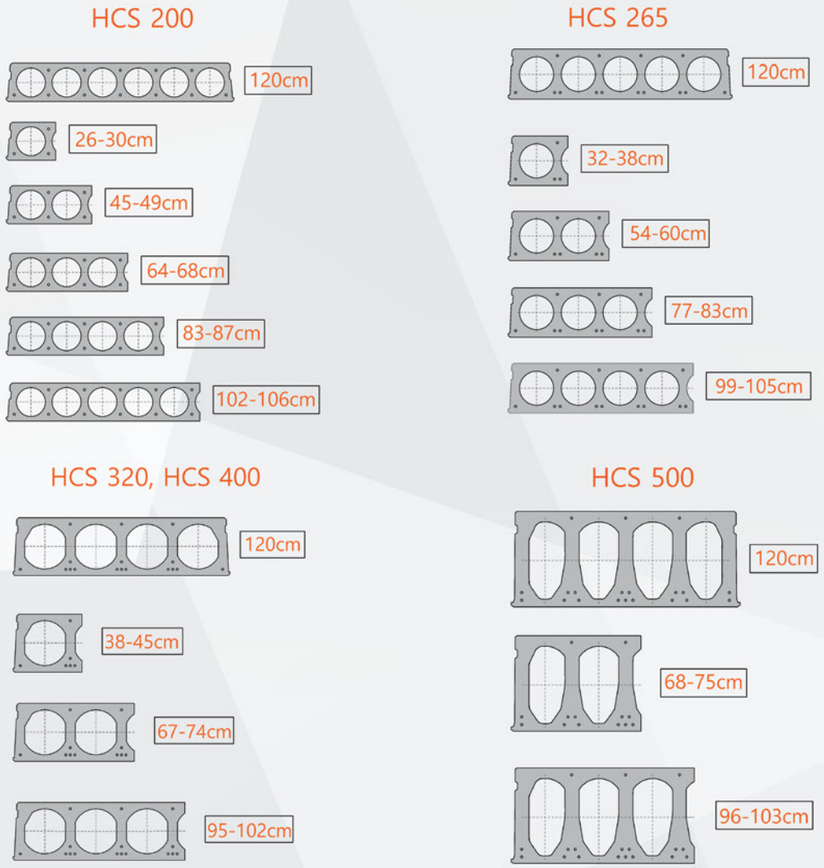
ECHO		ELEMATIC	
HCS 15x120 dužina do 7M		**HCS 20x120** dužina do 11M	
HCS 20x120 dužina do 11M		**HCS 26.5x120** dužina do 12M	
HCS 25x120 dužina do 12M		**HCS 32x120** dužina do 14M	
HCS 30x120 dužina do 14M		**HCS 40x120** dužina do 17M	
HCS 35x120 dužina do 15M		**HCS 50x120** dužina do 20M	
HCS 40x120 dužina do 17M			

Radi lakšeg uklapanja, tj. redanja šupljih ploča prilikom formiranja međuspratne konstrukcije, ploče je moguće seći po dužini. Širine sečenja su određene statičkim proračunom i prikazane su u sledećim crtežima.

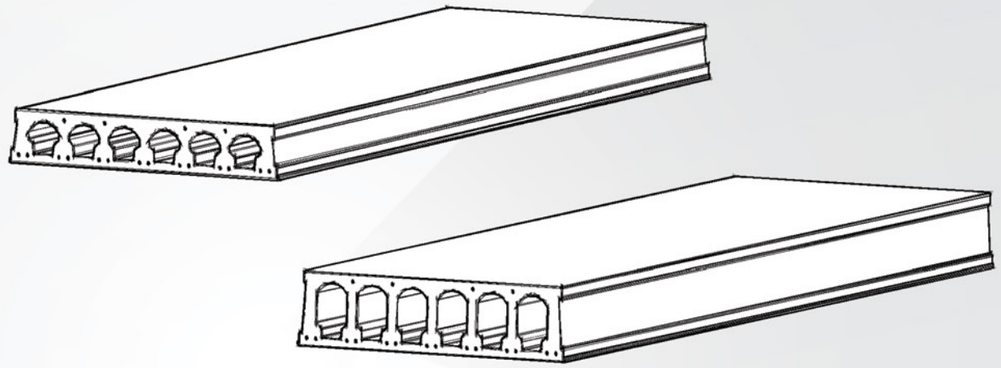
In order to facilitate the fitting of the hollow plates when forming the intermediate structure, the panels can be cut lengthwise. The cutting widths are determined by the static calculation, and are shown in the following drawings.

ECHO

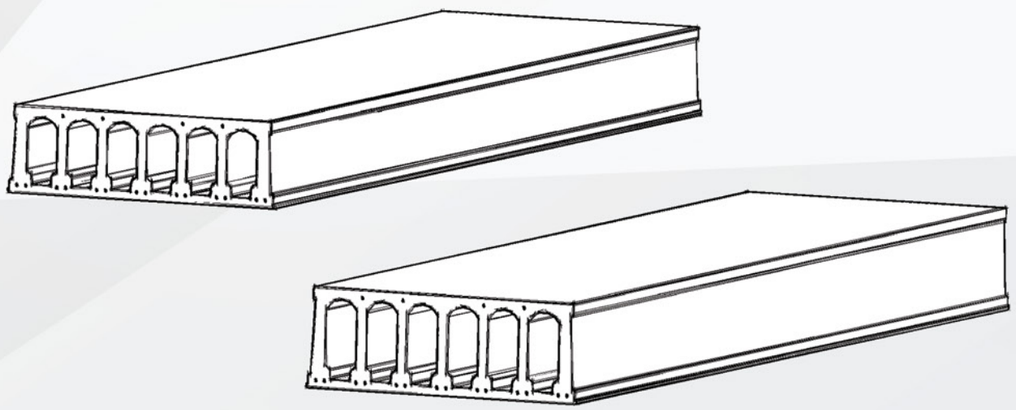
ELEMATIC

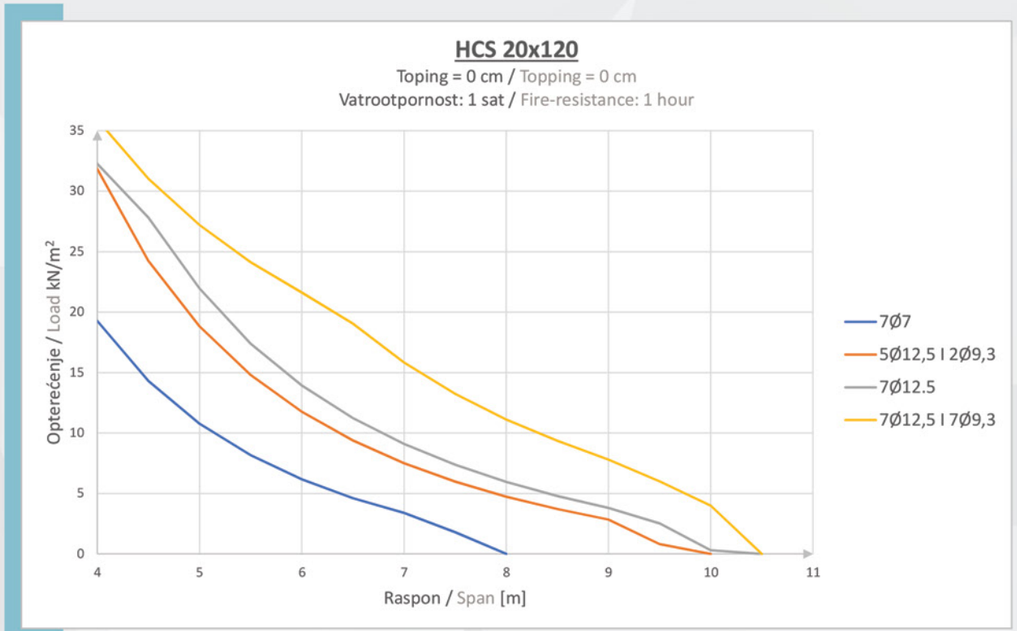


TABELE NOSIVOSTI PLOČA ECHO TEHNOLOGIJE /
TABLES CAPACITY SLABS ECHO TECHNOLOGY



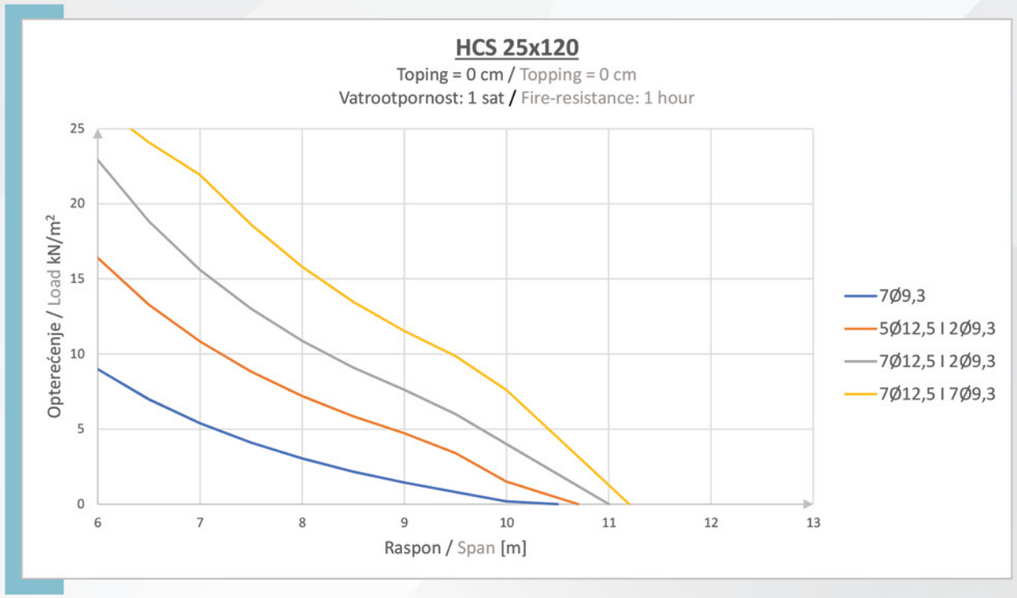
ECHO PRECAST ENGINEERING





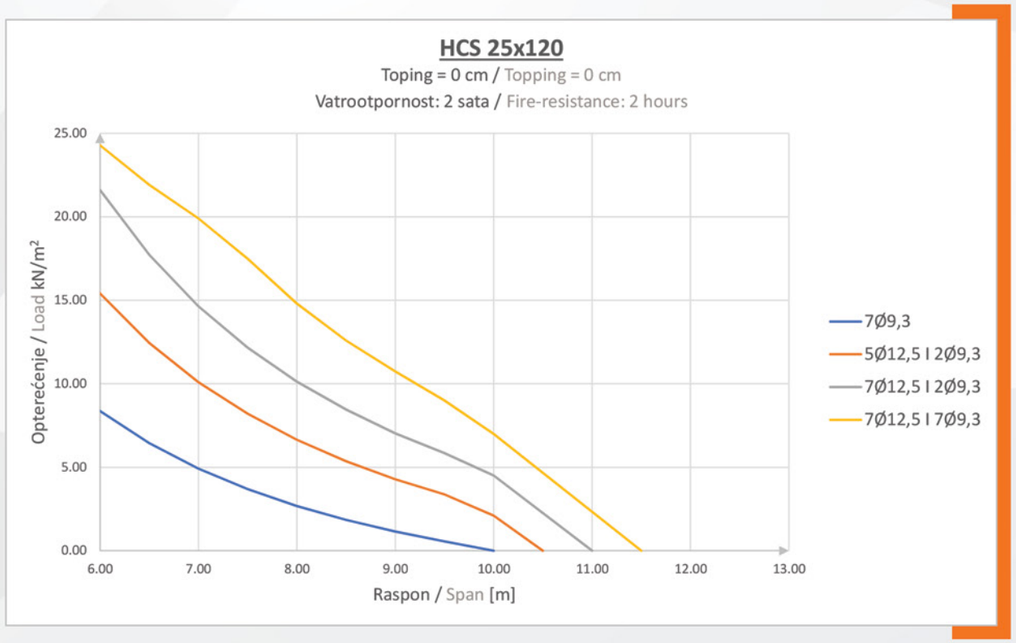
- Klasa betona / Concrete: C50/60
- Težina / Weight: 310 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 35 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

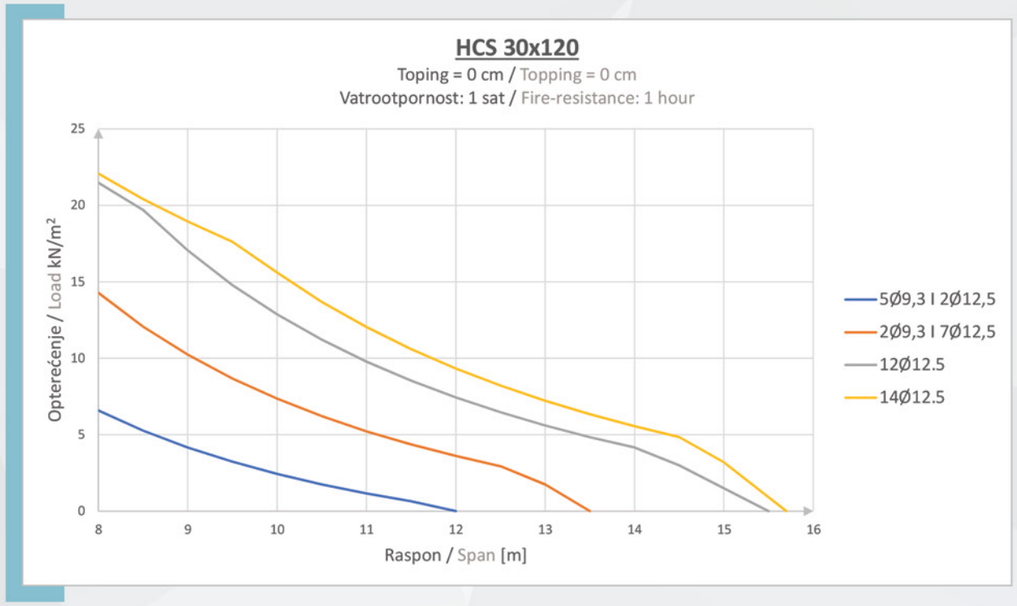
- Klasa betona / Concrete: C50/60
- Težina / Weight: 310 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 45 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250



- Klasa betona / Concrete: C50/60
- Težina / Weight: 341.9 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 30 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

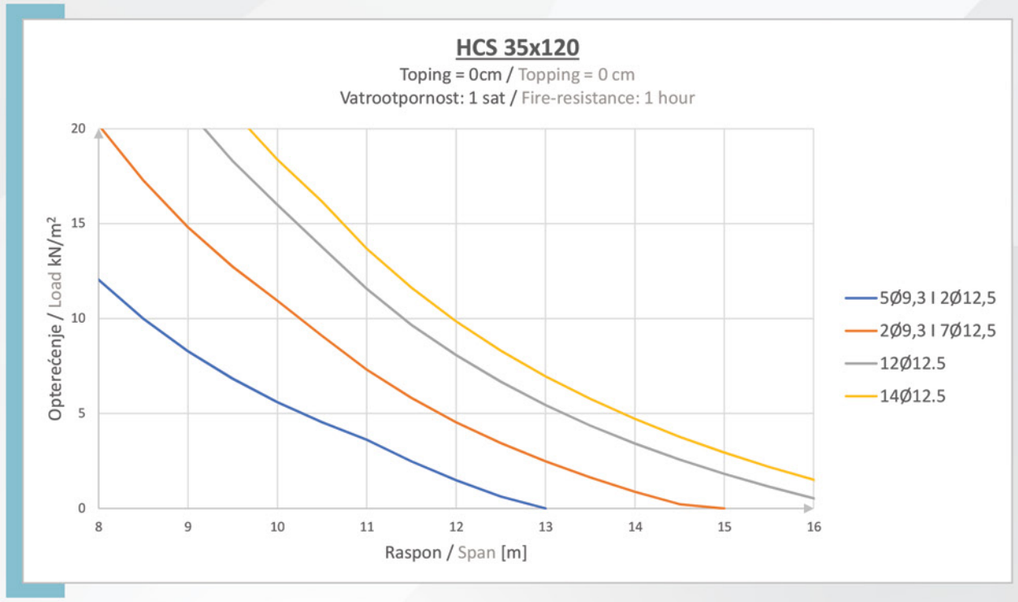
- Klasa betona / Concrete: C50/60
- Težina / Weight: 341.9 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 45 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250



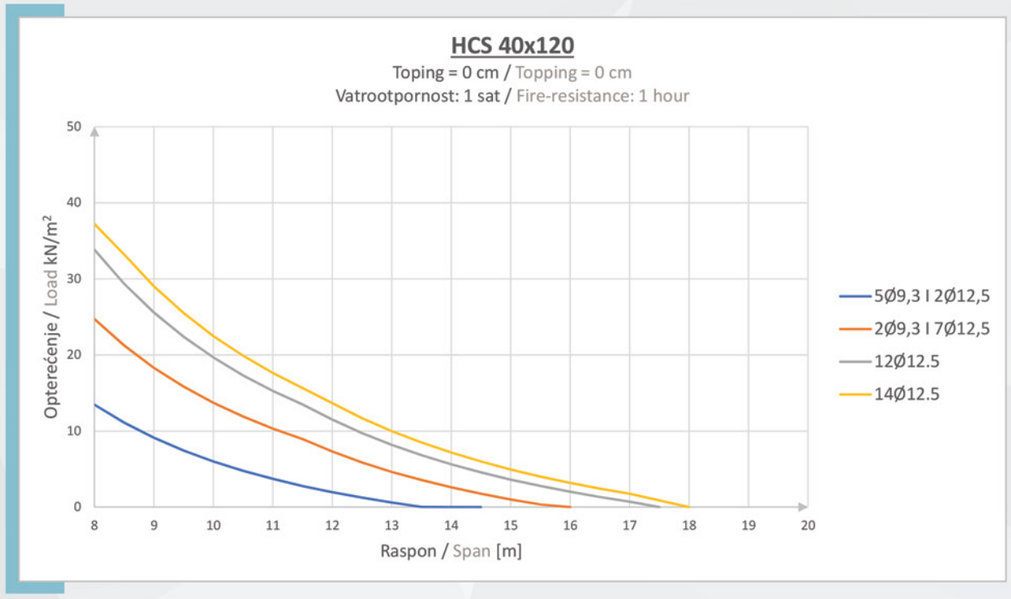


- Klasa betona / Concrete: C50/60
- Težina / Weight: 380.11 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 35 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

- Klasa betona / Concrete: C50/60
- Težina / Weight: 380.11 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 45 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

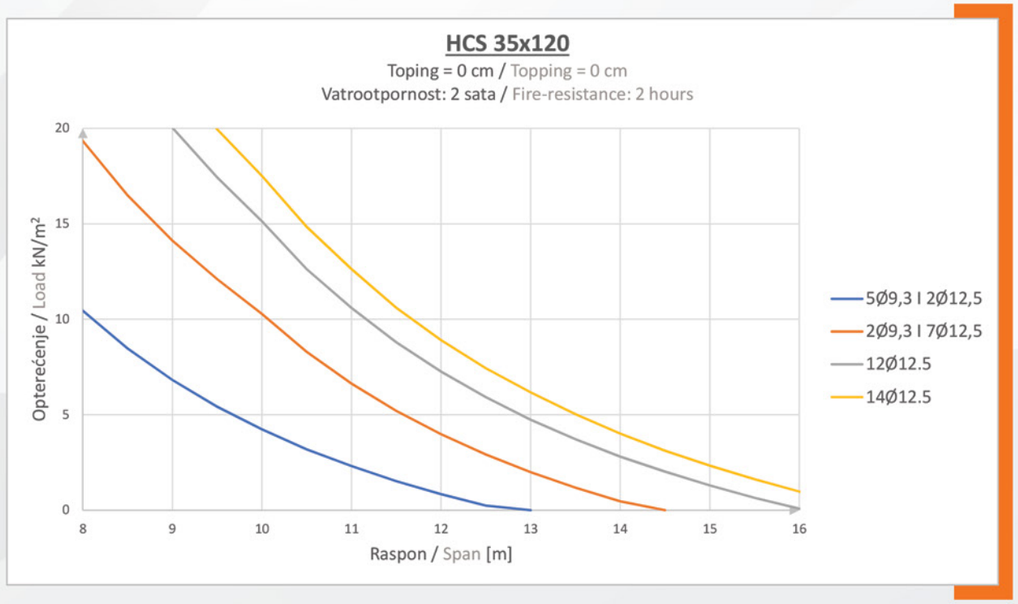


- Klasa betona / Concrete: C50/60
- Težina / Weight: 423.47 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 35 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

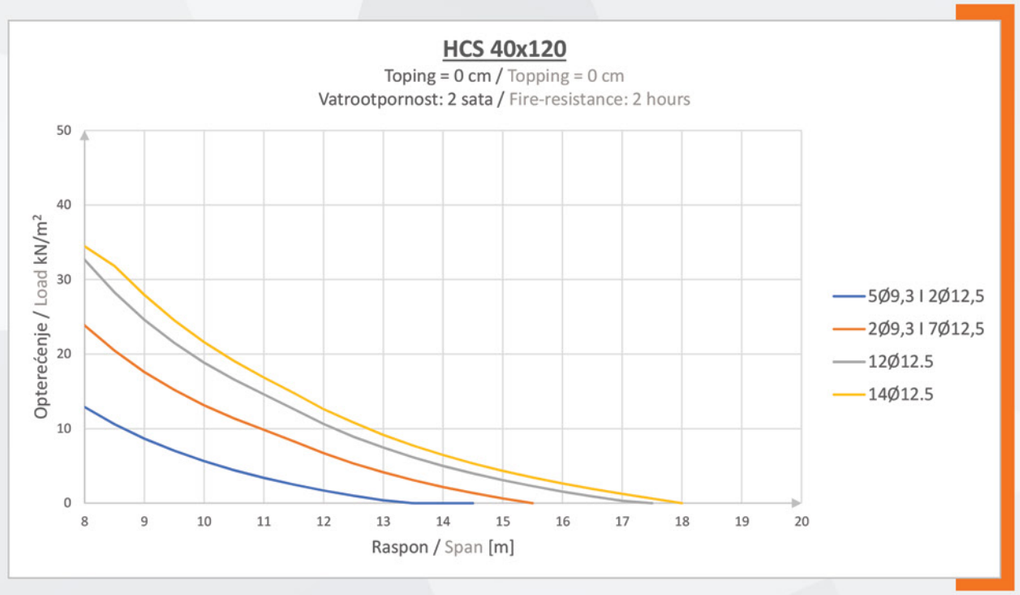


- Klasa betona / Concrete: C50/60
- Težina / Weight: 458 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 35 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

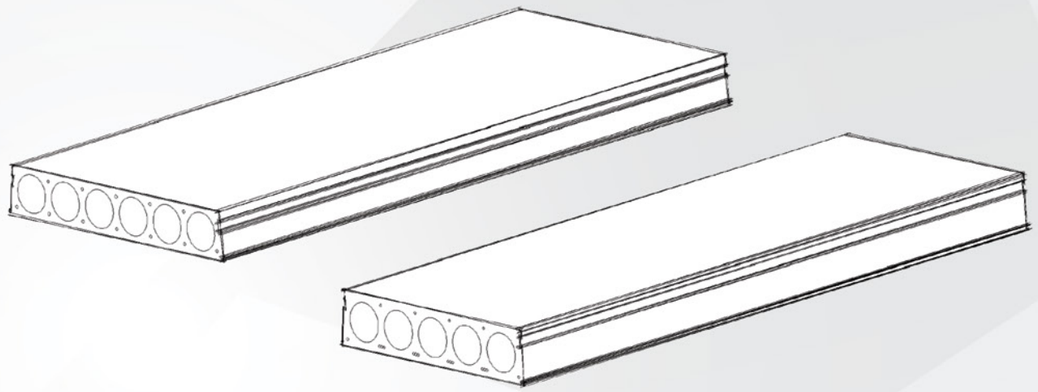
- Klasa betona / Concrete: C50/60
- Težina / Weight: 423.47 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 45 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250



- Klasa betona / Concrete: C50/60
- Težina / Weight: 458 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 45 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

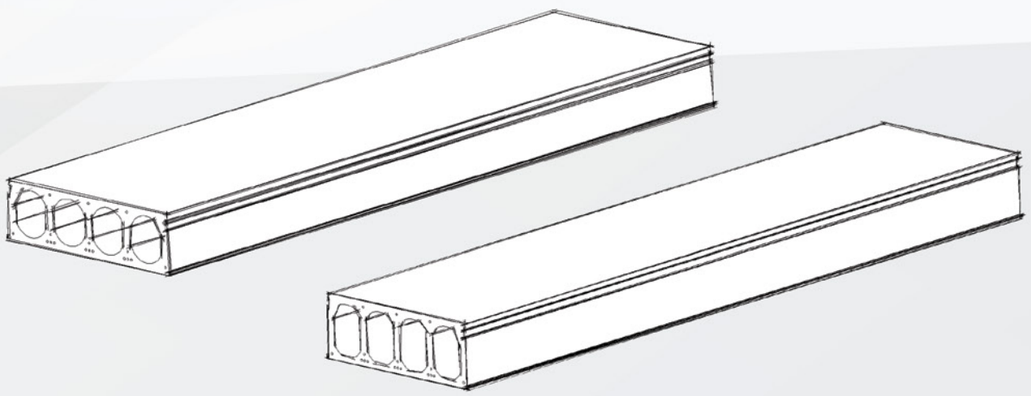


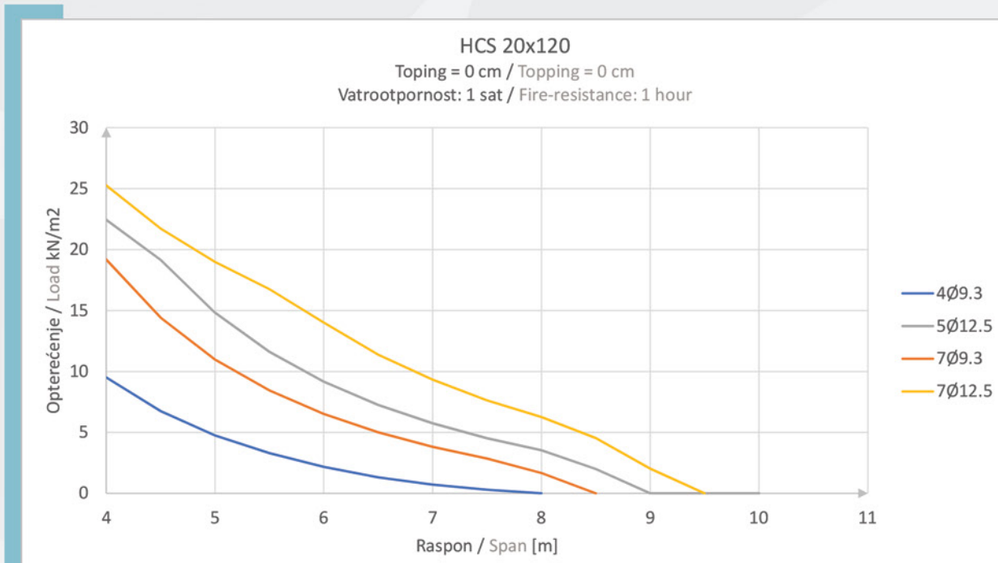
TABELE NOSIVOSTI PLOČA ELEMATIC TEHNOLOGIJE /
TABLES CAPACITY SLABS ELEMATIC TECHNOLOGY



ELEMATIC

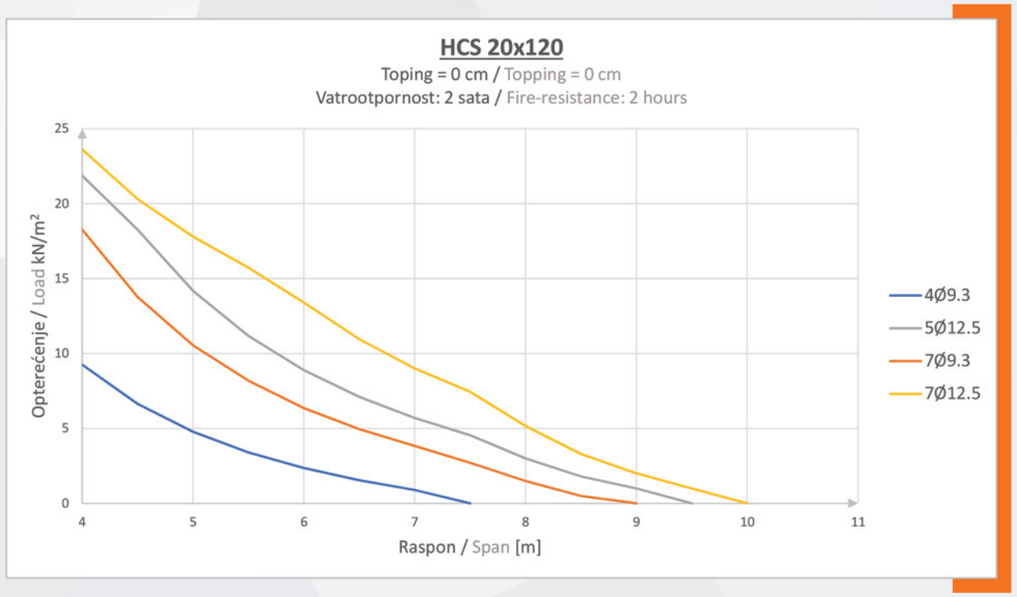
SMART EVOLUTION





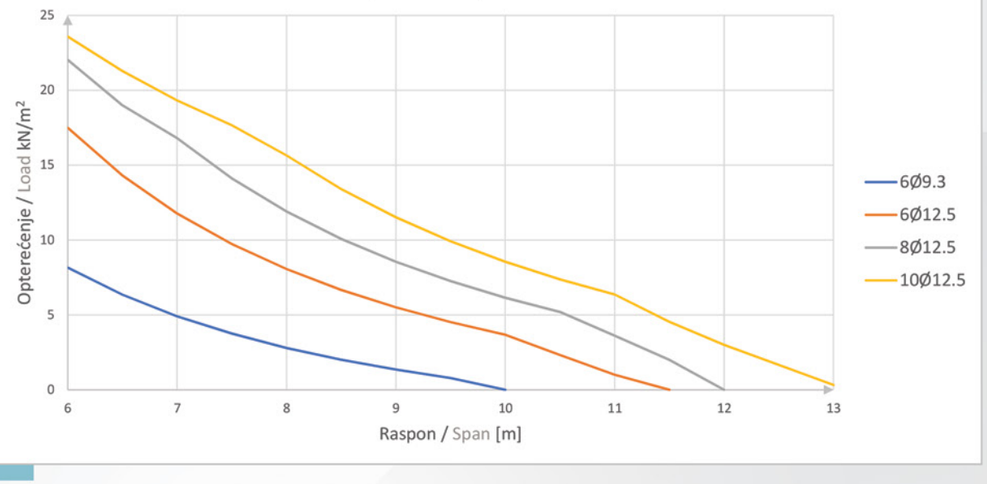
- Klasa betona / **Concrete:** C50/60
- Težina / **Weight: 250 kg/m²**
- f_{pk} = 1860 N/mm² za užad / **for ropes** Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / **Protective layer of the lower rope** = 35mm
- Zapreminska težina betona / **The volume of concrete :** 2500 kg/m³
- Kriterijum ugibanja / **Deflection max:** L / 250

- Klasa betona / **Concrete:** C50/60
- Težina / **Weight: 250 kg/m²**
- f_{pk} = 1860 N/mm² za užad / **for ropes** Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / **Protective layer of the lower rope** = 45 mm
- Zapreminska težina betona / **The volume of concrete :** 2500 kg/m³
- Kriterijum ugibanja / **Deflection max:** L / 250



HCS 26.5x120

Toping = 0 cm / Topping = 0 cm
Vatrootpornost: 1 sat / Fire-resistance: 1 hour

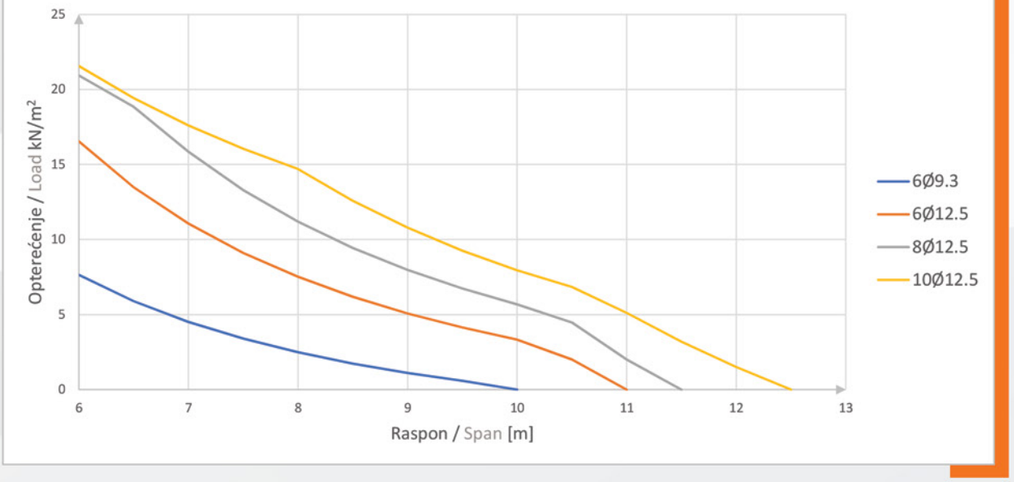


- Klasa betona / Concrete: C50/60
- Težina / Weight: 352 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 35 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

- Klasa betona / Concrete: C50/60
- Težina / Weight: 352 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 45 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

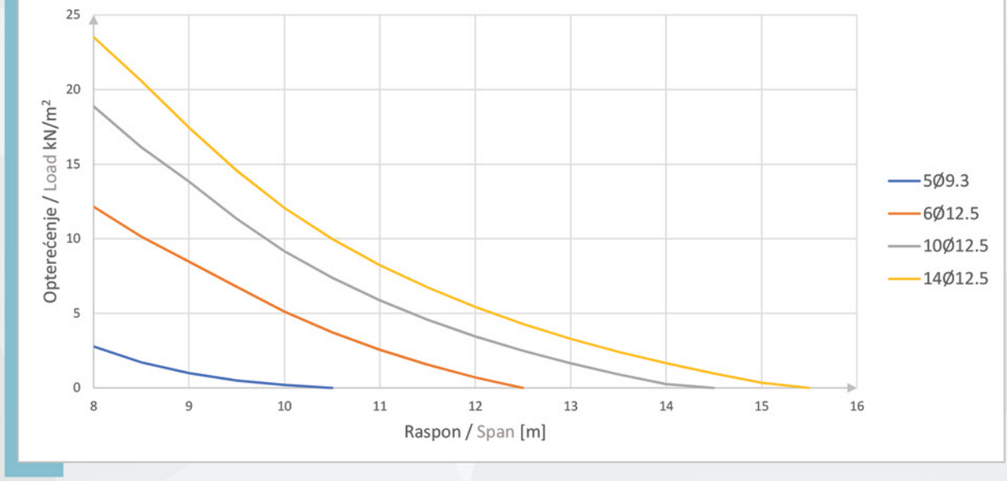
HCS 26.5x120

Toping = 0 cm / Topping = 0 cm
Vatrootpornost: 2 sata / Fire-resistance: 2 hours



HCS 32x120

Toping = 0 cm / Topping = 0 cm
Vatrootpornost: 1 sat / Fire-resistance: 1 hour

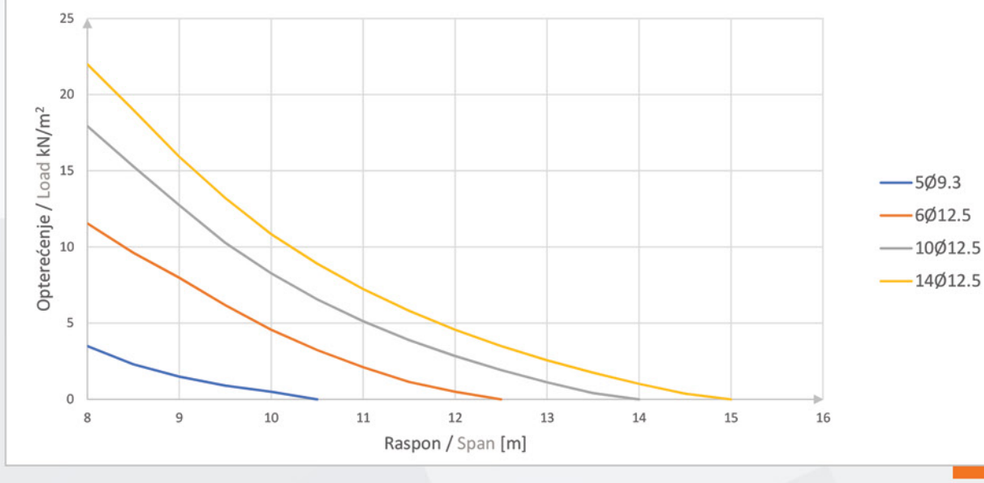


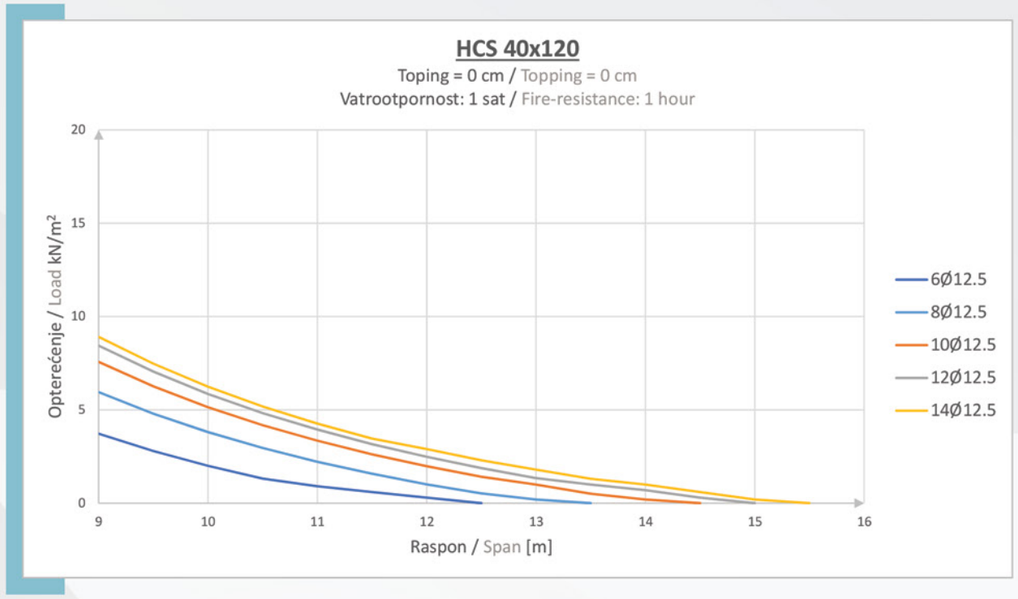
- Klasa betona / Concrete: C50/60
- Težina / Weight: 390 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 35mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

- Klasa betona / Concrete: C50/60
- Težina / Weight: 390 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 45 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

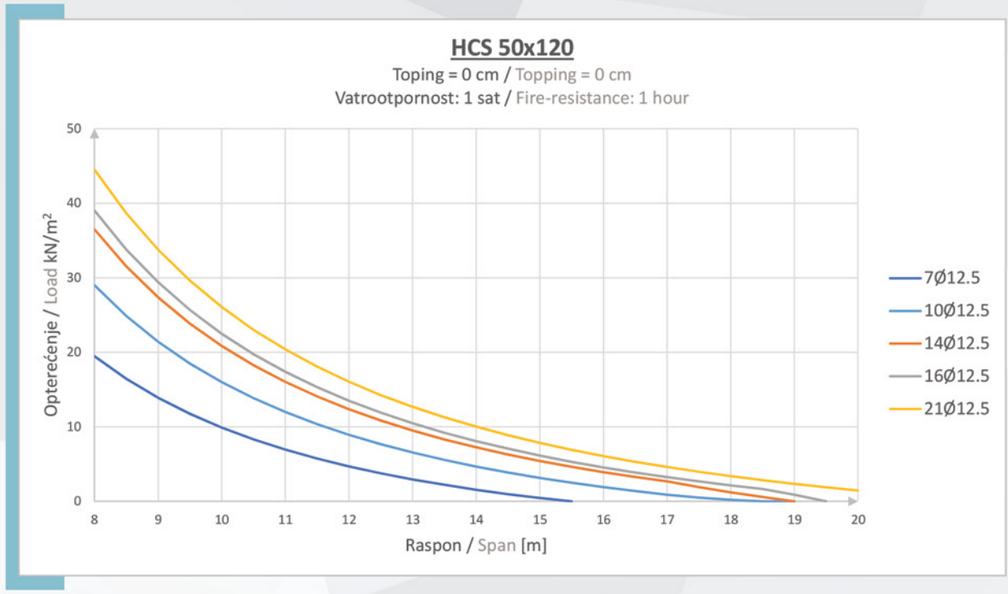
HCS 32x120

Toping = 0 cm / Topping = 0 cm
Vatrootpornost: 2 sata / Fire-resistance: 2 hours



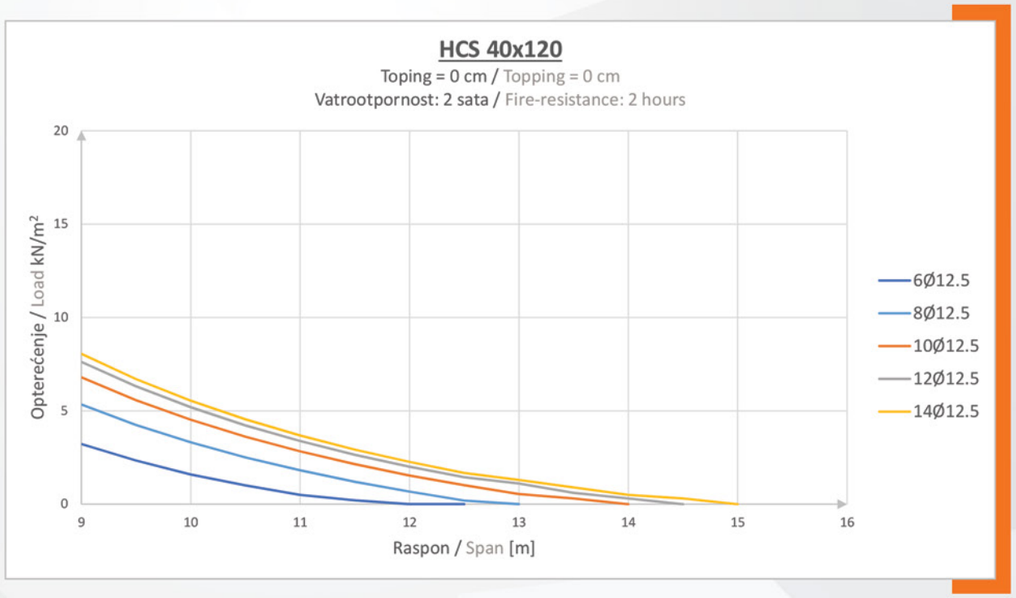


- Klasa betona / Concrete: C50/60
- Težina / Weight: 430 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 35 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250



- Klasa betona / Concrete: C50/60
- Težina / Weight: 590 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 35mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250

- Klasa betona / Concrete: C50/60
- Težina / Weight: 430 kg/m²
- f_{pk} = 1860 N/mm² za užad / for ropes Ø9.3 i Ø12.5
- Zaštitni sloj betona donje užadi / Protective layer of the lower rope = 45 mm
- Zapreminska težina betona / The volume of concrete: 2500 kg/m³
- Kriterijum ugibanja / Deflection max: L / 250



- Klasa betona / Concrete: C50/60
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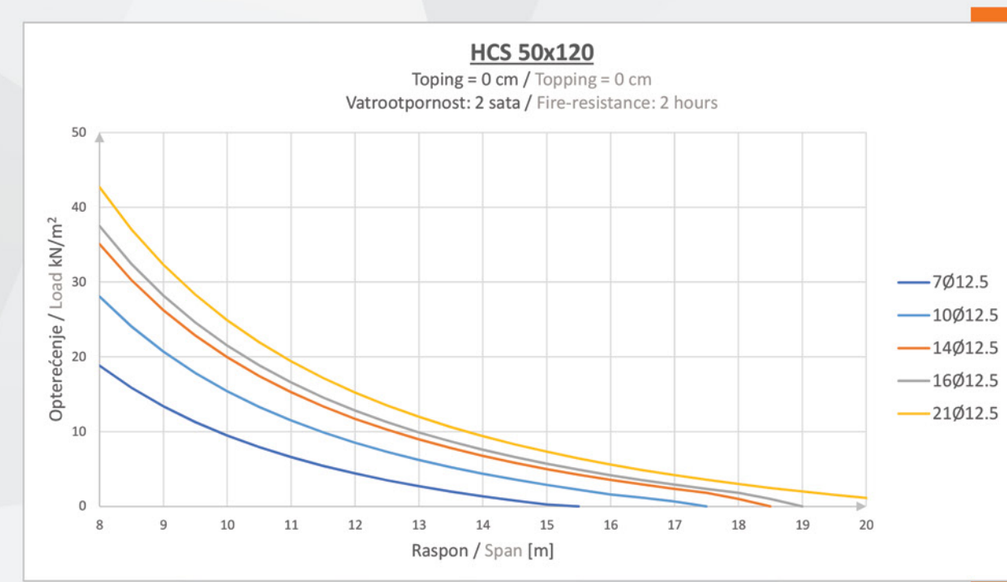
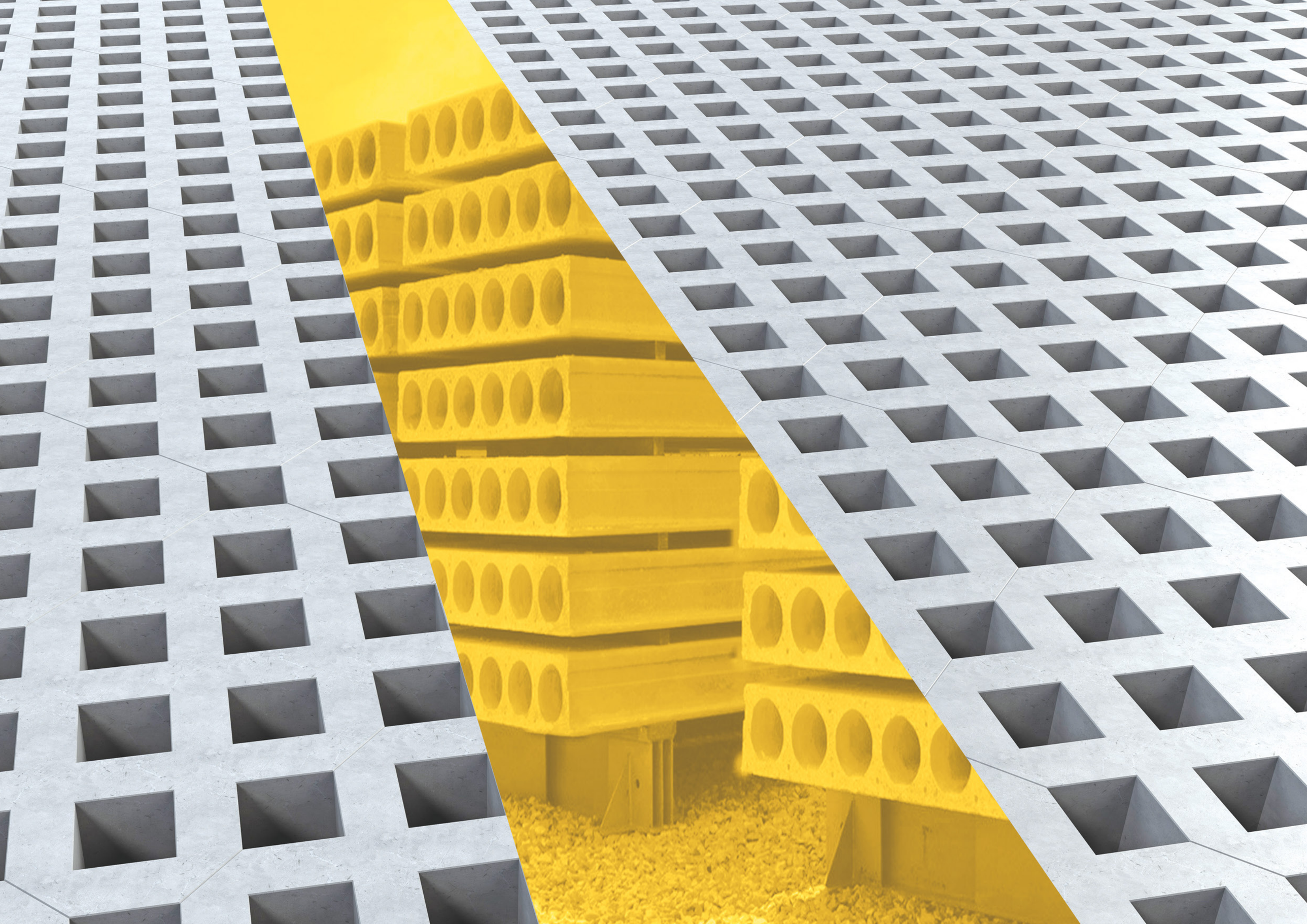
- Kriterijum ugibanja / Deflection max: L / 250





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