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PROBLEMS OF THE DESIGN AND CONSTRUCTION OF SLAB BETWEEN FLOORS

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Preliminary notes
This paper gives a brief overview of building floor slabs starting from slabs with wooden beams to the present reinforced concrete (panels AB). The authors in this paper analyze some new logical views on the issue of building floor slabs. Floor slabs are analyzed not only in terms of capacity, but also in terms of energy efficiency and safety during seismic activity. The authors offer a solution to build adaptive large residential and commercial area with the possibility of achieving cheaper and more competitive construction with the same gain (profit) in relation to the set of the classic construction and a high selling price. If you require the ability to achieve high capacity with longer spans, less weight and less prone to earthquakes, you can easily come to the conclusion that light grate cluster AB boards have an advantage over other solutions for building floor slabs. Excitation due to possible levelling of supports or torsion rotation of the object is practically possible. It can lead to a state of plate due to the earthquake, which is lower in the grate cluster plates compared to full-reinforced concrete slabs. StiroFert, the worldwide patented and tested light cluster grate AB panels, meet all of these requirements with an additional condition: energy efficiency. StiroFert have a specially designed and built structural expanded polystyrene as the "hull trapped" in the construction and concreting. This same "trapped payment" is a powerful insulation on the most needed place: on the ceiling, with the effect of harmonizing air temperature between the floor and the ceiling.

Keywords: *adaptability, energy efficiency, grate panel cluster, seismic excitation, StiroFert*

Problemi u projektiranju i izgradnji ploča između katova

Prethodno priopćenje
Ovaj članak daje kratak pregled izgradnje stropnih ploča počevši od ploče s drvenim gredama do današnjih armirano betonskih ploča (AB). Autori u ovom radu analiziraju neke nove logične poglede po pitanju izgradnje međukatnih ploča. Međukatne ploče analiziraju se ne samo u smislu nosivosti, već i u pogledu energetske učinkovitosti i sigurnosti tijekom seizmičke aktivnosti. Autori nude rješenje za izgradnju adaptabilnih velikih stambenih i poslovnih prostora uz mogućnost postizanja jeftinije i konkurentnije gradnje s istom dobiti (profit) u odnosu na skuplju klasičnu gradnju i visoku prodajnu cijenu. Ako se zahtijeva sposobnost da se postigne visoka nosivost s većim rasponima, manjom masom i većom otpornošću na potrese, lako se može doći do zaključka da roštiljno kasetne AB ploče imaju prednost nad drugim rješenjima za izgradnju međukatnih ploča. Pobuda zbog mogućih denivelacija oslonaca ili torzijske rotacije objekta je praktično moguća. To može dovesti do stanja osciliranja ploča zbog potresa, što je mnogo manje kod roštiljno kasetnih ploča u odnosu na pune armirano betonske ploče. StiroFert, širom svijeta patentirana i provjerena roštiljno kasetna AB ploča, ispunjava sve ove uvjete uz dodatni uvjet: energetska učinkovitost. StiroFert je posebno projektirana s konstrukcijski ugrađenim ekspandiranim polistirenom kao "zarobljenom oplatom" u fazi betoniranja i izgradnje. Ta ista "zarobljena oplata" je moćna izolacija na najpotrebnijem mjestu: na stropu, s učinkom usklađivanja temperature zraka između poda i stropa.

Ključne riječi: *energetska učinkovitost, prilagodljivost, roštiljno kasetna ploča, seizmička pobuda, StiroFert*

1 Introduction

Building floor structures have a long tradition. The need to build constructions with a large useful area on small surface was recognized long time ago.

Logical solution was to build multi-storey buildings. That resulted with building floor slabs, which were resting on the walls. First floor slabs structural solutions were determined with using wooden beams and ground clay [1], posed between the wooden beams (Fig. 1).

Figure 1 Wooden beams with mud and straw

The ground clay was not accidentally used as a material to be placed in such a ceiling. The authors came to the conclusion that the most important reason for selecting clay was the fact that it increases water absorption of the wood. This is the way that insures that the wood will remain dry, so that it will have greater durability. Even better solution would have been, if the clay had been mixed with lime $Ca(OH)_2$. It is interesting to note that even today we implement a similar solution for constructing timbers.

Building floor structures with brick and stone in the form of vaults [18], domes and arches was very popular in the past, so it has become tradition and it is still present (Fig. 2).

Figure 2 Building floor structures in the form of arches

Apart from the good side, as great durability for example, building floor structures with brick and stone has disadvantages. Major disadvantages are the great mass of this type of floor structure and sensitivity to horizontal forces and displacements furthest supports.

Usage of iron and steel in the construction industry results with a new type of floor structure, which is known as the "Prussian vault" [1, 17] "The Prussian vault" is a combination of steel in the form of "I" beams and brick masonry in the form of "shallow" arches resting between these carriers. Hundred years before, the Prussian vault was applied for larger ranges (6 to 10 m). First Prussian vault was applied in Germany in 1890 (Fig. 3).

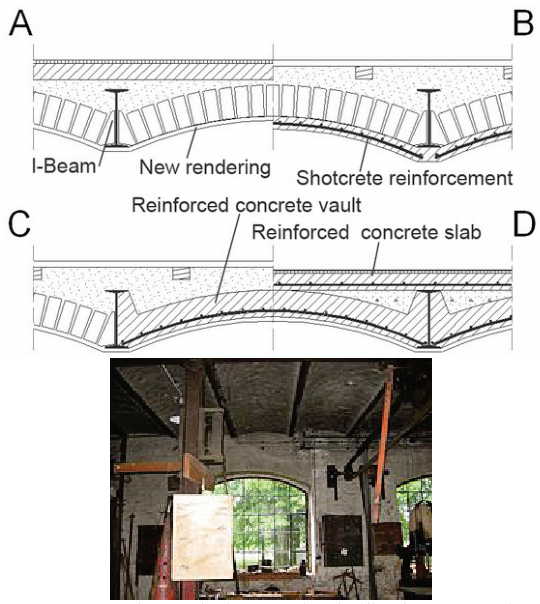


Figure 3 Prussian vaulted mezzanine facility for construction with a range of 6 to 10 m

Prussian vault is a floor structure lighter than a conventional barrel vault and dome-shaped one and it is applicable for the construction of multi-storey masonry buildings.

These types of floor constructions (wooden beams, dome-shaped ceiling and Prussian vault) were able to achieve a measurable load off their plane. In addition to the great mass, serious shortcomings of those floor structures is that they are not able to achieve stiffness in their own plane, which is important in the case of action of seismic forces. Such floor structure do not represent a rigid diaphragm in their own plane, which means that they could not transfer the horizontal force of the earthquake on the walls, in proportion to the stiffness of the walls. When an earthquake occurs it is not known how such objects would behave, which walls would be more burdened etc.

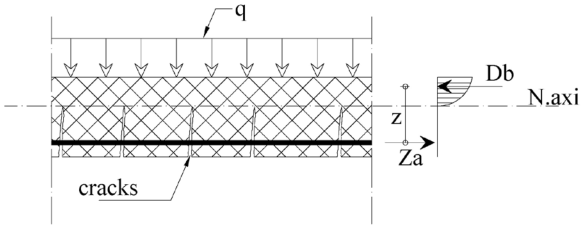
As is known, the earthquake force is proportional to the mass of the object. According to the method of the equivalent static load which is similar to EC8 modal spectral analysis [2, 5, 6, 14, 15], the total force of the earthquake S is calculated by:

$$S = K \times G, \tag{1}$$

where:
S – force of the earthquake, kN
K – coefficient, depends on the seismic zone, ductility, period of oscillation, the object type, −
G – mass of the object, kN.

The usage of concrete started more than 100 years ago, so constructors began to apply reinforced concrete to build floor constructions. This type of floor constructions still has the greatest application in the construction industry. The first panels of reinforced concrete slabs were full in their whole thickness. Full reinforced concrete slabs (AB plates) are commonly applied to the range of 6 m. Mass of solid AB plate depends on the plate range. Minimum thickness of concrete slabs is 12 cm. Plate used for ranges more than 6 m is at least 20 cm thick ($d < L/35$). Plate thickness depends on the load and on the future purpose of the facilities.

Full concrete slabs for ranges greater than 6 meters would be very large and economically irrational. The construction of high-rise buildings with multiple floors (dozens of stories) would be virtually impossible with such full AB plates, because the load on the foundation soil was too big. Also, the earthquake forces would be great, because the building would have too large mass G.



$$M_{\text{b max}} = \frac{q \cdot l^2}{8}, -Z_{\text{a}} = +D_{\text{b}} = \frac{M_{\text{b max}}}{z}$$

Figure 4 Full utilization of concrete slabs and panels section

If we look at the usability of a section of such plate, we can see that we practically take advantage of only one part of the cross-section, the one that is under pressure (Fig. 4). In reinforced concrete slabs, that part usually takes 1/4 of the slab's height. In the tension zone tightening is transferred to the reinforcement. Virtually, most of the concrete is dead weight. Therefore, constructors designed floor slabs with ribs and cavities (Fig. 5).

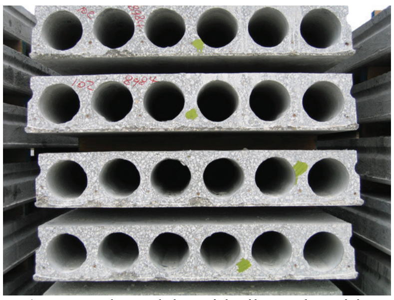


Figure 5 Floor slabs with ribs and cavities

Cavities within the blade can be done in several ways [19]. We can place cardboard tubes or expanded polystyrene (polystyrene-foam) into the concrete, so they take the role of "captive shell" that is permanently cemented. Today, we already have such a solution which produces lightweight mounting plates with extruder machine, which leaves behind a continuous concrete strip with holes and built-in reinforcement. Such plates are usually prefabricated and adhesively pre-stressed.

Currently on the market there is a solution that is massively applied, known as the "fert". "Fert" ceilings are made from prefabricated beams with reinforcement steel in the form of the spatial grid (Fig. 6) [20].

Figure 6 "Fert" mezzanine structure with filling elements as captive plating

Between the "fert" beams we placed fillings made from baked hollow ceramic blocks with the role of "captive plating". "Fert" middle floors are very practical and economically feasible. The disadvantage of this solution and other similar lightened plates with ribs and "captive plating" is that there are ribs in one direction only. Monolith concrete board should be built across the slabs with ribs and cavities (Fig. 5) in thickness of 6 to 10 cm. The grid "Q" reinforcement should be built in, too. Be sure that stiffening rib that goes in the other direction is done in certain intervals. Precisely, the reason for stiffening ribs is a possible action force, due to the earthquake. The problem is that the stiffening rib may be omitted due to ignorance or dishonesty of the system builders. Above the ribs and elements is a thinner concrete slab of thickness 4 to 6 cm, with grid "Q" reinforcement. "Fert" floor joists are usually $d = 16 + 4 = 20$ cm thick and they can handle ranges up to 6 m with its own weight of 3,5 kN/m^2. It is a much smaller mass than the full 20 cm thick panel and it has a mass of 5,0 kN/m^2 for the range of 6 m. As already mentioned, the lack of roof floor structure is insufficient stiffness in their plane. That is the reason why the mezzanine boards made from "fert" beams are not applied at high-rise buildings with many floors.

Figure 7 Grillage cluster-floor joists

There are different solutions for facilitated floor structures. One of the best solutions is grillage floor structures from cluster-reinforced concrete (Fig. 7). The only drawbacks of these structures are the price and complexity of the design due to the need for formwork ribs in both directions.

There are solutions where the ribs can be derived by using prefabricated polymeric PVC "bathtubs", which are placed on the formwork. When the concrete has hardened, plastic "tubs" are dismantled along with the formwork. In grate cluster floor slabs, ribs can be sound in both directions, which is of particular importance in the case of earthquake activity. Supporting ribs in two directions is interesting in the case of linear load board (walls) or if you need to perform some openings during construction and even later, during operation.

2 StiroFert grillage-cluster inter floor construction of a new generation

As mentioned earlier, in order to overcome the higher ranges, to achieve greater capacity and security with low mass, a grill-cluster reinforced concrete structures are the best possible solution. StiroFert floors (Fig. 8) are patented [8, 9, 10, 21] grillage-cluster and it meets the above criteria. They have thermo and noise-insulating properties and they are fire resistant, too. It is easy for performance, which affects the speed and cost of construction.

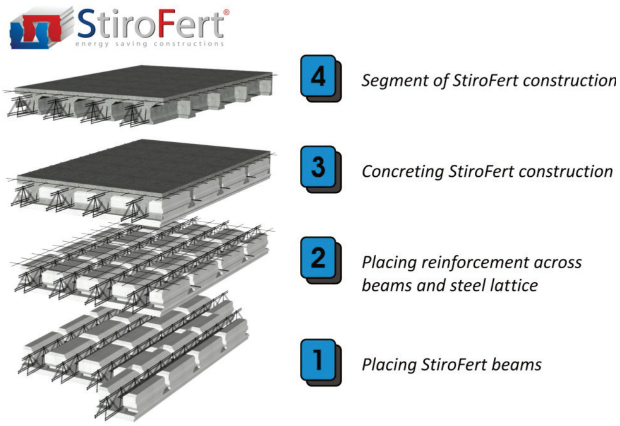


Figure 8 Patented StiroFert grillage-cluster AB plate

Expanded polystyrene forms longitudinal ribs with minimum width of 10 cm at axial distance of 33 cm to 50 cm. There are transverse ribs, perpendicular to the longitudinal rib, 6 to 10 cm wide at axial distance of 50 cm. Steel lattices are placed into the longitudinal channels of StiroFert elements placed over spacers which ensures the correct prescribed protective layer of concrete over reinforcement. Lattice reinforcement ensures good adhesion with concrete at nodes. Good adhesion between concrete and reinforcement allows better performance than concrete-reinforcement with small deflections and greater payload structure. In order to design structures in accordance with these conditions, supporting tight-fit reinforcement is placed into the fine-grained layer of high quality concrete (minimum class C37/40 strength) during the process of manufacturing. Thanks to self-steaming method, fine-grained concrete cures rapidly within polystyrene elements (Fig. 10). StiroFert concrete beams are made so that they are placed one upon another, in rows. After five to ten lines placed in height, beams are covered with PVC foil, so beams are under favourable conditions (high humidity and high temperature) [16]. These conditions guarantee accelerated hardening of concrete and large production capacity of these boards in a small area within manufacturing plants or concrete runway, in external conditions of production. Finished StiroFert beams are transported to building sites and mounted on struts (Fig. 10). At the construction site, after installation of StiroFert beams, secondary transverse reinforcement ribs (Ø10-B500A) are placed as well as transverse ribs and reinforcing mesh (Q-131) in the layer of 4 to 5 cm thick concrete slab, which is then paved with concrete over the entire surface of the floor slab. Transverse ribs can be wearable and in this case ribs are adequately reinforced. The best solution to pave StiroFert plate is using pumps and vibrating with the vibrating rod. Expanded polystyrene (Styrofoam) plays the role of "captive plating" in the casting stage. After casting, expanded polystyrene is located on the ceiling in the average thickness of at least 13 cm, and it is very important for insulation (Fig. 9).

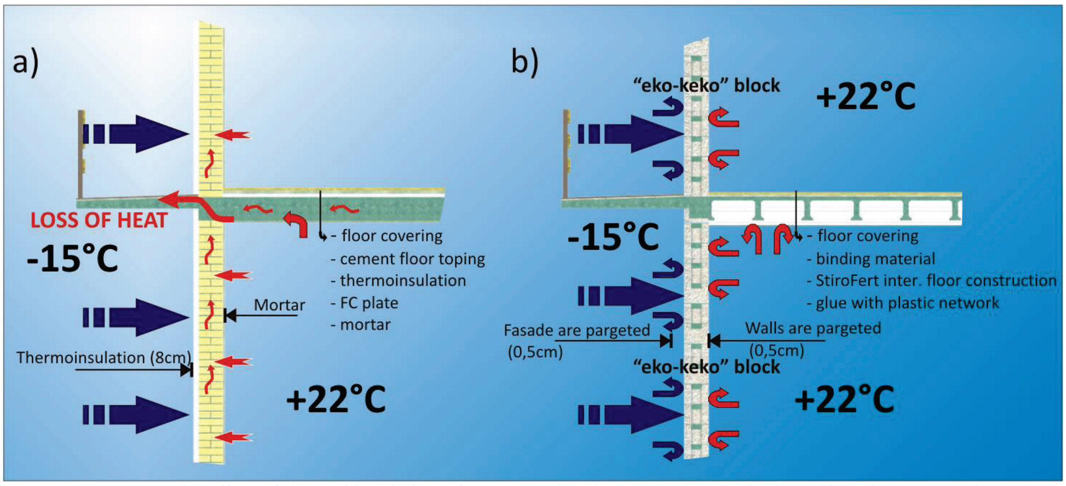


Figure 9 The effect of thermal insulation of a) conventional construction methods and b) StiroFert panel

The warm air rises to the ceiling and the heat is not transferred to the concrete floor slabs. This means that the heat from the room cannot be lost according to the known laws of thermodynamics. In this case, heat cannot be lost over colder places ("cold bridges"), such as walls, balconies, foundations, gable walls and the outer parts of the walls with window and door openings [11, 12, 13]. The authors of this study point to the logical conclusion that this is in strict accordance with thermodynamics. Only under the condition of insulation ceiling of the room, a cooler place in the room is the floor. The effect of this type of construction is that the warm air begins to move to the floor of the room, so warmer and cooler air are mixed and the difference in the temperature on the ceiling and on the floor is only 1 °C.

a) b) c) d)

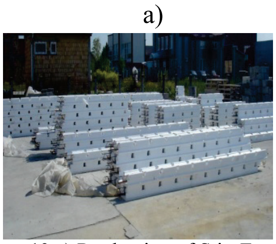
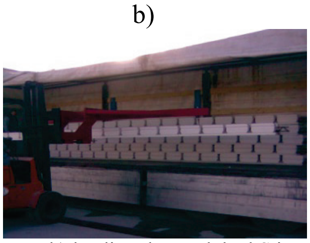
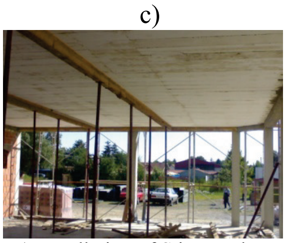
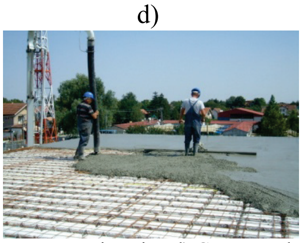





Figure 10 a) Production of StiroFert beams, b) loading the truck bed StiroFert, c) Installation of StiroFert beams on construction site, d) Concrete slab on the site

Increasing energy efficiency is the European and the world trend and the legal requirement of construction. Convenient movement of air around the premises minimizes the occurrence of condensation even in PVC and does not allow the general appearance of condensation and mold in the corners of the rooms, the ceilings and walls. The minimum thickness of the polystyrene in the longitudinal and transverse ribs is 5 cm, and through this layer we can put installation of electricity.

StiroFert floor slabs are manufactured in thicknesses of 5 + 15 + 5 = 25 cm for a range of up to 7 m. The amount of concrete is 0,11 m^3/m^2 which means that there is very little dead load (2,75 kN/m^2).

For a range of 7 to 9 meters the thickness of these beams is 5 + 20 + 5 = 30 cm. The amount of concrete is 0,13 m^3/m^2 and dead weight is 3,25 kN/m^2 (alternative full concrete slab is 25 cm thick with a mass of 6,25 kN/m^2). Ranging from 9 to 10,5 m is performed with a thickness of 5 + 25 + 5 = 35 cm. The amount of concrete is 0,15 m^3/m^2 and dead load is 3,75 kN/m^2 (the alternative is a full concrete slab thickness of 30 cm with a mass of 7,5 kN/m^2).

Let`s compare a 400 m^2 ceiling made as StiroFert and as full plate, considering only influential powers in relation to the mass of structures and seismic coefficients.

Table 1 Comparative analysis of mass (G) and seismic forces (S) of StiroFert grate cluster AB plates and classic solid reinforced concrete slab for the building with one floor slabs

400 m^2 plate for range of 7 meters	Thickness and volume of the concrete	Concrete mass G	Seismic force $S = K \times G$
StriFert plate	thickness d = 0,11 m V = 0,11 × 400 = 44 m^3	44 × 25 = 1100 kg	S = 0,13 × 1100 = 143 kN
Full concrete plate	thickness d = 0,20 m V = 80 m^3	80 × 25 = 2000 kg	S = 0,13 × 2000 = 260 kN

The seismic force $S = K \times G$ at a full plate is 45 % higher (just looking at the impact of weight plates) than the seismic force at StiroFert plate. Imagine that it is a facility that has ten floors, under the assumption that it is a skeleton system where columns and walls have negligible mass compared to the mass of the plate, then the total seismic force is S (Tab. 3).

Table 2 Comparative analysis of mass (G) and seismic forces (S) of StiroFert grate cluster AB plates: classical solid reinforced concrete slab for the building that has ten floor slabs

400 m^2 plate for range of 7 meters	Thickness and volume of the concrete	Concrete mass G	Seismic force $S = K \times G$
StriFert plate	thickness d = 0,11 m V = 0,11 × 400 = 44 m^3	44 × 25 = 1100 kg	S = 10 × 0,13 × 1100 = 1430 kN
Full concrete plate	thickness d = 0,20 m V = 80 m^3	80 × 0,25 = 2000 kg	S = 10 × 0,13 × 2000 = 2600 kN

Seismic forces cause bending moments, so at the full board bending moments are 45 % higher than the bending moments at easy-cluster grillage StiroFert AB plate. The increased mass of the walls and floors as well as processing the payload with a coefficient of reduction in case of an earthquake, would give even higher values of bending moments Then the percentage of the difference between the static forces of StiroFert and full concrete slabs should be slightly lower (30 %). Larger horizontal seismic forces cause larger displacements and excitation of the whole building. At earthquake, possible levelling at individual pillar plates, the influence of torsion and bending moment influence, practically leads to excitation of the plate in the vertical sense, perpendicular to the plane of the board. Excitation of the plates, perpendicular to the plane, is more evident if the ranges and weight plates are higher. For these details, we can easily come to the conclusion that the best possible solution for building high and very high-rise buildings is mezzanine light a grill-plate inter-floor AB plates.

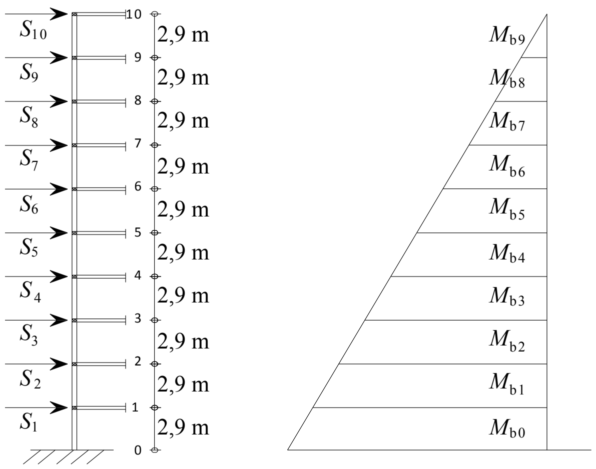


Figure 11 Seismic forces with bending moments in multi-storey building height H = 2,9 m
StiroFert grillage slab cluster AB: classical full AB plate

This paper is written in order to address some of the possibilities of a more practical solution of building floor slabs and buildings. It is meant to draw attention to the science and practice that some of the solutions are not adequate. Full concrete slabs, despite all the flaws, are intensively used, because there are payment systems offered on the market. If we analyze the static effects such as bending moment, caused by earthquake activity (Fig. 11), we get the following values, which can be compared (Tab. 3).

Seismic forces which are acting at the level of individual floors can be calculated according to the forms listed below:

$$S_{x_i,s} = (1-0{,}15)\cdot S_{x_i}\frac{G_s\cdot V_s}{\sum_{s=1}^{p} G_s\cdot V_s}, \tag{2}$$

$$S_{y_j,s} = (1-0{,}15)\cdot S_{y_j}\frac{G_s\cdot V_s}{\sum_{s=1}^{p} G_s\cdot V_s}, \tag{3}$$

where:
$S_{x_i,s}, S_{y_j,s}$ - individual forces of floor slabs for the x and y direction, kN
S_{x_i}, S_{y_j} - total seismic force for the x and y direction, kN
G_s - total mass of the building, kg
V_s - individual height between floor slabs and elevation of the ground (1 − 0,15) - coefficient (when we have more than 5 floors), m.

For the last floor we use the following equations:

$$S_{x_i,s} = (1-0{,}85)\cdot S_{x_i}, \tag{4}$$

$$S_{y_j,s} = (1-0{,}85)\cdot S_{y_j}, \tag{5}$$

where:
(1 − 0,85) - coefficient, used where there are more ten 5 floors, which multiplies
S_{x_i}, S_{y_j} - so storeys are additionally burdened.

Tab. 3 shows us that the choice of the size of floor slabs has a big influence on static forces (bending moments) in seismic activity. Full floor slabs are rigid in their own plane diaphragm which is a necessary condition, but unfortunately, they also have too much weight. Grillage cluster plates are rigid in their flat diaphragms and thereby they have about 45 % less weight for the same size range. If we observe oscillation of the plate perpendicular to the plane of the floor due to seismic activity, full reinforced concrete slab can oscillate only with vertical displacements perpendicular to its plane. Full reinforced concrete slab may not transfer fluctuations in its plane as it is in its very rigid plane.

Table 3 The comparative static analysis in seismic actions of taking into account only the weight (dead weight) of floor slabs

The comparative static analysis of seismic forces and S_i and bending moment M_{bi}					
StiroFert grillage-cluster AB plate			Full AB plate		
Node *i*	Seismic force S_i / kN	Bending moment M_{bi} / kN·m	Node *i*	Seismic force S_i / kN	Bending moment M_{bi} / kN·m
10	435,50	-	10	791,82	-
9	198,90	1262,95	9	361,63	2296,27
8	176,80	3102,70	8	321,45	5641,27
7	154,70	5455,17	7	281,27	9918,49
6	132,60	8256,30	6	241,09	15 011,45
5	110,50	11 441,95	5	200,91	20 803,54
4	88,40	14 948,05	4	160,73	27 178,27
3	66,30	18 710,51	3	120,54	34 019,11
2	44,20	22 665,20	2	80,36	41 209,45
1	22,10	26 748,00	1	40,18	48 633,00
0	-	30 895,15	0	-	56 173,00

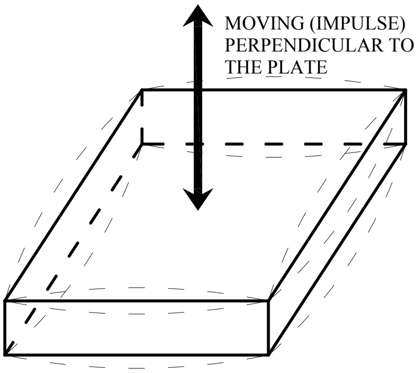


Figure 12 Moving full concrete slab due to seismic excitation, greater span perpendicular to the plane of plate

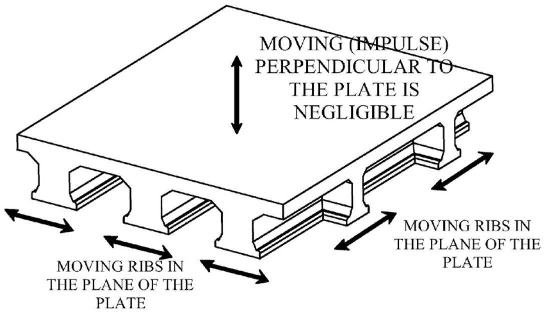


Figure 13 Moving of StiroFert due to seismic excitation plates - physical access

StiroFert panels and other similar grillage-panel cluster also want to oscillate perpendicular to its plane, if it was that kind of motivation. Since these plates are built with relatively thin ribs, the ribs are "excited" and they want to oscillate in the transverse direction (in the plane plate) because they are "softer" out of their plane. So in this way, they reduce oscillations perpendicular to the plane of the plate. In grillage cluster StiroFert plate oscillations are cancelled, as ribs intersect each 50 cm and 33 cm. Those effects maximally reduce oscillations in StiroFert and other similar grillage cluster plates. In this way, a significant part of the kinetic energy is transferred into a flat plate where they are simply lost.

The floor slabs are "silenced" by the oscillation in the event of an earthquake, which means that the board will not respond to stimulus coming from the walls or vice versa. All of these can be confirmed by experiment.

There is a building in Perast (Montenegro). It is about 400 years old and it is the UNESCO World Heritage Site. This building was restored with StiroFert plates, so wooden beams and floor slabs were replaced with StiroFert slabs. StiroFert plates allow greater safety in case of earthquake activity in this volatile area. Earthquake activity was confirmed in Perast (Montenegro), with the intensity of 5 degrees on the Richter scale. During that seismic movement no effects were recorded on StiroFert plates. Tenants of the building were subsequently informed about the earthquake in which some facilities at the site experienced minor damage. The goal was reached, investors and property owners, as well as the Institute for Protection of Cultural Monuments Perast Kotor, Herceg Novi, were satisfied. Currently, on the site, a couple of old buildings are being reconstructed in exactly the same manner as in this building.

Figure 14 The reconstructed object in Perast

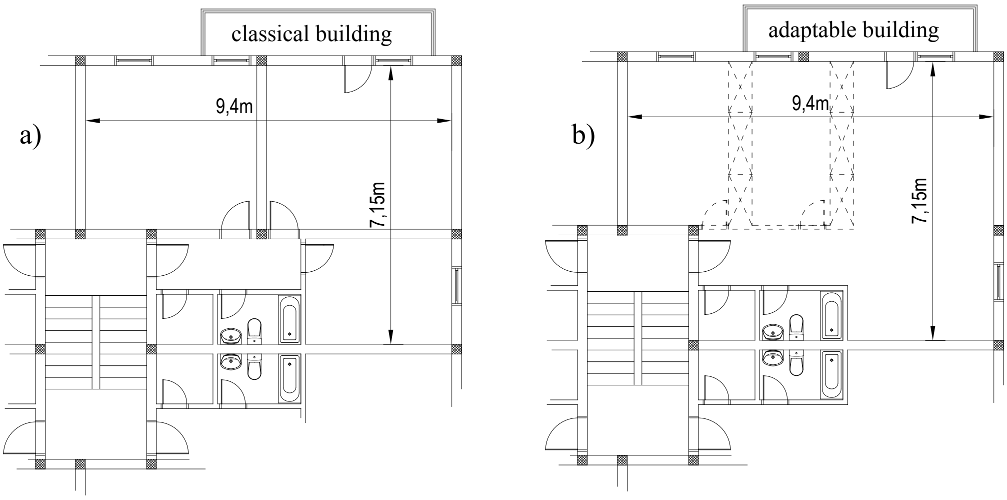


Figure 15 Adaptable spaces - a new quality

StiroFert grill-cluster-reinforced concrete floor slab has lower fluctuations outside the plane than the full board, and that leads us to the conclusion that with cluster-grill floor structures we can achieve greater ranges. Greater range of floor offers a new quality, such as:

- Adaptability of space
- Faster building system
- Competitive and lower prices for consumers with the ability to achieve higher profits for builders and investors.

With StiroFert plates we can build buildings where there are no dividing walls, so consumers can build them according to their own wish (Fig. 15). Building process is faster and therefore the apartments are cheaper. It is interesting to note that the profits for builders and investors still can be higher than the profit in conventional building system, because the profit is the difference between all of the construction costs and selling prices of housing or office space. The method of calculation of factors to which the indirect cost is redistributed so that the cost of direct labour is multiplied by the conversion factor (L factor f_o) and the equations have the following form:

$$C_K = A + (B \times f_o), \tag{6}$$

where:
C_K − cost
A − direct costs of material, labour, machinery and cooperative services, land, utilities
B − the cost of direct labour
$f_o = L$ - factor or conversion factor.

The selling price is different from the cost since it includes in itself the projected profits. It can be determined according to the following equation:

$$C_P = C_K \times k_{pd}, \tag{7}$$

where:
C_P − selling price
k_{pd} − coefficient of planned profit.

$$\text{Profit}: \; D = C_P - C_K. \tag{8}$$

Profit can have the same value if the cost is less, if the sale value is less than the cost of a higher and higher cost of sales. Thus height of gains (profits) may not be related only to the amount of the selling price because it is less favourable due to weaker form of market competitiveness. We see that the choice of systems and construction technology that offers adaptability of space using light cluster AB grate plate gives better conditions of purchase and sale for both the buyer and the real estate developers-investors.

3 Conclusions

This paper partially presented the historical development of building floor slabs. Floor slabs were analyzed with their good and bad sides. Given the opportunity to earn a larger capacity with longer spans, less weight and less perceptibility to earthquakes, we can easily come to the conclusion that lightweight grillage-cluster AB plates have undeniable advantage over other solutions. With all these features, patented new solution for next-generations - system of grillage-cluster AB panels known as StiroFert panels, offers the fastest possible production capacity under construction. In the operation phase expanded polystyrene appears to be the best possible insulation required on the ceiling. The energy efficiency of buildings is the European and world trends and statutory requirements. StiroFert as a solution meets up on the issue, as already described. Given extremely easy AB plates, this system can be used for constructing largest buildings in the world because it has low mass, low sensitivity to excitation of seismic impacts (according to phrase 1) and high fire resistance.

Grillage-cluster AB plates are harder to "awaken" and lead to a state of oscillation. This means that these boards can be used for longer spans (7 m to 10 m). Only concrete can satisfy resistance to fire. This is especially important for very high buildings, so the walls, pillars and floors are made from concrete. Low weight and good bearing capacity of grillage-cluster AB plates recommends them to be applied for the construction of adaptable facilities, as new values in the architectural-exploitation-economic terms. In fact, it is interesting that the construction technology of light grillage-cluster panels for longer spans is faster and cheaper. In the market the price of such property could be lower and more competitive. At the same time the profit made may be the same or greater for builders and real estate investors. Profit is the difference between the total cost of construction and the selling price of the property. This is evidence that the amount of profit (according to the Eq. (8)) in the construction of the real estate market may not be exclusively tied to the high cost of selling a property. So lightweight construction technology of floor grate cluster of concrete slabs is to the satisfaction and general social benefit of customers and users of real estate investors and developers and the construction industry as one of the most powerful industries that includes many other industries and employs the largest number of workers.

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