

# Analysis of ceiling of panel systems

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**Abstract:** The work shows the size of forces and deformations of the panels concrete structures for different combinations of load.

**Keywords:** Panels, concrete, permanent and variable loads, forces, eurocodes

## 1 Introduction

Panels systems were used in the Czech Republic for housing construction more than 30 years. Since the fifties of the last century to the years nineties was created approximately eighty separate and derived systems. An important part of these systems have always been the ceiling structure. They have been designed according to the regulations, standards and practices applicable in each period. Evaluation of the slab panels, still used in construction, according to current European standards, is the subject of the contribution. To explain - the current standards have different requirements for reliability and define a higher design load.

In West Bohemia since the end of the fifties was used three basic panel systems designated PS61, PS69 and T06B. Each system has its own ceiling structure. The paper presents and evaluates panels standard ceilings system PS69.

## 2 Analysis of ceiling panel system design PS692E 1989

PS 69 panel system is the most widely used system in western Bohemia since 1971.

### Description of the process: at the time of construction

#### Loads

Assessment for the construction of the headliner status at the time used the philosophy of limit states. Load calculation was made according to CSN 730035, partial factor for permanent actions had a value of 1.1 (panel) and 1.3 (other designs). Variable load was considered normative value of 1,5 kN /m<sup>2</sup>, coefficient 1.4 Basic load combination was drawn up according to czech standard CSN 730035.

#### Material

Concrete was Class III (corresponds to the present C16 / 20), compressive strength of 11.5 Mpa. Reinforcement was a steel, type 10338 (290 MPa) and 10425 (375 MPa) Reinforced concrete proposal was made by the then valid CSN 731201

## Description of the procedure today

### Loads

Design and assessment for the construction of the ceiling panel today also utilizes the philosophy of limit states. Load calculation is performed according to EN 1991-1-1, partial factor for permanent loads have a value of 1.35. Variable load is considered normative value of 1.5 kN / m<sup>2</sup>, coefficient 5.1 Basic load combinations have been prepared in accordance with EN 1990 for permanent and temporary situations. Loads combinations: wherw for 3 equations 6.10 and char. combination according to EN 1990.

### Material

Concrete meets today's C16 / 20, compressive strength 20 Mpa. Reinforcement was a steel, type 10338 (290 psi) and 10425 (375 MPa). Values are taken from ISO 13822 and related CSN 730,038th

### Calculations

Assessment cross-sections is according to EN 1992-1-1 (EC 2) for ultimate bearing capacity (ULS). Is calculated deformation panel. We evaluate cracks in concrete and strength

### Partitions

Given the weight partitions useful for panel construction

porousconcrete	0,65 kN/m <sup>2</sup>
with plaster or tiles	0,99 kN/m <sup>2</sup>
gypsum plaster board	0,25 kN/m <sup>2</sup>

### Combinations of loads

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Loads Types	char.	char. with partit.	perm. char.	design 6.10_	design 6.10a	design 6.10b	part 6.10_	part 6.10a	quasi-perm.	part	freque.	load old	capac. Mu	Mu
	(kNm)			1,35	0,700	0,850			0,30		0,50	CSN	CSN	EC2
Permanent	16,25	16,25	16,25	21,94	21,94	18,65	21,94	21,94	16,25	16,25	16,25			
Variable	5,53	5,53	0,00	8,29	5,80	8,29	8,29	5,80	1,66	1,66	2,76			
Partition		3,17					4,28	4,28	0,00	3,17				
Summary	21,78	24,95	16,25	30,23	27,75	26,94	34,51	32,02	17,91	21,08	19,02	26,10	40,27	40,63
<b>comparison values</b>														
	1,00		0,75	1,39	1,27	1,24			0,82		0,87	1,20	1,85	1,87
Reserve %	1,00													<b>46,4</b>
with part.		1,00					1,38	1,28		0,84		1,05	1,61	1,63
Reserve %	1,00													<b>26,87</b>

Fig. 1- Sizes moments from various combinations of load and ultimate bearing capacity (kNm)

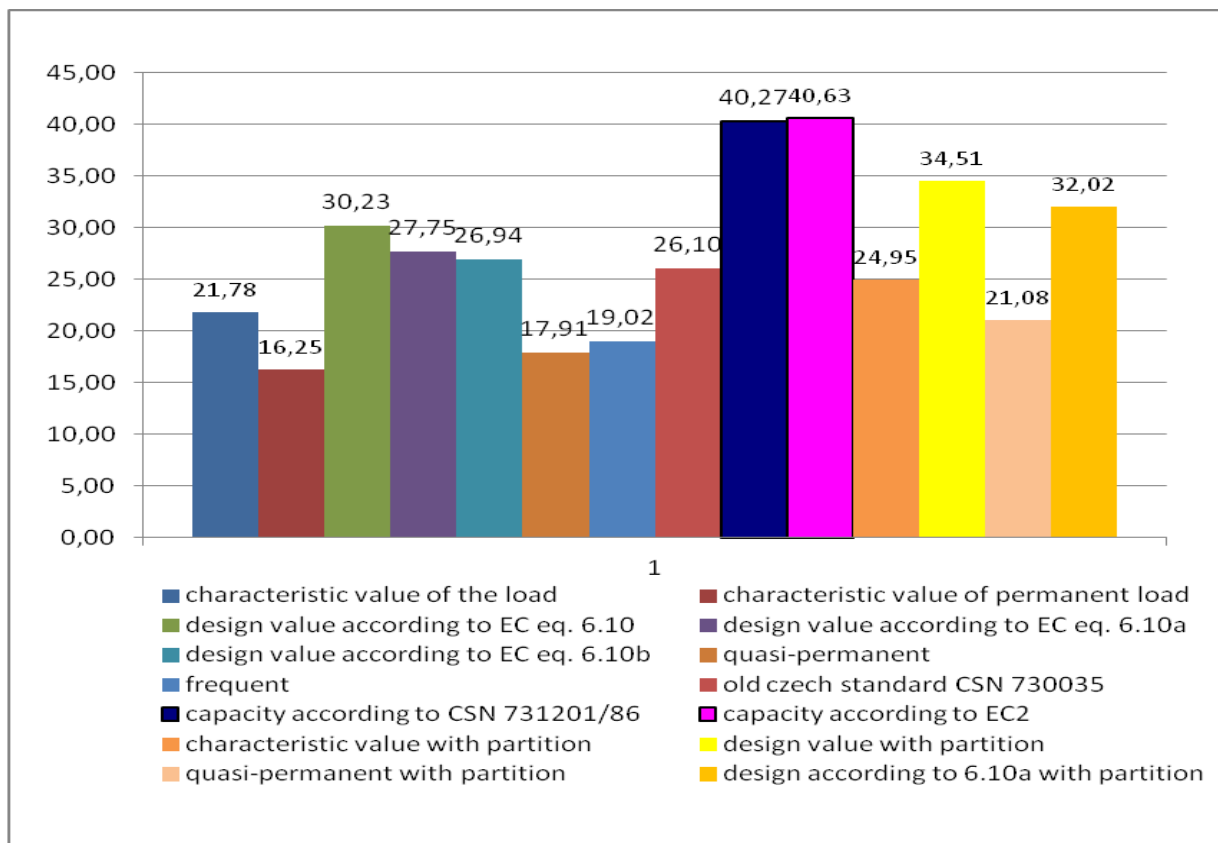


Fig.2- Sizes moments from various combinations of load and ultimate bearing capacity in the graph. (kNm)- without partitions and also with different partitions.

**Static ratings results of panels ceiling structure** from load increase compared to the original proposal shown in the table Reserve in load bearing capacity is given in the table.

Combination – bending moment	
characteristic load combination	1
proposal at the time of construction - old standard CSN 730035	1,20
assessment by equation 6.10 EN 1990	1,39
assessment by equation 6.10a EN 1990	1,27
assessment by equation 6.10b EN 1990	1,24
quasi-permanent combination	0,82
frequent combination	0,8
bearing capacity by original standard CSN 731201	1,85
bearing capacity by EC 2	1,87

Fig 3 - Table comparing the values of moments

Finding reserve bearing capacity is important for further adjust and repairs. This has implications for the assessment of modifications in flats such as loading new walls, new cores for bathroom and toilet, flooring and plaster. Reserve in load bearing capacity depends on the combination loads

### **Deformations**

Brick partition is considered from porous concrete thickness 75 mm with plaster and tiles. This manual is satisfactory from the point of view of the ceiling deflection. Thicker and heavier partition can not use.

From the calculation for the quasi-permanent load combination (service live 50 years)

Panel only partition	10,59 mm
Panel with partition 75 mm	13,70 mm
Panel with partition 100 mm	14,15 mm
Limit deflection $L / 250$	14,02 mm

Calculated deflection for partition 75 mm is lower than the allowable deflection

## **3 Research results**

Evaluation panels system PS69 is very important for further use objects from this system. System already used in Western Bohemia from 25 to 45 years. A further objects will be used in the future.

Ceiling panel system PS 69 statically conforms to the assessment, according to Eurocodes. The panel can aggravate extra partitions.. It can be with a brick partition wall made of porous concrete with a maximum thickness of 75 mm. Panel has a higher capacity (26,87%), but it decisions deflection. Porous concrete partition about 100 mm thickness is at the limits of applicability, it is by calculating already over the limit usability. We can use the aforementioned brick partitions with a thickness of 75 mm or partitions made of gypsum plasterboard with lower weight

Standard ceiling panel of system PS69 was tested according to Eurocodes. Other panels of system Ps69 and panels of other systems (T06B, PS61) should tested when working on projects also always.

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## **References**

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