



P91.temp

The Firewin Systems

11/2015

## P91.temp Knauf fire protection plaster

P91.temp – Knauf VERMIPLASTER® Indoor

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### Knauf Vermiplaster® Indoor

#### Fire protection gypsum plaster

Page


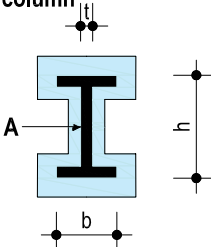

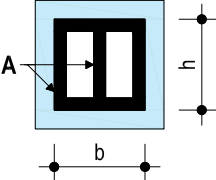
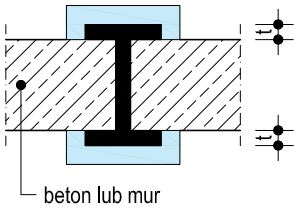
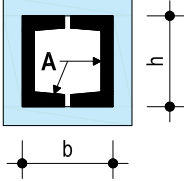
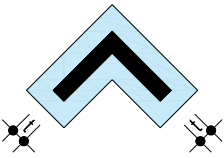
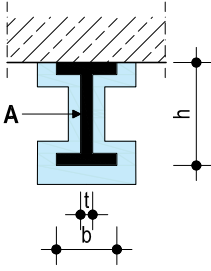
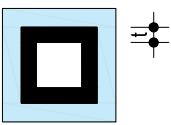
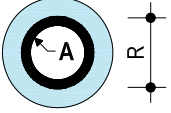
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Product description	Scope of application	Properties
<p>KNAUF VERMIPLASTER® Indoor is a fire protection gypsum plaster intended for indoor use. It is composed of gypsum as a binder and a special mix of light additives that ensure easy machine application. KNAUF VERMIPLASTER® Indoor received European Technical Approval ETA - 11/0229.</p> <p><b>Method of delivery</b> Bags of 20 kg                      article no. 416556</p> <p><b>Storage</b> Bags should be stored in a dry place on wooden pallets. Damaged or opened bags should be tightly sealed and used up as first. Product shelf life – 6 months from the manufacture date. Can be stored in temperatures of up to 45°C.</p>	<p>The gypsum plaster KNAUF VERMIPLASTER® Indoor was developed for fire protection of indoor premises. If a fire occurs, the product purpose is to maintain the load-bearing capacity of construction elements which must remain undamaged until the fire is extinguished or the building evacuated.</p> <p><b>The plaster is intended for the following elements, in accordance with ETAG 018-3:</b></p> <ul style="list-style-type: none"> <li>▪ Closed and open section steel beams and columns</li> <li>▪ Monolithic, slab floors and reinforced concrete walls</li> <li>▪ Reinforced concrete beams and columns</li> <li>▪ Composite elements with lost shuttering</li> </ul>	<ul style="list-style-type: none"> <li>▪ Gypsum plaster in accordance with ETA 11/0229 for the protection of: Steel up to R 120 Trapezoidal sheets as lost shuttering up to REI 120 Concrete up to REI 240</li> <li>▪ Easy machine application</li> <li>▪ Easy to work with</li> <li>▪ Much higher yield in comparison with other products</li> <li>▪ Hardens fast</li> <li>▪ Based on gypsum</li> <li>▪ For indoor use</li> <li>▪ White colour</li> <li>▪ Does not aggressively react with steel structures</li> <li>▪ No adverse effects after use in food industry</li> </ul>

Technical details		
Reaction to fire	A1 non-flammable	PN EN 13501-1
Bulk density	500 – 600 kg/m <sup>3</sup>	
Beginning of setting	ca 90 – 170 min.	
End of setting	ca 180 – 300 min.	
Resistance to water vapour diffusion μ	8	PN EN ISO 10456
Bending tensile strength	> 0,70 MPa	PN EN 13279-2
Compressive strength	> 1,70 MPa	
Adhesion to concrete	> 0,10 MPa	PN EN 13279-2
Adhesion to steel	> 0,10 MPa	PN EN 1015-12
Adhesion to galvanised steel	> 0,05 MPa	EGOLF SM 5
Surface hardness	> 1,90 MPa	
pH	12 – 13	
Consumption	ca 6,5 – 7 kg/m <sup>2</sup> /10 mm	
<p><i>Differences from those values are possible, caused by conditions on the construction site. Precise material consumption should be determined directly in the particular facility.</i></p>		

### Determination of the U/A section factor for steel beams and columns

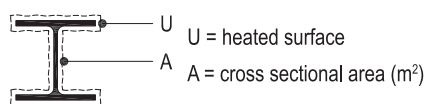
Diagrams

Type of section	Exposure to fire	U/A	Type of section	Exposure to fire	U/A
values of: b, h, t - in cm, area A - in cm <sup>2</sup>		m <sup>-1</sup>	values of: b, h, t - in cm, area A - in cm <sup>2</sup>		m <sup>-1</sup>
<b>Flat steel</b>	4 sides	$\frac{200}{t}$	<b>Beam or column</b>	4 sides	$\frac{4b - 2t + 2h}{A} \cdot 100$
					
<b>Flange</b>	4 sides	$\frac{200}{t}$	<b>Beam or column</b>	4 sides	$\frac{2b + 2h}{A} \cdot 100$
					
<b>Flange</b>	3 sides	$\frac{100}{t}$	<b>Beam or column</b>	4 sides	$\frac{2b + 2h}{A} \cdot 100$
					
<b>Angle</b>	4 sides	$\frac{200}{t}$	<b>Beam</b>	3 sides	$\frac{3b - 2t + 2h}{A} \cdot 100$
					
<b>Hollow section, columns</b>	4 sides	$\frac{100}{t}$			
					
	4 sides	$\frac{2\pi R}{A} \cdot 100$			
					

In the case of steel beams and columns other than I-shaped and H-shaped having a section factor:

- U/A < 250 - modified thickness =  $d \left( 1 + \frac{U/A}{1000} \right)$
- U/A ≥ 250 - modified thickness = 1.25 d

### Steel beams and columns



The spray thickness required is calculated based on the U/A section factor and the section shape. The values given are approximations. They may be slightly different depending on the rolled beam manufacturer.

Table 1.1

Section factor U/A for steel beams and columns (m <sup>-1</sup> )														
IPN profile			HEA profile			HEB profile			HEM profile			IPE profile		
	Exposure 3 sides	4 sides		Exposure 3 sides	4 sides		Exposure 3 sides	4 sides		Exposure 3 sides	4 sides		Exposure 3 sides	4 sides
80	345.6	401.1	100	217.9	264.6	100	179.6	218.1	100	96.4	116.4	80	370.4	430.6
100	301.9	349.1	120	220.2	267.6	120	166.5	201.8	120	92.2	111.1	100	335.9	389.3
120	268.3	309.2	140	208.3	252.9	140	154.7	187.2	140	85.5	103.6	120	310.6	359.1
140	238.3	274.3	160	189.7	233.5	160	139.6	169.1	160	82.8	99.9	140	290.9	335.4
160	219.7	252.2	180	185.4	225.2	180	130.2	157.7	180	79.8	96.2	160	268.7	309.5
180	200.1	229.4	200	174.7	211.9	200	121.6	147.2	200	75.7	91.4	180	254.1	292.1
200	184.8	211.6	220	161.7	196.0	220	115.4	139.6	220	73.2	88.4	200	234.4	269.5
220	171.1	195.7	240	147.1	178.4	240	107.5	130.2	240	60.7	73.1	220	221.1	253.9
240	160.1	183.1	260	140.6	170.5	260	104.7	126.7	260	59.3	71.5	240	204.9	235.5
260	148.5	169.7	280	135.7	164.4	280	102.1	123.3	280	58.4	70.4	270	197.2	226.6
280	138.6	158.1	300	126.2	152.9	300	95.9	116.1	300	50.1	60.4	300	187.7	215.6
300	131.1	149.1	320	117.4	141.5	320	91.1	109.7	320	50.0	59.9	330	174.1	199.7
320	123.3	140.1	340	111.6	134.1	340	88.4	105.9	340	50.4	60.2	360	162.3	185.7
340	116.7	132.5	360	107.1	128.2	360	85.8	102.4	360	50.9	60.5	400	152.7	174.1
360	109.9	124.6	400	101.3	120.1	400	82.4	97.6	400	52.1	61.4	450	143.7	163.1
380	104.8	118.7	450	96.1	112.9	450	77.5	91.3	450	53.5	62.6	500	132.8	150.1
400	99.6	112.7	500	91.6	106.8	500	76.3	88.9	500	54.4	63.3	550	124.6	140.5
425	94.5	106.8	550	90.2	104.3	550	75.6	87.4	550	55.7	64.3	600	115.4	129.5
450	89.1	100.7	600	88.7	102.0	600	74.8	85.9	600	56.8	65.2			
475	84.2	95.1												
500	80.3	90.6												
550	75.1	84.5												
600	67.1	75.6												

# P91.temp Fire protection gypsum plaster Knauf Vermiplaster® Indoor



Steel beams and columns - protection thickness required

## Minimum thickness of Knauf VERMIPLASTER® Indoor

all dimensions in mm

The thickness of the plaster Knauf VERMIPLASTER® Indoor depends on the U/A section factor of steel beams and columns, critical temperature of steel and the fire resistance class required.

VERMIPLASTER® Indoor can be used for protection of I-section and H-section beams bearing load on three or four sides.

Protection thickness for other cross-sections to be chosen in accordance with information on page 4.

Table 2

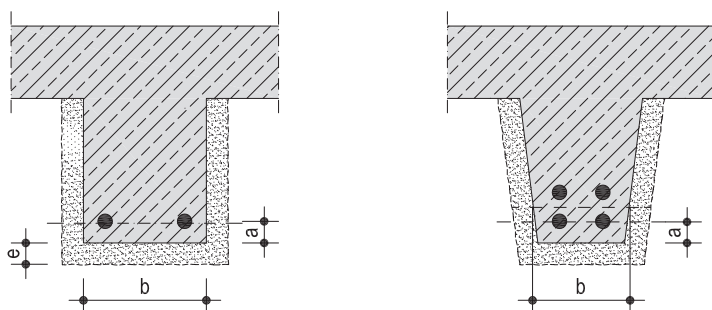
U/A value	R15 T [°C]					R30 T [°C]					R60 T [°C]					R90 T [°C]					R120 T [°C]				
	350	400	450	500	550	350	400	450	500	550	350	400	450	500	550	350	400	450	500	550	350	400	450	500	550
≤ 60	6					7	6				11	10	9	8	7	16	14	13	12	11	21	19	17	15	14
70	6					7	6				12	10	9	8		17	15	13	12	11	22	19	18	16	15
80	6					7	6				12	11	10	9		18	16	15	13	12	23	21	19	18	16
90	6					7	6				13	12	11	10	9	19	17	15	14	13	24	22	20	19	17
100	6					8	7	6			14	12	11	10		19	18	16	15	14	25	23	21	20	18
110	6					8	7	6			14	13	12	11	10	20	19	17	16	15	26	23	22	21	19
120	6					8	7	6			15	13	12	11		21	19	18	16	15	27	24	23	22	20
130	6					8	7		6	15	14	13	12	11	21	20	18	17	16	28	25	24	23	21	
140	6					9	8	7	6	15	14	13	12	11	22	20	19	18	16	29	26	25	23	22	
150	6					9	8	7	6	16	14	13	12		23	21	20	18	17	29	27	26	24	23	
160	6					9	8	7		6	16	15	14	13	12	23	21	20	19	18	30	27	26	25	23
170	6					9	8	7	6	16	15	14	13	12	23	22	20	19	18	30	28	27	25	24	
180	6					9	8		7	6	17	15	14	13		24	22	21	20	18	31	29	28	26	25
190	6					9	8		7	6	17	16	15	14	13	24	23	21	20	18	31	29	28	27	25
200	6					10	9	8	7	6	17	16	15	14	13	24	23	22	20	19	32	30	29	27	26
210	6					10	9	8	7		17	16	15	14	13	25	23	22	21	19	34	30	29	28	26
220	6					10	9	8	7		17	16	15	14		25	24	22	21	20	36	31	29	28	27
230	6					10	9	8	7		18	16	15	14		25	24	23	21	20	-	31	30	28	27
240	6					10	9	8		7	18	17	16	15	14	26	24	23	22	20	-	31	30	29	28
250	6					10	9	8		7	18	17	16	15	14	26	24	23	22	21	-	32	31	29	28
260	6					10	9	8		7	18	17	16	15	14	26	25	23	22	21	-	32	31	30	28
270	6					10	9		8	7	18	17	16	15	14	26	25	24	23	21	-	34	31	30	29
280	6					10	9		8	7	18	17	16	15	14	26	25	24	23	22	-	36	32	30	29
290	6					10	9		8	7	18	17	16		15	27	25	24	23	22	-	32	31	29	
300	6					10	9		8	7	19	18	17	16	15	27	26	24	23	22	-	32	31	30	
310	6					10	9		8	7	19	18	17	16	15	27	26	25	24	22	-	33	31	30	
320	6					10	9		8		19	18	17	16	15	27	26	25	24	23	-	35	31	30	
330	6					11	10		8		21	19	17	16	15	28	27	26	25	23	-	35	32	31	
340	7	6				12	11	9	8	23	21	19	17	16	30	29	27	26	24	-	35	33	32		
350	9	8	6			14	13	12	10	9	25	23	21	19	18	32	31	29	28	26	-	35	34	33	
360	9	8	6			14	13	12	11	9	25	23	21	20	18	32	31	29	28	27	-	36	34	33	
370	10	8	6			14	13	12	11	9	25	23	22	20	18	33	31	30	28	27	-		34	33	
380	10	8	7	6		14	13	12	11	10	25	24	22	20	19	33	31	30	28	27	-		34	33	
390	10	8	7	6		15	13	12	11	10	26	24	22	20	19	33	31	30	28	27	-		35	33	
400	10	8	7	6		15	13	12	11	10	26	24	22	21	19	33	31	30	29	27	-		35	33	
410	10	8	7	6		15	14	12	11	10	26	24	22	21	19	33	32	30	29	27	-		35	33	
420	10	9	7	6		15	14	12	11	10	26	24	22	21	19	33	32	30	29	28	-		35	34	
430	10	9	7	6		15	14	13	11	10	26	24	23	21	19	33	32	30	29	28	-		35	34	
440	10	9	7	6		15	14	13	11	10	26	24	23	21	20	33	32	30	29	28	-		35	34	
450	10	9	7	6		16	14	13	12	10	26	25	23	22	20	33	32	31	29	28	-		35	34	
460	10	9	8	6		16	14	13	12	11	26	25	23	22	20	33	32	31	29	28	-		36	34	
470	11	9	8	6		16	14	13	12	11	27	25	24	22	20	33	32	31	30	28	-			34	
480	11	9	8	6		16	14	13	12	11	27	25	24	22	20	33	32	31	30	28	-			34	
490	11	9	8	7	6	16	14	13	12	11	27	25	24	22	21	33	32	31	30	28	-			34	
500	11	9	8	7	6	16	14	13	12	11	27	25	24	22	21	33	32	31	30	28	-			34	
510	11	9	8	7	6	16	14	13	12	11	27	25	24	22	21	34	32	31	30	29	-			35	
520	11	9	8	7	6	16	14	13	12	11	27	25	24	23	21	34	32	31	30	29	-			35	
530	11	9	8	7	6	16	15	13	12	11	27	26	24	23	21	34	32	31	30	29	-			35	
540	11	10	8	7	6	16	15	14	12	11	27	26	24	23	21	34	33	31	30	29	-			35	

### Guidelines for application of VERMIPLASTER® Indoor on concrete

1. The values given in the tables refer to standard weight concrete (2000 do 2600 kg/m<sup>3</sup> - see EN 206-1) with silica additions.
2. If limestone or light additives are used in reinforced concrete columns or beams, minimum cross sectional dimensions can be decreased by 10%.
3. If values given in the tables are used, no additional control of shear and torsion strength or anchoring details are needed.
4. Data in the tables set out in this chapter is based on the reference load of  $f = 0.7$ , unless indicated otherwise in the appropriate chapters.
5. Decrease of characteristic strength of reinforcement steel and prestressed steel as a function of temperature:  
 reinforcement steel: 500 °C  
 prestressed steel (bars: EN 10138-4): 400 °C  
 prestressed steel (cables and cable harnesses: EN 10138-2 and 10138-3): 350 °C
6. The values do not apply to precast concrete elements.

All dimensions given in mm

### Reinforced concrete beams



$e$  = thickness of KNAUF VERMIPLASTER® Indoor  
 $b$  = minimum dimensions  
 $a$  = minimum axial distance of reinforcement

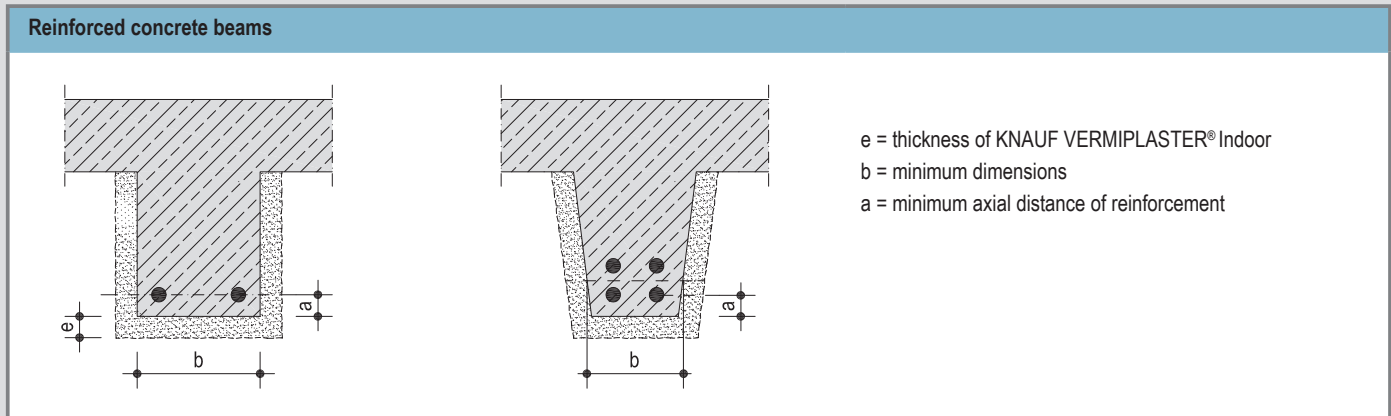
The values correspond to concrete thickness in accordance with European Technical Approval ETA-11/02/29

Table 3

Knauf VERMIPLASTER® Indoor thickness used	Time (min.)				
	30	60	90	120	180
$e_{min} = 6,9$ mm average overall thickness used	13	26	27	26	-
$e_{max} = 18,5$ mm average overall thickness used	33	46	59	64	60

- The results apply only to reinforced vertical and horizontal concrete columns and beams that are exposed to fire on several sides.
- The results apply only to concrete having a density of 2025 kg/m<sup>3</sup> to 2740 kg/m<sup>3</sup>.
- The results apply only to concrete in which cracks occur due to a load equal to or higher than the tested concrete: 50,0 N/mm<sup>2</sup> after 728 days.
- The results apply only to beams having the base width equal to or higher than 150 mm.

All dimensions given in mm



**Minimum dimensions and axial distance of reinforcement from the surface of simply supported beams from reinforced and prestressed concrete** Table 4

Knauf VERMIPLASTER® Indoor thickness used	Classification											
	R 30		R 45		R 60		R 90		R 120		R 180	
	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$
$e_{min} = 6.9$ mm average overall thickness used	150	2	150	10.5	150	9	150	28	174	39	240	80
	150	2	150	10.5	150	9	173	18	214	34	300	70
	150	2	160.5	5.5	174	4	273	13	274	29	400	65
	187	2	230.5	0.5	274	0	373	8	474	24	600	60
$e_{max} = 12.0$ mm average overall thickness used	150	0	150	1.7	150	0.2	150	13.9	157.3	22.3	240	80
	150	0	150	1.7	150	0.2	158.9	3.9	197.3	17.3	300	70
	150	0	151.7	0	165.2	0	258.9	0	257.3	12.3	400	65
	178.2	0	221.7	0	265.2	0	358.9	0	457.3	7.3	600	60
$e_{max} = 18.5$ mm average overall thickness used	150	0	150	0	150	0	150	0	150	1	180	20
	150	0	150	0	150	0	150	0	176	0	240	10
	150	0	150	0	154	0	241	0	236	0	340	5
	167	0	210.5	0	254	0	341	0	436	0	540	0

- All the dimensions apply only to the Knauf VERMIPLASTER® Indoor plaster and must be used together with other guidelines while structure dimensions are taken.
- Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.

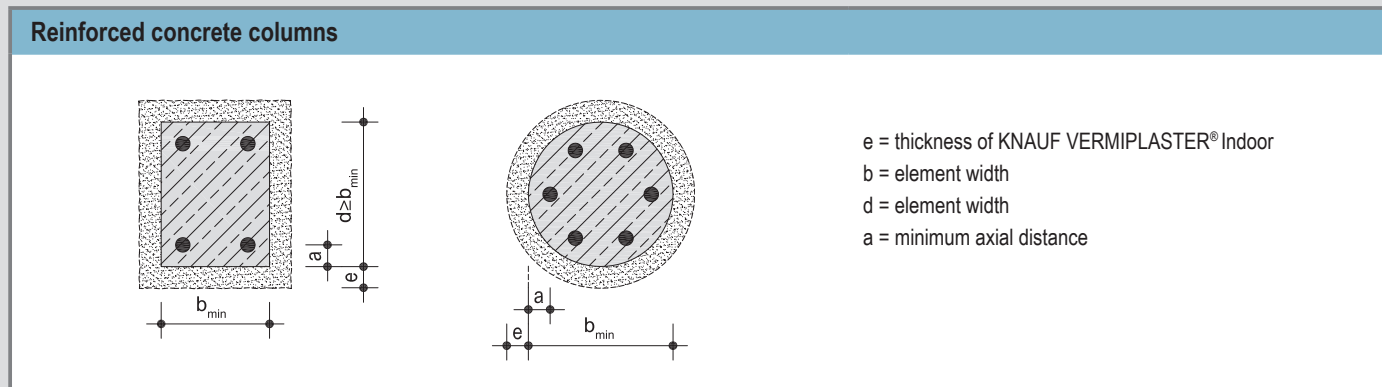
**Minimum dimensions and axial distance of reinforcement from the surface of joined beams made from reinforced and prestressed concrete** Table 5

Knauf VERMIPLASTER® Indoor thickness used	Classification											
	R 30		R 45		R 60		R 90		R 120		R 180	
	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$
$e_{min} = 6.9$ mm average overall thickness used	150	0	150	0.5	150	0	150	8	174	19	240	60
	150	0	160.5	0	174	0	223	0	274	9	400	50
									424	9	550	50
									474	4	600	40
$e_{max} = 12.0$ mm average overall thickness used	150	0	150	0	150	0	150	0	157.3	2.3	240	60
	150	0	151.7	0	165.2	0	208.9	0	257.3	0	400	50
									407.3	0	550	50
									457.3	0	600	40
$e_{max} = 18.5$ mm average overall thickness used	150	0	150	0	150	0	150	0	150	0	180	0
	150	0	150	0	154	0	191	0	236	0	340	0
									386	0	490	0
									436	0	540	0

- All the dimensions apply only to the Knauf VERMIPLASTER® Indoor plaster and must be used together with other guidelines while structure dimensions are taken.
- Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.



All dimensions given in mm



The values correspond to concrete thickness in accordance with European Technical Approval ETA-11/0229/29

Table 6

Knauf VERMIPLASTER® Indoor thickness used	Time (min.)				
	30	60	90	120	180
$e_{min} = 6,9$ mm average overall thickness used	13	26	27	26	-
$e_{max} = 18,5$ mm average overall thickness used	33	46	59	64	60

- The results apply only to reinforced vertical and horizontal concrete columns and beams that are exposed to fire on several sides.
- The results apply only to concrete having a density of 2025 kg/m<sup>3</sup> to 2740 kg/m<sup>3</sup>
- The results apply only to concrete in which cracks occur due to a load equal to or higher than the tested concrete: 50,0 N/mm<sup>2</sup> after 28 days.
- The results apply only to beams having the base width equal to or higher than 150 mm.



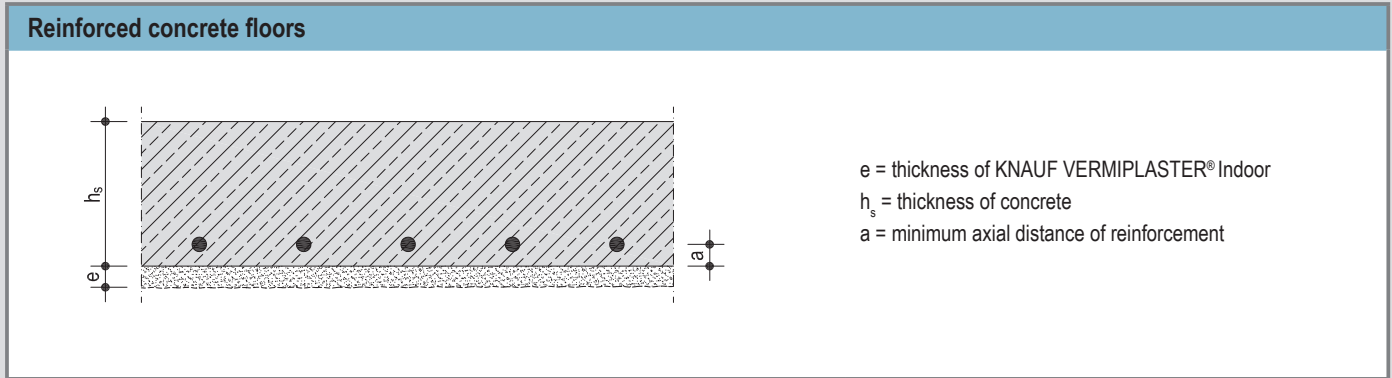
Minimum dimensions and axial distance of reinforcement from the surface of rectangular-section or circular-section columns

Table 7

Knauf VERMIPLASTER® Indoor thickness used	Classification											
	R 30		R 45		R 60		R 90		R 120		R 180	
	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$	$b_{min}$	$a$
$e_{min} = 6,9$ mm average overall thickness used	187	19	210.5	20.5	224	20	323	26	324	31	450	70
	287	14	310.5	15.5	324	14	423	13	424	25		
$e_{max} = 12,0$ mm average overall thickness used	178.2	10.2	201.7	11.7	215.2	11.2	308.9	11.9	307.3	14.3	450	70
	278.2	5.2	301.7	6.7	315.2	5.2	408.9	0	407.3	8.3		
$e_{max} = 18,5$ mm average overall thickness used	167	0	190.5	0.5	204	0	291	0	286	0	390	10
	267	0	290.5	0	304	0	391	0	386	0		

- All the dimensions apply only to the Knauf VERMIPLASTER® Indoor plaster and must be used together with other guidelines while structure dimensions are taken.
- Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.

All dimensions given in mm

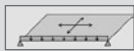


The values correspond to concrete thickness in accordance with European Technical Approval ETA-11/0229/29

Table 8

Knauf VERMIPLASTER® Indoor thickness used	Time (min.)					
	30	60	90	120	180	240
$e_{min} = 10,61$ mm average overall thickness used	29	37	41	41	40	39
$e_{max} = 20,18$ mm average overall thickness used	43	54	64	68	72	73

- The results apply only to reinforced concrete floors and walls that are exposed to fire on one side.
- The results apply only to concrete having a density of 1908.25 kg/m<sup>3</sup> to 2662.25 kg/m<sup>3</sup> (tested concrete density from 2245 kg/m<sup>3</sup> to 2315 kg/m<sup>3</sup>).
- The results apply only to slabs with a thickness of 120 mm or more.



Minimum dimensions and axial distance of reinforcement from the surface of reinforced and compressed elements of simply supported concrete slabs reinforced in one or two directions

Table 9

Knauf VERMIPLASTER® Indoor thickness used	Classification													
	REI 30		REI 45		REI 60		REI 90		REI 120		REI 180		REI 240	
	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$
$e_{min} = 10,61$ mm average overall thickness used	120	0	120	0	120	0	120	0	120	0	120	15	136	26
$e_{max} = 20,18$ mm average overall thickness used	120	0	120	0	120	0	120	0	120	0	120	0	120	0

- For crosswise reinforced slabs, where  $L_x$  and  $L_y$  represent mutually perpendicular slab span and where  $L_y$  always has a longer span.
- Axial distance  $a$  (mm) for crosswise reinforced slabs, where  $L_y/L_x \leq 1.5$  and  $1.5 < L_y/L_x \leq 2$ , equals 0.
- Only for REI 240 with Knauf VERMIPLASTER® Indoor having a thickness of 10.61 mm with the measurement of slab sides  $L_y/L_x \leq 1.5$ , value "a" equals 1. For  $1.5 \leq L_y/L_x \leq 2$ , it equals 11.
- Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.

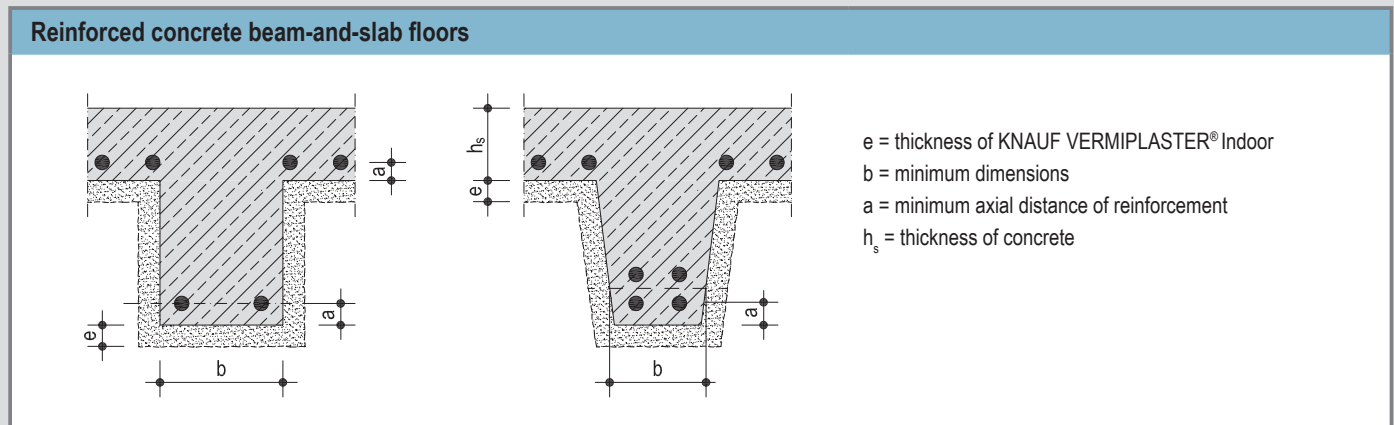


Minimum dimensions and axial distance of reinforcement from the surface of reinforced and compressed elements of floor slabs with concealed heads

Table 10

Knauf VERMIPLASTER® Indoor thickness used	Classification													
	REI 30		REI 45		REI 60		REI 90		REI 120		REI 180		REI 240	
	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$
$e_{min} = 10,61$ mm average overall thickness used	121	0	137	0	143	0	159	0	159	0	160	5	161	11
$e_{max} = 20,18$ mm average overall thickness used	120	0	121.5	0	126	0	136	0	132	0	128	0	127	0

- All the dimensions apply only to the Knauf VERMIPLASTER® Indoor plaster and must be used together with other guidelines while structure dimensions are taken.
- Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.



**Minimum dimensions and axial distance of reinforcement from the surface of simply supported beams from reinforced or compressed concrete** Table 11

Knauf VERMIPLASTER® Indoor thickness used	Classification											
	R 30		R 45		R 60		R 90		R 120		R 180	
	bmin	a	bmin	a	bmin	a	bmin	a	bmin	a	bmin	a
$e_{min} = 6,9$ mm average overall thickness used	150	2	150	10,5	150	9	150	28	174	39	240	80
	150	2	150	10,5	150	9	173	18	214	34	300	70
	150	2	160,5	5,5	174	4	273	13	274	29	400	65
	187	2	230,5	0,5	274	0	373	8	474	24	600	60
$e_{max} = 12,0$ mm average overall thickness used	150	0	150	1,7	150	0,2	150	13,9	157,3	22,3	240	80
	150	0	150	1,7	150	0,2	158,9	3,9	197,3	17,3	300	70
	150	0	151,7	0	165,2	0	258,9	0	257,3	12,3	400	65
	178,2	0	221,7	0	265,2	0	358,9	0	457,3	7,3	600	60
$e_{max} = 18,5$ mm average overall thickness used	150	0	150	0	150	0	150	0	150	1	180	20
	150	0	150	0	150	0	150	0	176	0	240	10
	150	0	150	0	154	0	241	0	236	0	340	5
	167	0	210,5	0	254	0	341	0	436	0	540	0

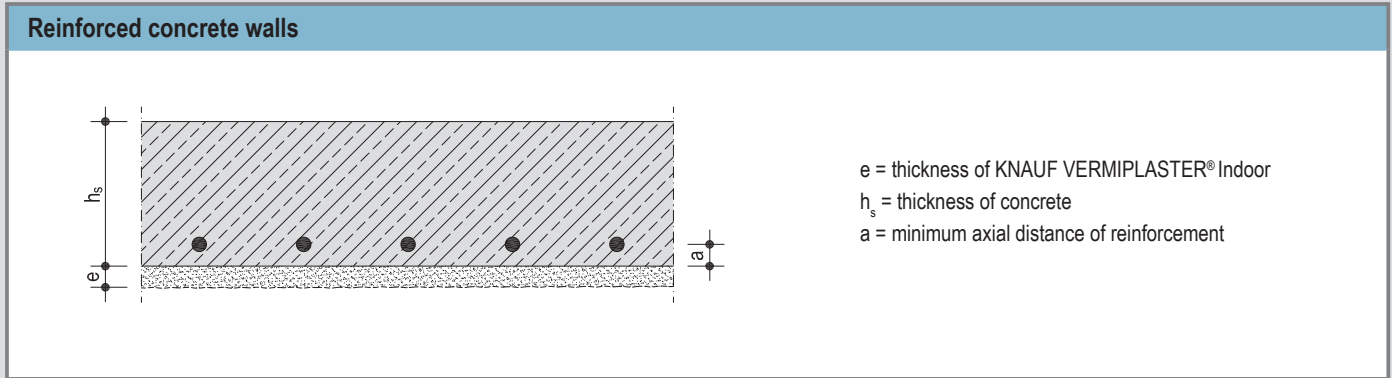
■ All the dimensions apply only to the Knauf VERMIPLASTER® Indoor plaster and must be used together with other guidelines while structure dimensions are taken.  
 ■ Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.

**Minimum dimensions and axial distance of reinforcement from the surface of reinforced or compressed simply supported floor slabs reinforced in one or both directions** Table 12

Knauf VERMIPLASTER® Indoor thickness used	Classification											
	REI 30		REI 45		REI 60		REI 90		REI 120		REI 180	
	$h_s$	a	$h_s$	a	$h_s$	a	$h_s$	a	$h_s$	a	$h_s$	a
$e_{min} = 10,61$ mm average overall thickness used	120	0	120	0	120	0	120	0	120	0	120	0
$e_{max} = 20,18$ mm average overall thickness used	120	0	120	0	120	0	120	0	120	0	120	0

■ All the dimensions apply only to the Knauf VERMIPLASTER® Indoor plaster and must be used together with other guidelines while structure dimensions are taken.  
 ■ Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.

All dimensions given in mm



The values correspond to concrete thickness in accordance with European Technical Approval ETA-11/0229/29

Table 13

Knauf VERMIPLASTER® Indoor thickness used	Time (min.)					
	30	60	90	120	180	240
$e_{min} = 10,61$ mm average overall thickness used	29	37	41	41	40	39
$e_{max} = 20,18$ mm average overall thickness used	43	54	64	68	72	73

- The results apply only to concrete slabs and walls that are exposed to fire on one side.
- The results apply only to concrete having a density of 1908.25 kg/m<sup>3</sup> to 2662.25 kg/m<sup>3</sup> (tested concrete density from 2245 kg/m<sup>3</sup> to 2315 kg/m<sup>3</sup>).

### Minimum thickness of a non-load-bearing wall (crosswall) $h_s$

Table 14

Knauf VERMIPLASTER® Indoor thickness used	Time (min.)						
	EI 30	EI 45	EI 60	EI 90	EI 120	EI 180	EI 240
$e_{min} = 10,61$ mm average overall thickness used	31	37	43	59	79	110	136
$e_{max} = 20,18$ mm average overall thickness used	17	21,5	26	36	52	78	102

- All the dimensions apply only to the Knauf Vermiplaster® Indoor plaster and must be used together with other guidelines while structure dimensions are taken.
- Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.

### Minimum dimensions and axial distance of reinforcement from surfaces of load bearing concrete walls (the wall is exposed to fire on one side)

Table 15

Knauf VERMIPLASTER® Indoor thickness used	Klasifikace													
	REI 30		REI 45		REI 60		REI 90		REI 120		REI 180		REI 240	
	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$	$h_s$	$a$
$e_{min} = 10,61$ mm average overall thickness used	91	0	92	0	93	0	99	0	119	0	170	10	231	21
$e_{max} = 20,18$ mm average overall thickness used	77	0	76,5	0	76	0	76	0	92	0	138	0	197	0

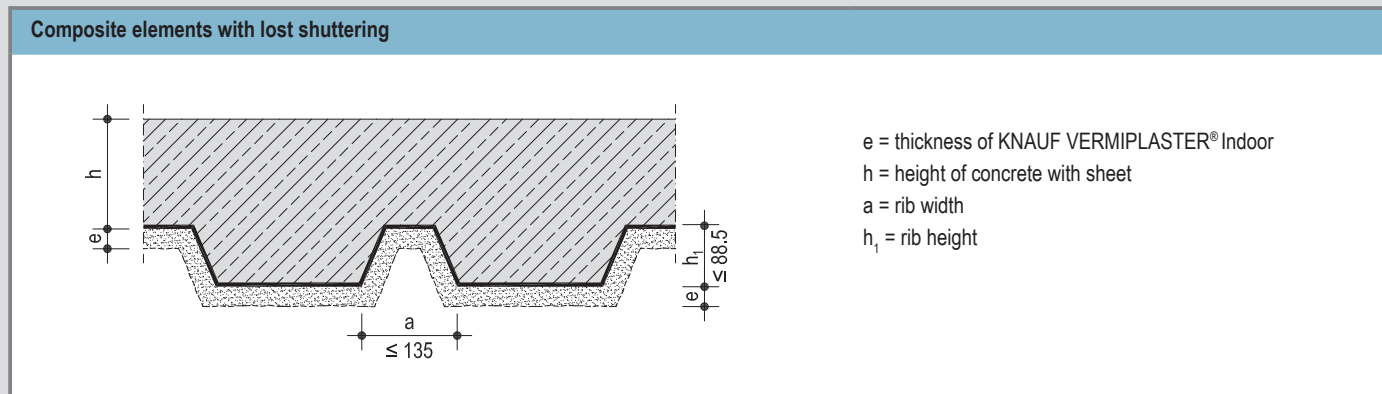
- All the dimensions apply only to the Knauf Vermiplaster® Indoor plaster and must be used together with other guidelines while structure dimensions are taken.
- Zero values for distance of reinforcement from the element surface take into account only the fire factor. Minimum reinforcement cover is needed as required by concrete technology.

# P91.temp Fire protection gypsum plaster Knauf Vermiplaster® Indoor



Composite elements with lost shuttering (trapezoidal sheet with concrete)

All dimensions given in mm



## Minimum thickness of applied gypsum plaster Knauf VERMIPLASTER® Indoor

Table 16

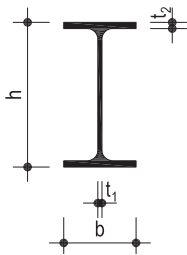
Total thickness of concrete and trapezoidal sheet h	Classification			
	REI 30	REI 60	REI 90	REI 120
100	11	15	19	24
110	11	15	19	24
120	11	15	19	24
130	11	15	19	24
140	11	15	19	24
150	11	15	19	24
160	11	15	19	24
170	11	15	19	24
180	11	15	19	24
190	11	15	19	24
200	11	15	19	24
210	11	15	19	24
220	11	15	19	24
230	11	15	19	24
240	11	15	19	24
250	11	15	19	24
260	11	15	19	24
270	11	15	19	24
280	11	15	19	24

Minimum thickness of plaster Knauf VERMIPLASTER® Indoor for fire protection in minutes (REI). Critical temperature of an element combined with trapezoidal sheet is 350 °C

### Limitations on using results obtained in accordance with European Technical Approval ETA-11/0229

- Assessment results apply to floors that are exposed to fire on the steel side and fulfil the following conditions:
  - Sheet thickness is 0.75 mm or more.
  - Width „a” of the rib on which fireproof material is directly applied should not exceed 1.5 x thickness of the tested sample, i.e.  $a \leq 135$  mm.
  - Height  $h_1$  of the rib should not exceed 1.5 x height of the tested sample, i.e.  $h_1 \leq 88.35$  mm
- Assessment results can be used only for concrete/steel slabs having a density of 0.85 to 1.15 x thickness of tested concrete, i.e. from 2014 to 2726 kg/m<sup>3</sup>.
- Assessment results apply to concrete elements the strength of which is equal to or higher than the strength of the tested concrete, i.e. 33.8 MPa after 28 days.
- Assessment results apply to all concrete elements made from concrete with silica added.
- Assessment results can be used only for concrete/steel slabs, where the slab active thickness is equal to or higher than the thickness of the slab tested (90.3 mm).

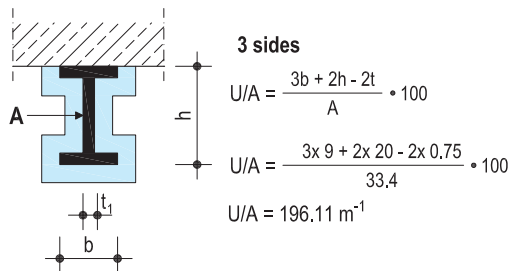
### Open section steel beams and columns



Type of section: **I 200**  
 Critical temperature of steel: **500°C**  
 Cross-section dimensions:  
 h: **200 mm**  
 b: **90 mm**  
 t<sub>1</sub>: **7.5 mm**  
 t<sub>2</sub>: **11.3 mm**  
 A: **33.4 cm<sup>2</sup>**  
 Fire resistance: **R 90**  
 Exposure to fire: **3 sides**  
 Thickness of Knauf VERMIPLASTER® Indoor -e-: **?? mm**

**Proposal:**  
see page 4

Determination of the U/A factor for steel beams and columns



**Proposal:**  
see page 7

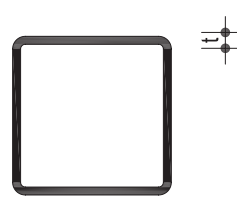
Min. thickness of Knauf VERMIPLASTER® Indoor (mm)

	R90 T [°C]				
	350	400	450	500	550
140	22	20	19	18	16
150	23	21	20	18	17
160	23	21	20	19	18
170	23	22	20	19	18
180	24	22	21	20	18
190	24	23	21	20	18
200	24	23	22	20	19
210	25	23	22	21	19
220	25	24	22	21	20

**Result:**

Thickness of Knauf VERMIPLASTER® Indoor: **22 mm**  
 U/A factor:  $60 \text{ m}^{-1} \leq 196.11 \text{ m}^{-1} \leq 540 \text{ m}^{-1}$   
 Protection thickness:  $6 \text{ mm} \leq 22 \text{ mm} \leq 36 \text{ mm}$   
 Limitations on using the obtained results in accordance with ETA-11/0229

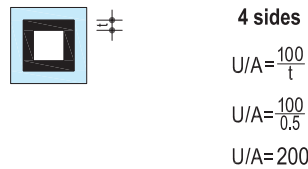
### Closed section steel beams and columns



Type of section: **R<sub>k</sub> 100x100x5 mm**  
 Critical temperature of steel: **500°C**  
 Cross-section dimensions:  
 t: **5 mm**  
 Fire resistance: **R 90**  
 Exposure to fire: **4 sides**  
 Thickness of Knauf VERMIPLASTER® Indoor -e-: **?? mm**

**Proposal:**  
see page 4

Determination of the U/A factor for steel beams and columns



**Proposal:**  
see page 7

Min. thickness of Knauf VERMIPLASTER® Indoor (mm)

	R90 T [°C]				
	350	400	450	500	550
140	22	20	19	18	16
150	23	21	20	18	17
160	23	21	20	19	18
170	23	22	20	19	18
180	24	22	21	20	18
190	24	23	21	20	18
200	24	23	22	20	19
210	25	23	22	21	19
220	25	24	22	21	20

**Result:**

In the case of steel beams and columns other than I-shaped or H-shaped, having a section factor:

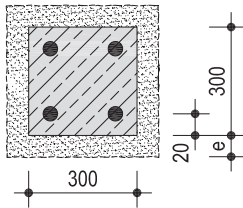
-  $U/A < 250$  - modified thickness =  $d \left( 1 + \frac{U/A}{1000} \right)$

-  $U/A \geq 250$  - modified thickness = 1.25 d

Thickness of Knauf VERMIPLASTER® Indoor: **24 mm**  
 U/A factor:  $60 \text{ m}^{-1} \leq 196.11 \text{ m}^{-1} \leq 540 \text{ m}^{-1}$

Protection thickness:  $6 \text{ mm} \leq 24 \text{ mm} \leq 36 \text{ mm}$   
 Limitations on using the obtained results in accordance with ETA-11/0229

### Reinforced concrete columns



Fire resistance: **R 90**  
 Dimension -b-: **300/300 mm**  
 Axial distance of reinforcement -a-: **20 mm**  
 Thickness of concrete: **2400 kg/m<sup>3</sup>**  
 Thickness of Knauf VERMIPLASTER® Indoor -e-: **?? mm**

**Proposal:**  
 see page 10, tab. 7

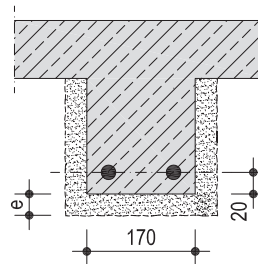
Min. dimensions and axial distance of column reinforcement for a column having rectangular or circular cross-section.

Knauf VERMIPLASTER® Indoor thickness used	Classification	
	R 90	a
e <sub>min</sub> = 6.9 mm average overall thickness used	b <sub>min</sub> 323	26
	423	13
e <sub>max</sub> = 12.0 mm average overall thickness used	308.9	11.9
	408.9	0
e <sub>max</sub> = 18.5 mm average overall thickness used	291	0
	391	0

**Result:**

Thickness of Knauf VERMIPLASTER® Indoor: **18.5 mm**  
 Dimension -b-: **300 mm ≥ 291 mm**  
 Axial distance of reinforcement -a-: **20 mm ≥ 0 mm**  
 Min. column width: **300 mm ≥ 150 mm**  
 Density: **2740 kg/m<sup>3</sup> ≥ 2400 kg/m<sup>3</sup> ≥ 2025 kg/m<sup>3</sup>**  
 Limitations on using the obtained results in accordance with ETA-11/0229

### Reinforced concrete beams



Fire resistance: **R 120**  
 Dimension -b-: **170 mm**  
 Axial distance of reinforcement -a-: **20 mm**  
 Thickness of concrete: **2400 kg/m<sup>3</sup>**  
 Thickness of Knauf VERMIPLASTER® Indoor -e-: **?? mm**

**Proposal:**  
 see page 9, tab. 4

Min. dimensions and axial distance of reinforcement for simply supported beams from reinforced and compressed concrete

Knauf VERMIPLASTER® Indoor thickness used	Classification	
	R 120	a
e <sub>min</sub> = 6.9 mm average overall thickness used	b <sub>min</sub> 174	39
	214	34
	274	29
	474	24
e <sub>max</sub> = 12.0 mm average overall thickness used	157.3	22.3
	197.3	17.3
	257.3	12.3
	457.3	7.3
e <sub>max</sub> = 18.5 mm average overall thickness used	150	1
	176	0
	236	0
	436	0

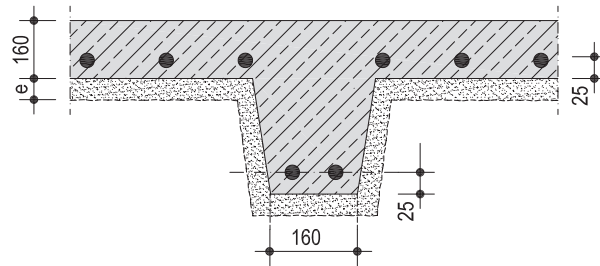
**Result:**

Thickness of Knauf VERMIPLASTER® Indoor: **12 mm**  
 Dimension -b-: **170 mm ≥ 157.3 mm**  
 Axial distance of reinforcement -a-: **20 mm ≤ 22.3 mm**

**New proposal and result:**

Thickness of Knauf VERMIPLASTER® Indoor: **18.5 mm**  
 Dimension -b-: **170 mm ≥ 150 mm**  
 Axial distance of reinforcement -a-: **20 mm ≤ 1 mm**  
 Min. beam width: **170 mm ≥ 150 mm**  
 Density: **2740 kg/m<sup>3</sup> ≥ 2400 kg/m<sup>3</sup> ≥ 2025 kg/m<sup>3</sup>**  
 Limitations on using the obtained results in accordance with ETA-11/0229

### Concrete beam slabs



Fire resistance: **R 90**  
 Dimension -b-: **160 mm**  
 Slab thickness -h<sub>s</sub>-: **160 mm**  
 Axial distance of reinforcement -a-: **25 mm**  
 Thickness of concrete: **2400 kg/m<sup>3</sup>**  
 Thickness of Knauf VERMIPLASTER® Indoor -e-: **?? mm**

**Proposal:**  
 see page 12, tab. 11

**Proposal:**  
 see page 12, tab. 12

Min. beam dimensions and axial distance of reinforcement for rectangular-section or circular-section beams

Knauf VERMIPLASTER® Indoor thickness used	Classification	
	R 90	
	b <sub>min</sub>	a
e <sub>min</sub> = 6.9 mm average overall thickness used	150	28
	173	18
	273	13
	373	8
e <sub>max</sub> = 12.0 mm average overall thickness used	150	13.9
	158.9	3.9
	258.9	0
e <sub>max</sub> = 18.5 mm average overall thickness used	358.9	0
	150	0
	150	0
	341	0

Min. dimensions and axial distance of reinforcement from the surface of reinforced and compressed elements for simply supported plain slabs working in one or two direction(s)

Knauf VERMIPLASTER® Indoor thickness used	Classification	
	REI 90	
	h <sub>s</sub>	a
e <sub>min</sub> = 10.61 mm average overall thickness used	120	0
e <sub>max</sub> = 20.18 mm average overall thickness used	120	0

**Result - beam**

**Result - floor**

Thickness of Knauf VERMIPLASTER® Indoor: **12.0 mm**  
 Dimension -b-: **160 mm ≥ 150 mm**  
 Axial distance of reinforcement -a-: **25 mm ≥ 13.9 mm**  
 Min. beam width: **160 mm ≥ 150 mm**  
 Density: **2740 kg/m<sup>3</sup> ≥ 2400 kg/m<sup>3</sup> ≥ 2025 kg/m<sup>3</sup>**  
 Limitations on using the obtained results  
 in accordance with ETA – 11/0229

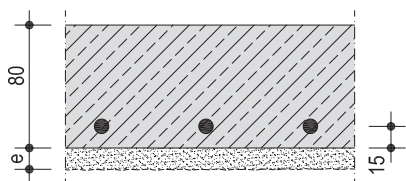
Thickness of Knauf VERMIPLASTER® Indoor: **10.61 mm**  
 Dimension -b-: **160 mm ≥ 120 mm**  
 Axial distance of reinforcement -a-: **25 mm ≥ 0 mm**  
 Min. slab thickness: **160 mm ≥ 120 mm**  
 Density: **2740 kg/m<sup>3</sup> ≥ 2400 kg/m<sup>3</sup> ≥ 2025 kg/m<sup>3</sup>**  
 Limitations on using the obtained results  
 in accordance with ETA – 11/0229

**Selection of more favourable solution (slab or beam)**

Thickness of Knauf VERMIPLASTER® Indoor: **12.0 mm**  
 For both cases the value is



### Reinforced concrete walls - non-load-bearing



Fire resistance: **EI 90**  
 Wall thickness  $-h_s-$ : **80 mm**  
 Axial distance of reinforcement  $-a-$ : **15 mm**  
 Thickness of concrete: **2100 kg/m<sup>3</sup>**  
 Thickness of Knauf VERMIPLASTER® Indoor  $-e-$ : **?? mm**

**Proposal:**  
 see page 13, tab. 14

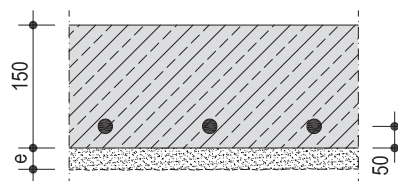
Min. thickness of a non-load-bearing wall (crosswall)  $-h_s-$

Knauf VERMIPLASTER® Indoor thickness used	Classification
	<b>EI 90</b>
	$h_s$
$e_{min} = 10.61$ mm average overall thickness used	59
$e_{max} = 20.18$ mm average overall thickness used	36

**Result:**

Thickness of Knauf VERMIPLASTER® Indoor: **10.61 mm**  
 Wall thickness  $-h_s-$ : **80 mm  $\geq$  59 mm**  
 Axial distance of reinforcement  $-a-$ : **15 mm  $\geq$  is estimated at**  
 Density: **2662.25 kg/m<sup>3</sup>  $\geq$  2100 kg/m<sup>3</sup>  $\geq$  1908.25 kg/m<sup>3</sup>**  
*Limitations on using the obtained results in accordance with ETA – 11/0229*

### Reinforced concrete walls - load-bearing



Fire resistance: **REI 120**  
 Dimension  $-b-$ : **150 mm**  
 Axial distance of reinforcement  $-a-$ : **50 mm**  
 Thickness of concrete: **2400 kg/m<sup>3</sup>**  
 Thickness of Knauf VERMIPLASTER® Indoor  $-e-$ : **?? mm**

**Proposal:**  
 see page 13, tab. 15

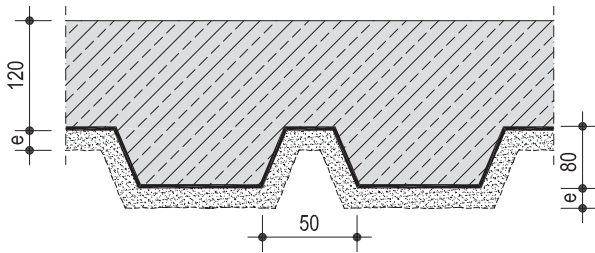
Min. dimensions and axial distance of reinforcement from load-bearing surfaces for reinforced concrete walls (wall exposed to fire on one side REI)

Knauf VERMIPLASTER® Indoor thickness used	Classification	
	<b>REI 120</b>	
	$h_s$	$a$
$e_{min} = 10.61$ mm average overall thickness used	119	0
$e_{max} = 20.18$ mm average overall thickness used	92	0

**Result:**

Thickness of Knauf VERMIPLASTER® Indoor: **10.61 mm**  
 Wall thickness  $-h_s-$ : **150 mm  $\geq$  119 mm**  
 Axial distance of reinforcement  $-a-$ : **50 mm  $\geq$  0 mm**  
 Density: **2662.25 kg/m<sup>3</sup>  $\geq$  2400 kg/m<sup>3</sup>  $\geq$  1908.25 kg/m<sup>3</sup>**  
*Limitations on using the obtained results in accordance with ETA – 11/0229*

## Composite elements with lost shuttering



Fire resistance: **REI 60**  
 Height of concrete with sheet -h-: **120 mm**  
 Rib height -h<sub>r</sub>-: **15 mm**  
 Total height : **200 mm**  
 Rib width -a-: **50 mm**  
 Sheet thickness: **1 mm**  
 Thickness of concrete **2400 kg/m<sup>3</sup>**  
 Thickness of Knauf VERMIPLASTER® Indoor -e-: **?? mm**

**Proposal:**  
 see page 14, tab. 16

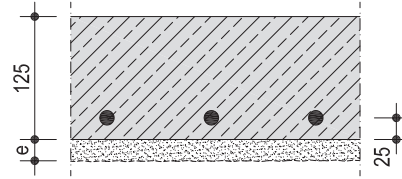
Min. thickness of Knauf VERMIPLASTER® Indoor layer -e-

Total thickness of concrete and trapezoidal sheet -h-	Classification
	<b>REI 60</b>
100	15
110	15
<b>120</b>	<b>15</b>
130	15
140	15
150	15
160	15
170	15
180	15
190	15
200	15

**Result:**

Thickness of Knauf VERMIPLASTER® Indoor: **15.0 mm**  
 Total thickness -h-: **120 mm ≥ 90.3 mm**  
 Sheet thickness: **1 mm ≥ 0.75 mm**  
 Density: **2726 kg/m<sup>3</sup> ≥ 2400 kg/m<sup>3</sup> ≥ 2014 kg/m<sup>3</sup>**  
*Limitations on using the obtained results in accordance with ETA – 11/0229*

## Simply supported reinforced concrete floors



Fire resistance: **REI 180**  
 Dimension -b-: **125 mm**  
 Axial distance of reinforcement-a-: **25 mm**  
 Thickness of concrete **2400 kg/m<sup>3</sup>**  
 Thickness of Knauf VERMIPLASTER® Indoor -e-: **?? mm**

**Proposal:**  
 see page 11, tab. 9

Min. dimensions and axial distance of reinforcement from reinforced surface and compressed elements of simply supported plain slabs working in one or two direction(s)

Knauf VERMIPLASTER® Indoor thickness used	Classification	
	<b>REI 180</b>	
	h <sub>s</sub>	a
e <sub>min</sub> = 10.61 mm average overall thickness used	120	15
e <sub>max</sub> = 12.0 mm average overall thickness used	120	0

**Result:**

Thickness of Knauf VERMIPLASTER® Indoor: **10.61 mm**  
 Dimension -b-: **125 mm ≥ 120 mm**  
 Axial distance of reinforcement -a-: **25 mm ≥ 15 mm**  
 Min. slab thickness: **125 mm ≥ 120 mm**  
 Density: **2740 kg/m<sup>3</sup> ≥ 2400 kg/m<sup>3</sup> ≥ 2025 kg/m<sup>3</sup>**  
*Limitations on using the obtained results in accordance with ETA – 11/0229*

### Processing

#### Substrate

The substrate must be clean, dry and free from dust and grease. The remaining old and flaking paint should be removed, and where it cannot be removed, it must be checked whether it is fit for plaster application. The plaster Knauf VERMIPLASTER® Indoor can be used on steel parts or steel sheets without a primer. An exception are only surfaces with peeling corroded elements. These must be removed mechanically.

**We strongly recommend that before each new application of the plaster Knauf VERMIPLASTER® Indoor, its adhesion to the loadbearing element be tested.**

- The plaster Knauf VERMIPLASTER® Indoor can be used on alkyd, epoxy, zinc silicate substrates, or on old paint layers.
- Oil paints and paints releasing pigments must be removed with appropriate agents.
- Before the Knauf VERMIPLASTER® Indoor plaster is applied on the remaining non-removable paint, plaster adhesion to that substrate should be checked.
- In places with high humidity and/or condensation risk, load-bearing elements must be covered with a protective coat.
- Steel parts and trapezoidal sheet: Peeling corroded elements should be removed. Old paint coating (or its part) should be removed or adhesion of Knauf VERMIPLASTER® Indoor to it should be checked. If anticorrosive protection for steel is envisaged, a compatible application should be used.
- Concrete: Anti-adhesion agents should be removed, together with the existing layer of crust. Use an appropriate primer.

#### Preparation

In order to achieve a requisite consistency, an appropriate amount of water should be added (ca. 1 bar/m of mortar hose). The applied amount of mortar depends on the air nozzle used. The consistency should be homogeneous and pasty. Mortar of requisite thickness must be uniformly applied on the prime coat from a distance of ca. 30 cm. Depending on the prime coat, a layer maximum 22 mm thick can be applied at a single time. If a greater thickness is needed (up to 40 mm), another layer can be applied after ca. 60 minutes, in accordance with the wet-on-wet technique. The first layer surface cannot run dry. The layer thickness must be continuously controlled during application.

#### VERMIPLASTER® Indoor thickness

- Min. thickness: 6 mm
  - Max. thickness during a single application: 22 mm
  - Max. thickness in two application stages: 40 mm
- Thickness values for particular degrees of fire resistance are set out in technical data sheet P91.temp

#### Machines / equipment

##### Machine mortar Knauf PFT G4/G5

- |                                |                                    |
|--------------------------------|------------------------------------|
| With rotor:                    | D4-3 (12 l/min) or D6-3 (20 l/min) |
| ▪ Stator                       | D4-3 (12 l/min) or D6-3 (20 l/min) |
| ▪ Rotor                        | D4-3 (12 l/min) or D6-3 (20 l/min) |
| ▪ Mortar hose                  | Ø 25 mm                            |
| ▪ Nozzle                       | Ø 10 or 12 mm                      |
| ▪ Wet mortar transfer distance | 25 m                               |
| ▪ Mixing pump                  | G4/G5                              |

#### Processing time

Depending on the substrate ca. 180 - 300 min.

#### Processing temperature / conditions

Neither plaster nor primer should be used indoor in a temperature lower than 5°C. Freshly applied plaster should be protected against direct exposure to sunlight, frost, rain and wind, until it is completely dry.

#### Drying

Good ventilation should be ensured, so that the plaster can quickly dry. If mastic asphalt flooring substrate is made on the construction site after VERMIPLASTER® Indoor has been applied, good ventilation should be ensured, so that the drying plaster will not be deformed due to temperature. Drying time: Depending on the temperature, humidity and ventilation, a 10 mm thick plaster dries on average for 14 days. The drying time can be longer in potentially unfavourable weather conditions (temperature/humidity).

#### Surface

The surface of the applied Knauf VERMIPLASTER® Indoor plaster is rough. If needed, it can be smoothed.

All subsequent layers must be chosen in such way that the fire resistance of Knauf VERMIPLASTER® Indoor is not compromised.

#### Testing / certification

The plaster is subject to permanent quality control carried out by a certified research institute and factory production control services. The production is certified in accordance with EN ISO 9001 and EN ISO 14001.

Notes



We reserve the right to make technical changes. The current version is always valid. Our warranty is expressly limited to our products in flawless condition. The stated constructional and structure properties, and characteristic building physics of Knauf systems can solely be ensured with exclusive use of Knauf system components or other products expressly recommended by Knauf. All application quantities and delivery amounts are based on empirical data that are not easily transferable to other deviating areas. All rights reserved. All amendments, reprints and photocopies, including those of excerpts, require our expressed permission.

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