

Education and Culture DG
Lifelong Learning Programme
LEONARDO DA VINCI

1&4
ANEFORÉ

FRATCOF

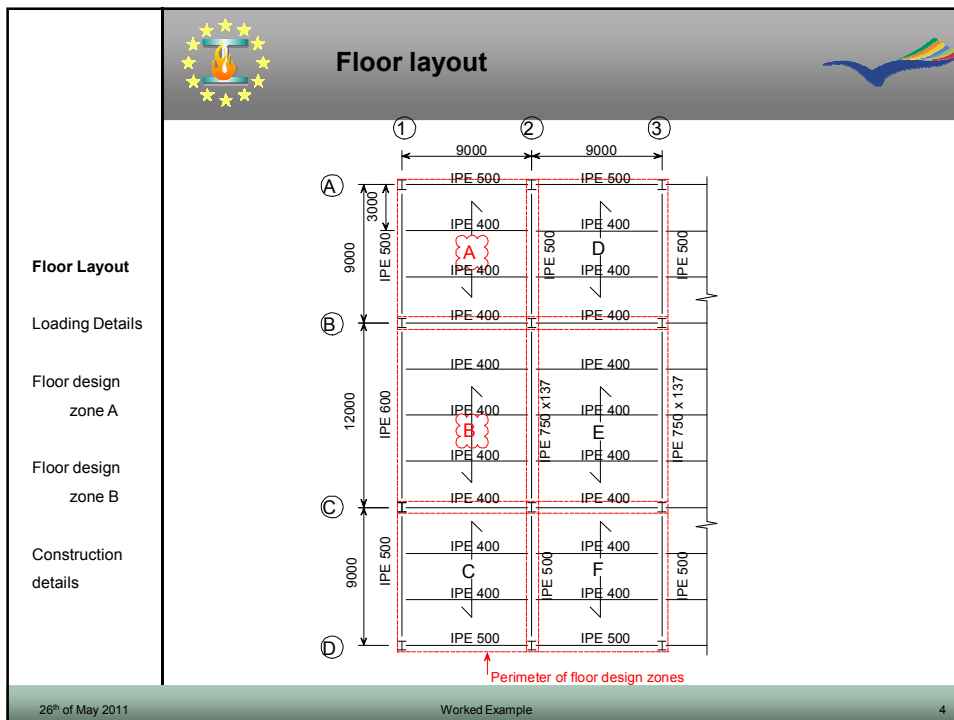
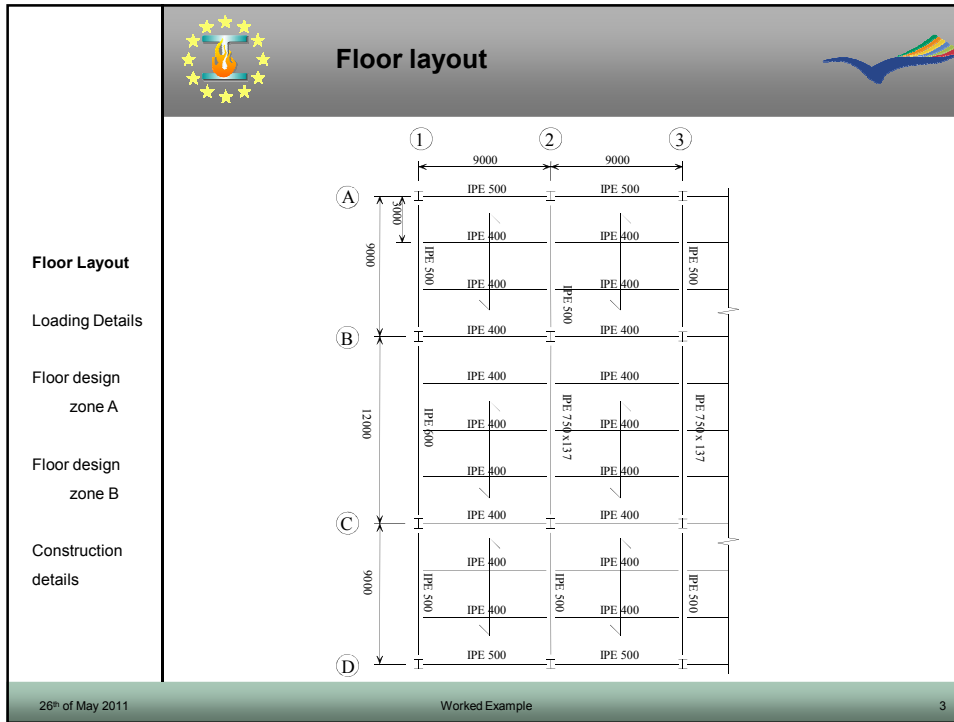
Design Guide - Worked Example



Ir. Riccardo Zanon 26th of May 2011






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- ☞ Floor Layout
- ☞ Loading Details
 - ☐ In normal (cold) condition
 - ☐ In Fire (hot) condition
- ☞ Resistance of floor design
 - ☐ zone A
 - ☐ zone B
- ☞ Construction details

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	 <h2 style="margin: 0;">Loading Details</h2> 	
<ul style="list-style-type: none"> Floor Layout Loading Details Floor design zone A Floor design zone B Construction details 	<ul style="list-style-type: none"> • Normal (Cold) <ul style="list-style-type: none"> – Leading variable action: 5 kN/m² – Accompanying variable action: 0 kN/m² – Dead load including beam, excluding slab: 1.2 kN/m² – Calculated slab weight including mesh: 2.65 kN/m² • Fire (Hot) <ul style="list-style-type: none"> – Combination Factor for permanent action: 1.0 – Combination factor for leading variable action: 0.5 – Combination factor for other variable action: 0.3 	
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	 <h2 style="margin: 0;">Floor Design - Zone A</h2> 	
<ul style="list-style-type: none"> Floor Layout Loading Details Floor design zone A Floor design zone B Construction details 	 <p style="font-size: small;"> FRACOF - The Analysis of Composite Floor Slabs in Fire Version: 1.00.015, April 2010 Environment Supporting Engine Version: 1.00.010 Engineering Calculation Engine Version: 1.00.13 PostProcessor Engine Version: 1.00.001 Internet Explorer Version: 7.0 S/N: 0311-0112-9982-9342-3834 This package is licensed to: olivier.vassart@arcelor.com and registered on 3 December 2009 If you have a question, comment, suggestion or bug report, please submit a Feedback form. If your e-mail address above is not correct please click here to re-register the package. </p> <p style="font-size: x-small;"> Software development & design by: FrestYLE Software Ltd., A division of SCI Queries relating to the use of the software should be directed to:  The Steel Construction Institute Unit 1, Sharncliffe Park, Apollo, Sheffield S15 7QN, UK Tel: +44 (0) 114 234 3522 Fax: +44 (0) 114 234 3370 Web: www.sci.ac.uk E-mail: infosteel@steel-sci.com  Centre Technique Industriel de la Construction Mécanique Espace Technologique, L'Orme des Merisiers, Immeuble Apollo Saint-Aubin, 91100, France Tel: +33 (0) 461 60 13 00 Fax: +33 (0) 461 60 13 03 Web: www.ctim.com E-mail: ctim@ctim.com </p>	
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Floor Design - Zone A



Floor Layout

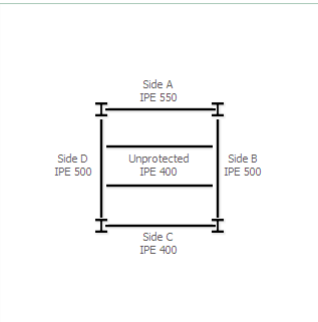
Loading Details

Floor design zone A

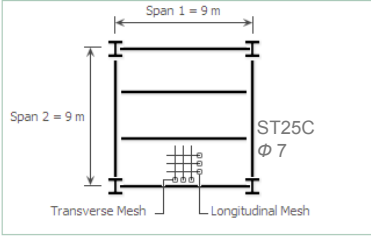
Floor design zone B

Construction details

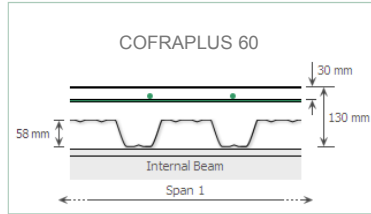
Beams




Mesh Orientation




Slab Section



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Floor Design - Zone A



Floor Layout

Loading Details

Floor design zone A

Floor design zone B

Construction details

BEAM check

Unprotected Beams

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Unprotected

Section size: IPE 400 Degree of shear connection: 51 %

Side A Perimeter Beam

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Side A

Section size: IPE 550 Construction type: Non Composite

Beam Location: Edge Beam Degree of shear connection: 0 %

Side C Perimeter Beam

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Side C

Section size: IPE 400 Construction type: Composite

Beam Location: Internal Beam Degree of shear connection: 51 %

Side B Perimeter Beam

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Side B

Section size: IPE 500 Construction type: Composite

Beam Location: Internal Beam Degree of shear connection: 72 %

Side D Perimeter Beam

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)


HD (European Wide Flange Columns)

Side D


Section size: IPE 500 Construction type: Non Composite

Beam Location: Edge Beam Degree of shear connection: 0 %

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Floor Design - Zone A



Results for the resistance of floor


Longitudinal mesh area: 257 mm²/m Bar size: 7 mm
 Transverse mesh area: 257 mm²/m Bar size: 7 mm
 Factored load in fire: 6.35 kN/m²

• **Tabular Results**


Time	Beam	Mesh	Slab top	Slab bottom	Beam capacity	Maximum allowable deflection	Slab yield	Enhancement	Slab capacity	Total capacity	Unity factor
mins	°C	°C	°C	°C	kN/m ²	mm	kN/m ²		kN/m ²	kN/m ²	
0	20	20	20	20	24.12	190	1.03	2.39	2.46	26.57	0.24
5	158	24	20	148	24.12	259	1.03	2.91	2.99	27.11	0.23
10	378	37	22	365	24.10	373	1.03	3.79	3.89	27.98	0.23
15	578	53	28	505	15.61	445	1.03	4.33	4.45	20.06	0.32
20	708	71	36	600	6.70	491	1.03	4.69	4.81	11.51	0.55
25	779	94	47	668	4.13	522	1.03	4.92	5.05	9.18	0.69
30	821	118	59	719	3.06	542	1.03	5.07	5.21	8.27	0.77
35	850	123	69	759	2.62	559	1.03	5.20	5.34	7.96	0.80
40	873	140	76	792	2.27	572	1.03	5.30	5.44	7.71	0.82
45	893	170	86	820	1.97	582	1.03	5.37	5.52	7.48	0.85
50	910	192	90	843	1.79	592	1.03	5.45	5.60	7.40	0.86
55	925	212	98	864	1.70	599	1.03	5.51	5.65	7.35	0.86
60	939	232	110	883	1.61	600	1.03	5.51	5.66	7.28	0.87

Maximum unity factor: 0.87 **Floor slab adequate**

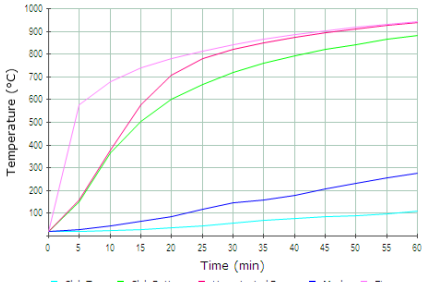
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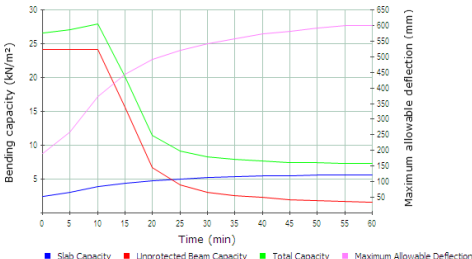


Floor Design - Zone A




Graphical outcome






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Floor Design - Zone B



Floor Layout

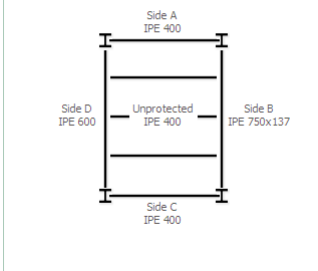
Loading Details

Floor design zone A

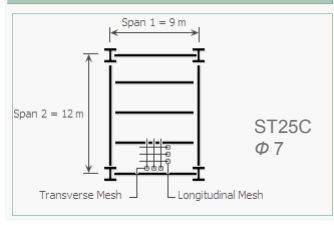
Floor design zone B

Construction details

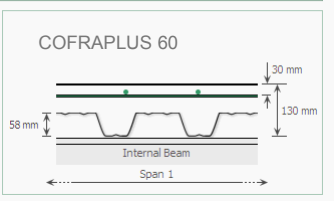
Beams




Mesh Orientation




Slab Section



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Floor Design - Zone B



Floor Layout

Loading Details

Floor design zone A

Floor design zone B

Construction details

Beam check

Unprotected Beams

Sections and Steel Grade

Families: European sections

Steel grade: S355

Unprotected

Section size: IPE 400

Degree of shear connection: 51 %

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Side A Perimeter Beam

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Side A

Section size: IPE 400

Construction type: Composite

Beam Location: Internal Beam

Degree of shear connection: 51 %

Side C Perimeter Beam

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Side C

Section size: IPE 400

Construction type: Composite

Beam Location: Internal Beam

Degree of shear connection: 71 %

Side B Perimeter Beam

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Side B

Section size: IPE 750x137

Construction type: Composite

Beam Location: Internal Beam

Degree of shear connection: 71 %

Side D Perimeter Beam

Sections and Steel Grade

Families: European sections

Steel grade: S355

Available sections

IPE (European I Beams)

HE (European Wide Flange Beams)

HL (European Wide Flange Beams)

HD (European Wide Flange Columns)

Side D

Section size: IPE 600


Construction type: Non Composite

Beam Location: Edge Beam


Degree of shear connection: %

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Floor Design - Zone B



Results for the resistance of floor


Longitudinal mesh area: 257 mm²/m Bar size: 7 mm
 Transverse mesh area: 257 mm²/m Bar size: 7 mm
 Factored load in fire: 6.35 kN/m²

• **Tabular Results**


Time	Beam	Mesh	Slab top	Slab bottom	Beam capacity	Maximum allowable deflection	Slab yield	Enhancement	Slab capacity	Total capacity	Unity factor
mins	°C	°C	°C	°C	kN/m ²	mm	kN/m ²		kN/m ²	kN/m ²	
0	20	20	20	20	24.12	254	0.79	2.94	2.34	26.45	0.24
5	158	24	20	148	24.12	322	0.79	3.48	2.76	26.88	0.24
10	378	37	22	365	24.10	437	0.79	4.38	3.48	27.58	0.23
15	578	53	28	505	15.61	508	0.79	4.95	3.93	19.54	0.32
20	708	71	36	600	6.70	555	0.79	5.31	4.22	10.92	0.58
25	779	94	47	668	4.13	585	0.79	5.55	4.41	8.54	0.74
30	821	118	59	719	3.06	606	0.79	5.71	4.54	7.60	0.84
35	850	123	69	759	2.62	622	0.79	5.84	4.64	7.26	0.88
40	873	140	76	792	2.27	636	0.79	5.95	4.72	6.99	0.91
45	893	170	86	820	1.97	645	0.79	6.02	4.78	6.75	0.94
50	910	192	90	843	1.79	656	0.79	6.11	4.85	6.64	0.96
55	925	212	98	864	1.70	663	0.79	6.16	4.89	6.59	0.96
60	939	232	110	883	1.61	666	0.79	6.19	4.91	6.53	0.97

Maximum unity factor: 0.97 **Floor slab adequate**

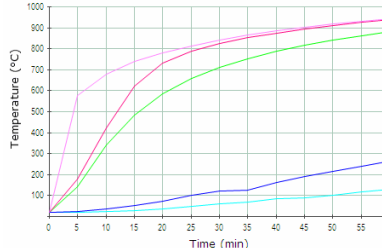
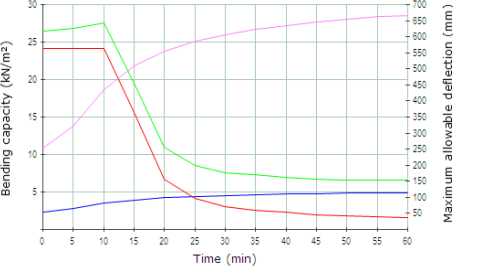
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Floor Design - Zone B



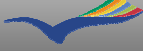
Graphical outcome

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Construction details



Covering of the mesh in the slab to ensure continuity of the rebars

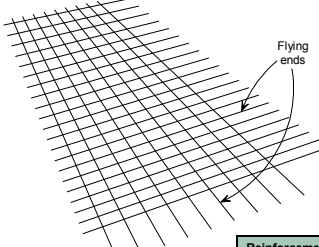
Floor Layout

Loading Details

Floor design zone A


Floor design zone B

Construction details




Reinforcement Type	Wire/Bar Type	Concrete Grade					
		LC 25/28	NC 25/30	LC 28/31	NC 28/35	LC 32/35	NC 32/40
Grade 500 Bar of diameter d	Ribbed	50d	40d	47d	38d	44d	35d
6 mm wires							
	Ribbed	300	250	300	250	275	250
7 mm wires							
	Ribbed	350	300	350	275	325	250
8 mm wires							
	Ribbed	400	325	400	325	350	300
10 mm wires							
	Ribbed	500	400	475	400	450	350

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Construction details



requirements for the edge of a composite floor slab

Floor Layout

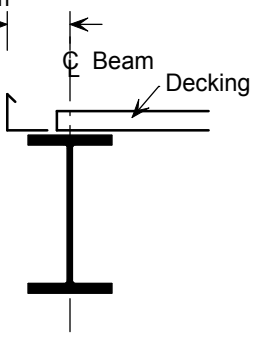
Loading Details

Floor design zone A



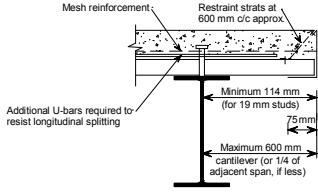
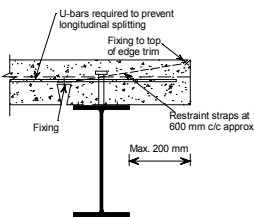
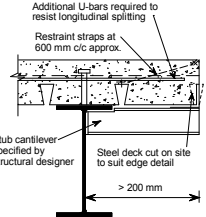
Floor design zone B



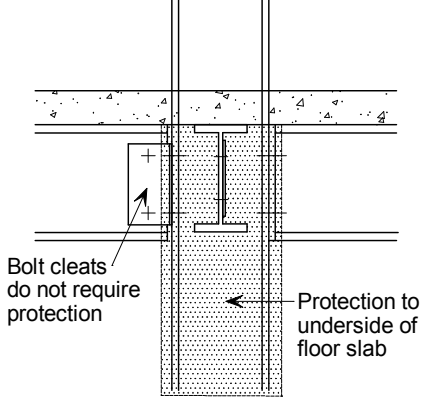
Construction details

Edge trim should be set out from centre line of beam (not grid) →



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	 <h3>Construction details</h3> 
	<h4>Typical edge details</h4>
Floor Layout	 <p>a) Typical end cantilever (decking ribs transverse to beam)</p>
Loading Details	
Floor design zone A	
Floor design zone B	
Construction details	
	 <p>b) Typical edge detail (decking ribs parallel to beam)</p>
	 <p>c) Side cantilever with stub bracket (decking ribs parallel to beam)</p>
	<p>26th of May 2011 Worked Example 17</p>

	 <h3>Construction details</h3> 
	<h4>Column protection</h4>
Floor Layout	 <p>Bolt cleats do not require protection</p> <p>Protection to underside of floor slab</p>
Loading Details	
Floor design zone A	
Floor design zone B	
Construction details	
	<p>26th of May 2011 Worked Example 18</p>