ArcelorMittal

CAR PARKS IN STEEL

Introduction
Steel car parks meet many requirements

- Safety
- Space
- Competitive cost

Metal framework

Bouillon car park
Hollerich, Luxembourg

Car park Airport
Stuttgart, Germany

Draw up your plans

- When drawing up plans, three criteria must
- be taken into account:
- Optimization of the occupancy of the car park while keeping convenience of use in mind
- Overall profitability for the operator throughout the period of use
- Inclusion of the project in the local development plan

Car park
Freiberg, Germany

How to optimise parking space?

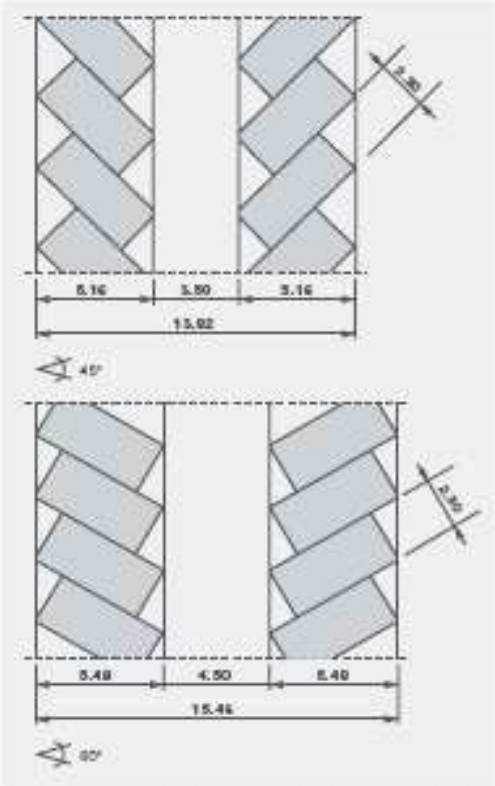
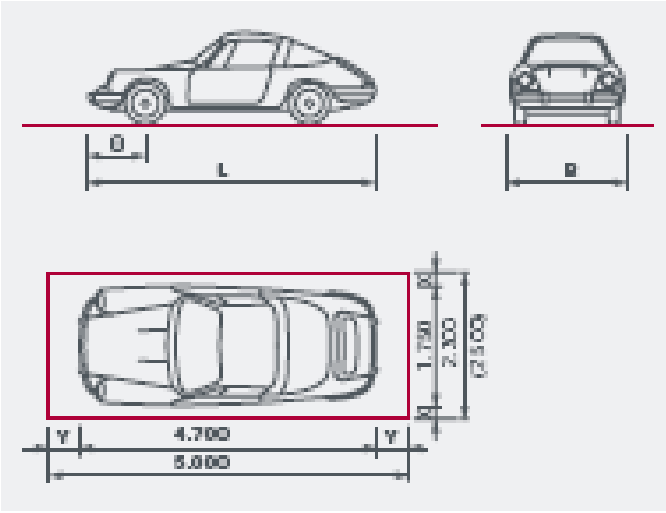


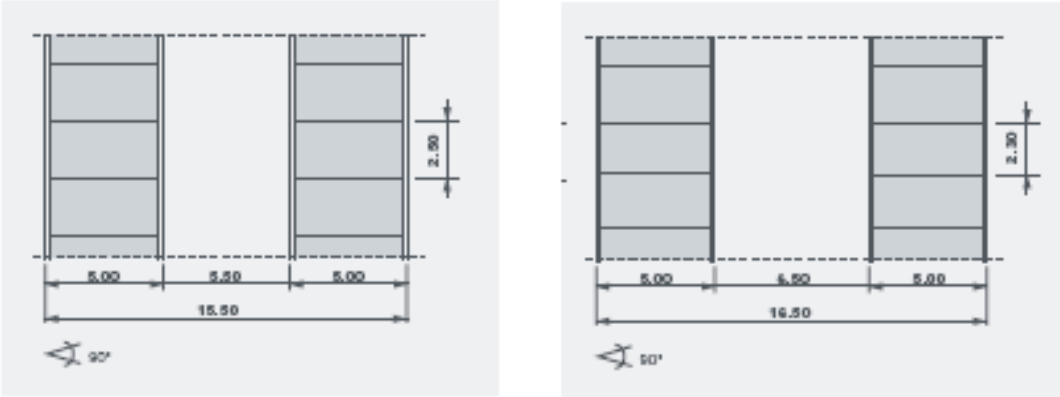
Figure 1: Arrangement of parking spaces for angles of 45 ° and 60 °

Basic dimensions of the parking spaces



How to optimise parking space?

Figure 2: Arrangement of parking spaces for angles of 90°



Comparison of the area required per space for the arrangements of figures 1 and 2

	Angle of spaces [°]	Projection of width of space [m]	Width of building [m]	Area required per parking space [m²]	[%]
A	45°	3,253	13,820	22,48	118
B	60°	2,656	15,460	20,53	108
C	90°	2,500	15,500	19,38	102
D	90°	2,300	16,500	18,98	100

Car park
Freiberg, Germany

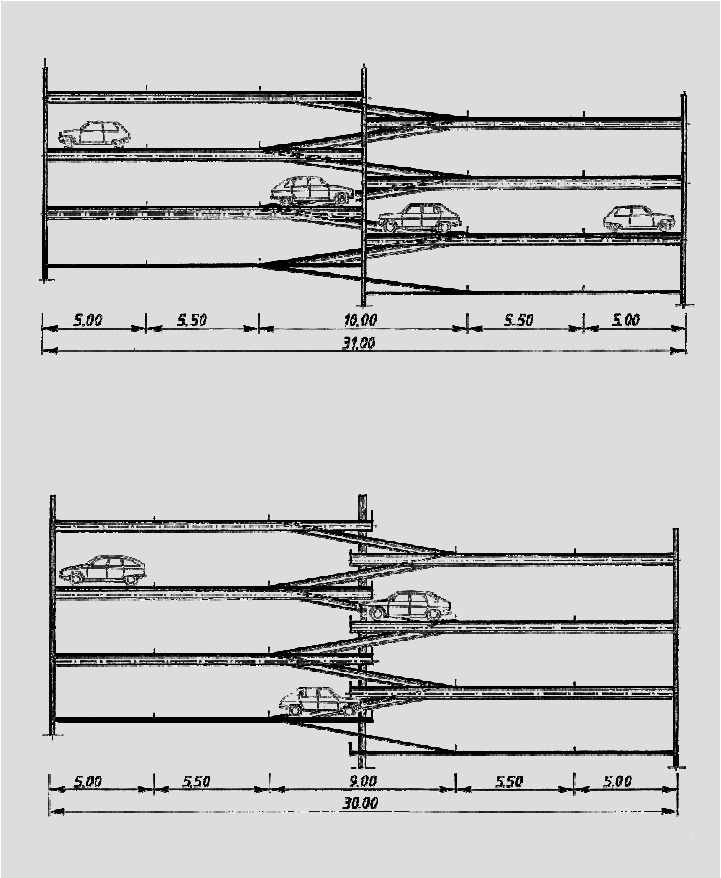
Loads

Mechanised car park
Bahar, Turkey

Car park
Munich, Germany

Optimizing car park design

Humy system without overlap of
half-storeys and with overlap



Separate half-ramps
for entry and exit

Optimizing car park design

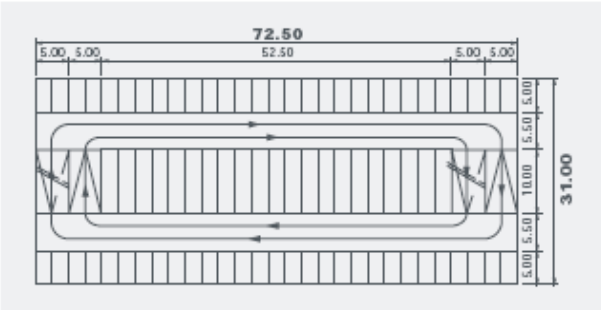
Ramp arrangement	Total area of each level [m²]	Number of spaces per level	Floor area per parking space [m²]	Distances	
				Entry [m]	Exit [m]
A	2248	100	22,48	654	521
B	2170	100	21,70	673	599
C	2248	102	22,03	514	271
D	2248	100	22,48	654	271
E	2889	100	28,89	316	251

Comparison of entry and exit distances for the ramp arrangements in figure 3 (car park with 4 levels or 8 half-levels)

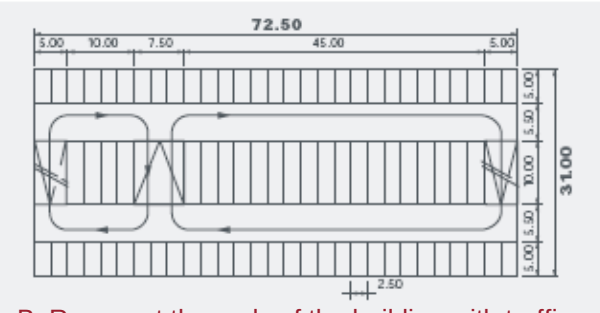
Car park
Dresden Airport, Germany

Optimizing car park design

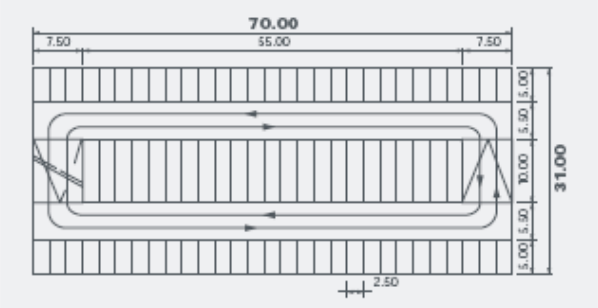
Figure 3: Arrangement of ramps



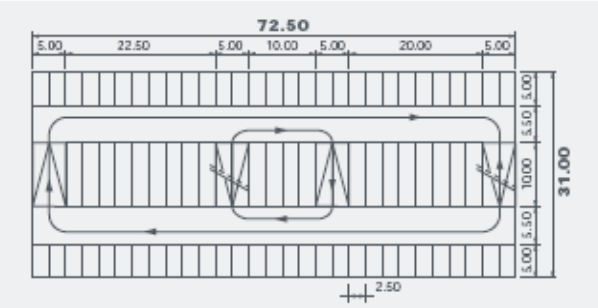
A: Entry and exit ramps adjacent, at the ends of the building, one-way traffic



B: Ramps at the ends of the building with traffic in both directions



C: Entry and exit traffic separated, exit route shortened



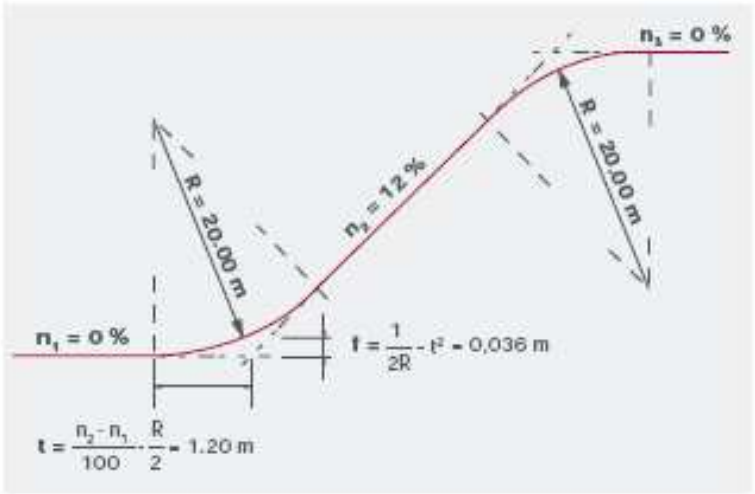
D: Entry and exit traffic mixed, exit route shortened

E: Helical ramps on the outside of the building

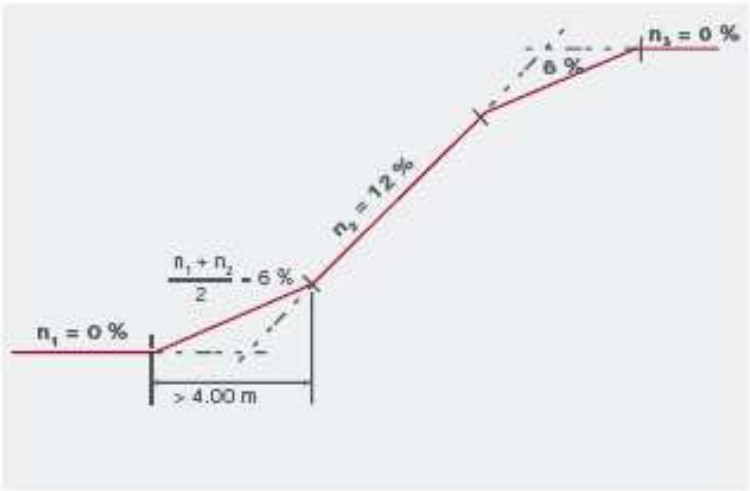
Car park
Leipzig,
Germany

Optimizing car park design

Ramp slope transitions



A: rounded



B: with intermediate slope

Car park
Dresden Airport, Germany

Metal structures suitable for car parks

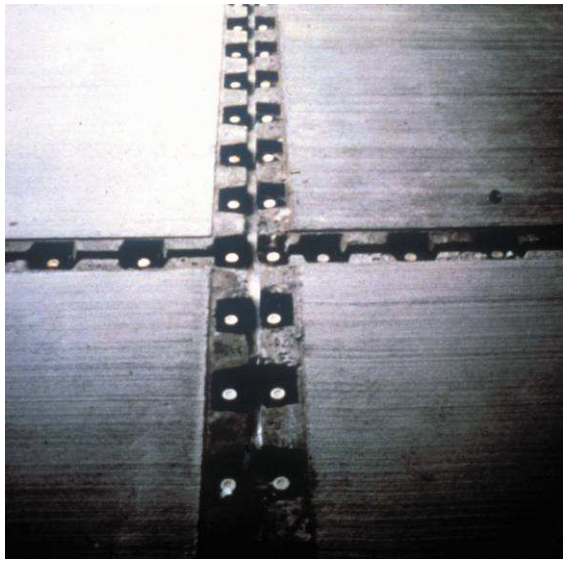
- Steel columns
- Steel floor sections

Simple assembly using bolted angle irons

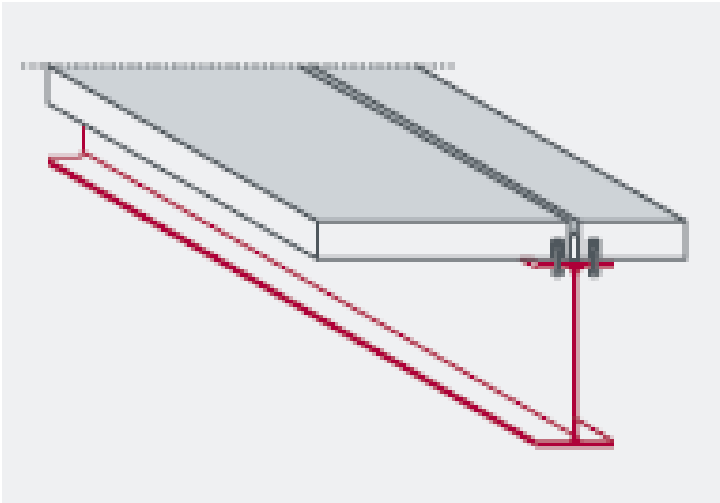
Composite steel section with studs welded in place before assembly

Car park
Munich Airport, Germany

Metal structures suitable for car parks



Composite action by filling the joints with special mortar



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Car park
Munich Airport, Germany

Metal structures suitable for car parks

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Rolled steel sections in S355 steel with non composite, prefabricated slabs

Span **l = 16,00 m**
Steel section spacing **b = 2,50 m**
Excess load **p = 2,5 kN/m²**

Slab thickness : **100 mm**
g = 7,00 kN/m
p = 6,25 kN/m

q = 1,35*7,00 + 1,5*6,25
= 18,825 kN/m
M= q*16²/8 = 602,4 kNm

Section : **IPE 500**
$M_{pl,y,Rd}$ = 1928*355/(1,1*1000)
= 622 kNm > 602 kNm

Gauge : **100 mm + 500mm**
= 600 mm

To limit the final deformation, the floor steel sections are given a camber corresponding to a load of g + 1/3 p.

Rolled steel sections in S355 steel with composite slab, poured on site (grade C25/30)

Span **l = 16,00 m**
Steel section spacing **b = 2,50 m**
Excess load **p = 2,5 kN/m²**

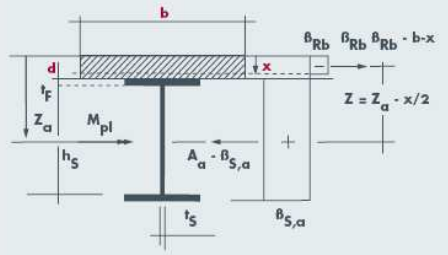
Slab thickness : **140 mm**
g = 9,25 kN/m
p = 6,25 kN/m

q = 1,35*9,25 + 1,5*6,25
= 21,86 kN/m
M= q*16²/8 = 700 kNm

Section : **IPE 400**
The neutral axis lies within the slab :
$x = (A_a f_y/g_a)/(b_{eff} 0,85 f_{ck}/g_c)$
= 77 mm < 140 mm
$M_{pl,y,Rd} = F_a(h_a+h_c-x/2)$
= 822 kNm > 700 kNm

Gauge : **140 mm + 400 mm**
= 540 mm

To limit the final deformation, the floor steel sections are given a camber corresponding to a load of g + 1/3 p.



Example of calculation of the dimensions of a floor steel section for a gauge (construction height) limit of 60 cm.

Car park
Munich Airport, Germany

Metal structures suitable for car parks

Composite steel sections with camber before mounting of the metal decks

Studs welded through the trays on site

Metal structures suitable for car parks

ArcelorMittal

Span :	16,00 m
Steel section spacing :	5,00 m
Prefabricated slab thickness :	120 mm
Life load :	2,50 kN/m²

Comparison of different grades of steel for a floor steel section without composite action

Grade of steel:	S235	S355	S460
Section :	IPE 750x196	IPE 750x147	IPE 600
Height of section (mm)	770	753	600
Height ratio	1,02	1,00	0,8
Linear weight of section (kg/m)	196	147	122
Linear weight ratio	1,33	1,00	0,83

Span :	16,00 m
Steel section spacing :	5,00 m
Prefabricated slab thickness :	140 mm
Life load :	2,50 kN/m²

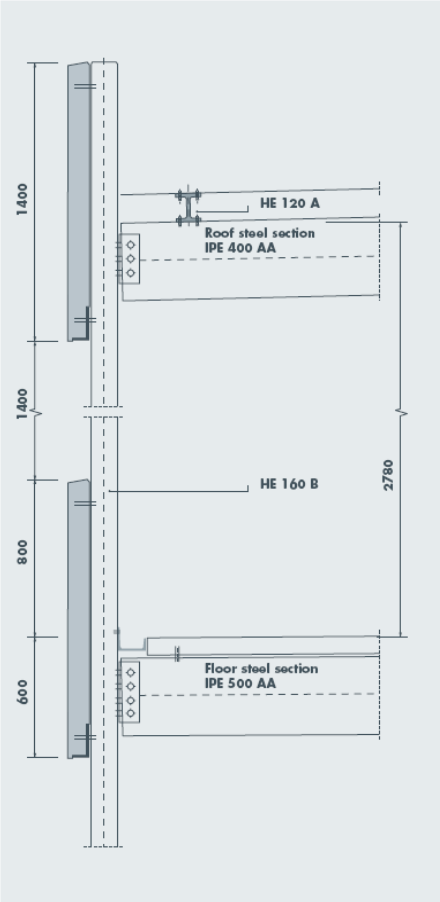
Comparison of different grades of steel for a floor steel section in composite construction

Grade of steel:	S235	S355	S460
Section :	IPE 600	IPE 550	IPE 500
Height of section (mm)	600	550	500
Height ratio	1,09	1,00	0,91
Linear weight of section (kg/m)	122	106	91
Linear weight ratio	1,15	1,00	0,86

Car park
Brussels Airport, Belgium

Application of the concept of natural fire / Fire protection

Open storey car parks



Detail of an open car park

Demonstration test carried out at the CNPP, Vernon (France) in 2000

Application of the concept of natural fire / Fire protection

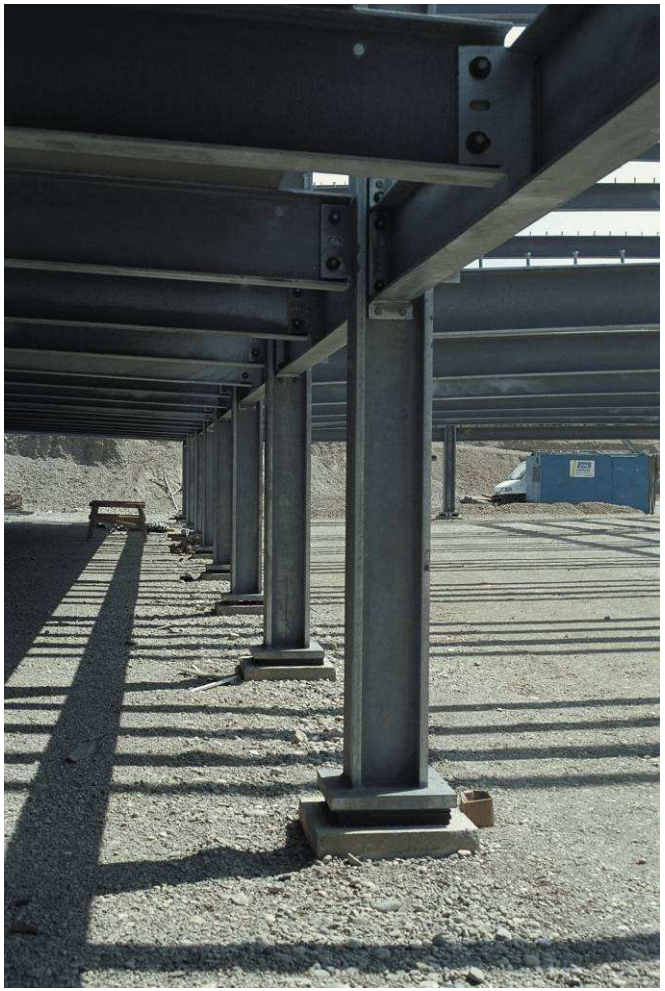
Enclosed and underground car parks

Underground car park with floor sections without passive protection

Detail of floor steel sections without passive protection

Structure condition after demonstration test, Vernon, France, 2000

Protection against corrosion

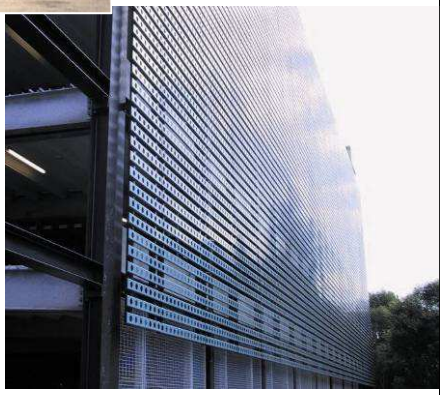


Foundations of a car park
Munich, Germany

Architectural design

Prins car park
at Stuttgart Airport,
Germany

Stadium car park at Luxembourg



Bouillon car park
Hollerich, Luxembourg

Profitability

Car park
Sindelfingen, Germany

Car park
Dresden Airport, Germany

Durability of hot rolled steel section structures

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Technical advice for users

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www.arcelormittal.com/sections