Economics of Steel Framed Buildings in Europe (ESE)

EXEMPLAR BUILDINGS

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Contents

1 INTRODUCTION

This report provides cost data for three exemplar buildings which represent typical European construction. The work is part of the ESE RFCS project Economics of Steel Framed Buildings in Europe, which is to provide a web-based costing tool for architects and specifiers. The tool is designed to perform a preliminary design of the structure, and uses material and labour cost rates to calculate the cost of the structure. It also incorporates other cost elements using rates per unit of measure for other items (e.g. façades, finishes, etc.).

The exemplar buildings comprise a residential/mixed retail use building in the UK, a commercial building in Belgium and an industrial building in the Netherlands. In some cases they are actual buildings, in others they are hypothetical. In the latter case, the buildings were designed to derive structural member sizes and floors. Quantities were estimated for both the structure and foundations. Costs were then estimated based on those quantities and current cost rates for the geographical location of the building. In addition, estimates were made of non-structural elements (e.g. architectural and mechanical and electrical items with budget cost estimates for each). The costs were aggregated to give a total cost, as well as costs per m^2 for the structure and for the complete building in each case.

The detailed data from these exemplar buildings has been used in the development of the costing tool, and may also be used as demonstration examples.

2 RESIDENTIAL/MIXED USE BUILDING

This is a hypothetical six-storey residential building with the following features:

- Rectangular plan form of approximately 17 m depth and 62 m length
- Ground floor retail outlets
- Glazed façade to retail outlets and insulated rendered cladding to residential levels

2.1 Architecture

The building provides residential accommodation on the upper five storeys which is based on three modules served by two independent stair cores. The middle module consists of four identical two bedroom flats, and the end modules are based on a mix of two- and one-bedroomed flats. Access to the flats is at the rear of the building via the core areas which each have stairs and a lift. The retail ground floor area provides for five retail outlets, with double door access from the front of the building.

The building walls are based on lightweight construction, with lightweight internal partitions and lightweight external cavity walls which support insulated rendered cladding. The roof construction is the same as the floors below, but with a built-up flat roof covering laid to falls.

The building is designed to meet the current acoustic requirements of Part E of the UK Building Regulations, and the residential accommodation has an acoustic battened floor on top of the structural slab, with a suspended ceiling below. The building requires one hour's fire resistance, and protection to the steelwork is by board generally, but the columns are concrete cased in the retail area. There is also a requirement to provide acoustic insulation to the columns, which is combined with the fire protection material.

Drawings of the building front elevation and cross-section are presented in Figure 2.1, and layouts of the retail and residential accommodation are given in Figure 2.2 and Figure 2.3 respectively.

2.2 Main structure

The structure is designed as a 'braced frame', with composite beams and composite floors using steel decking for the upper floors, but the ground floor is of reinforced concrete construction. The floor beams are a mixture of Universal Beam and Universal Column sections, while the all columns are Universal Column sections. Lateral loads are resisted by cross bracing located in the service cores. A typical arrangement for steelwork for the residential floors is shown in Figure 2.4.

2.3 Foundations

It is assumed that the foundations will be piles with pile caps and a system of ground floor beams. If the site is assumed to be near the river Thames in London, the soil profile is as given in Table 2.1.

Table 2.1 Ground conditions

Stratum	Top Elevation (mOD)
Made Ground	+5.0
Alluvial Clay	+3.0
Terrace Gravel	+1.0
London Clay	-4.0
Lambeth Beds	-19

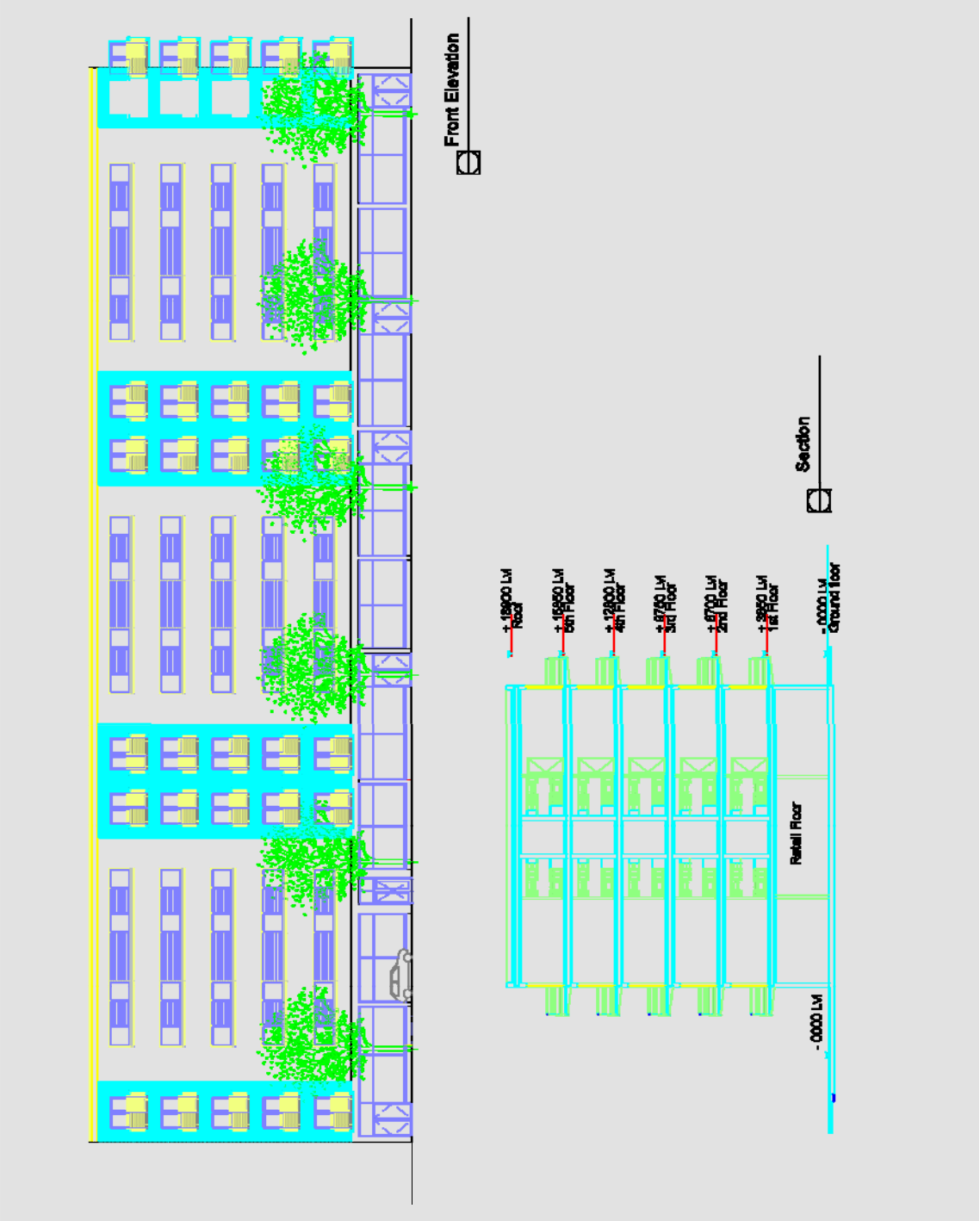

Figure 2.1 Building front elevation and section

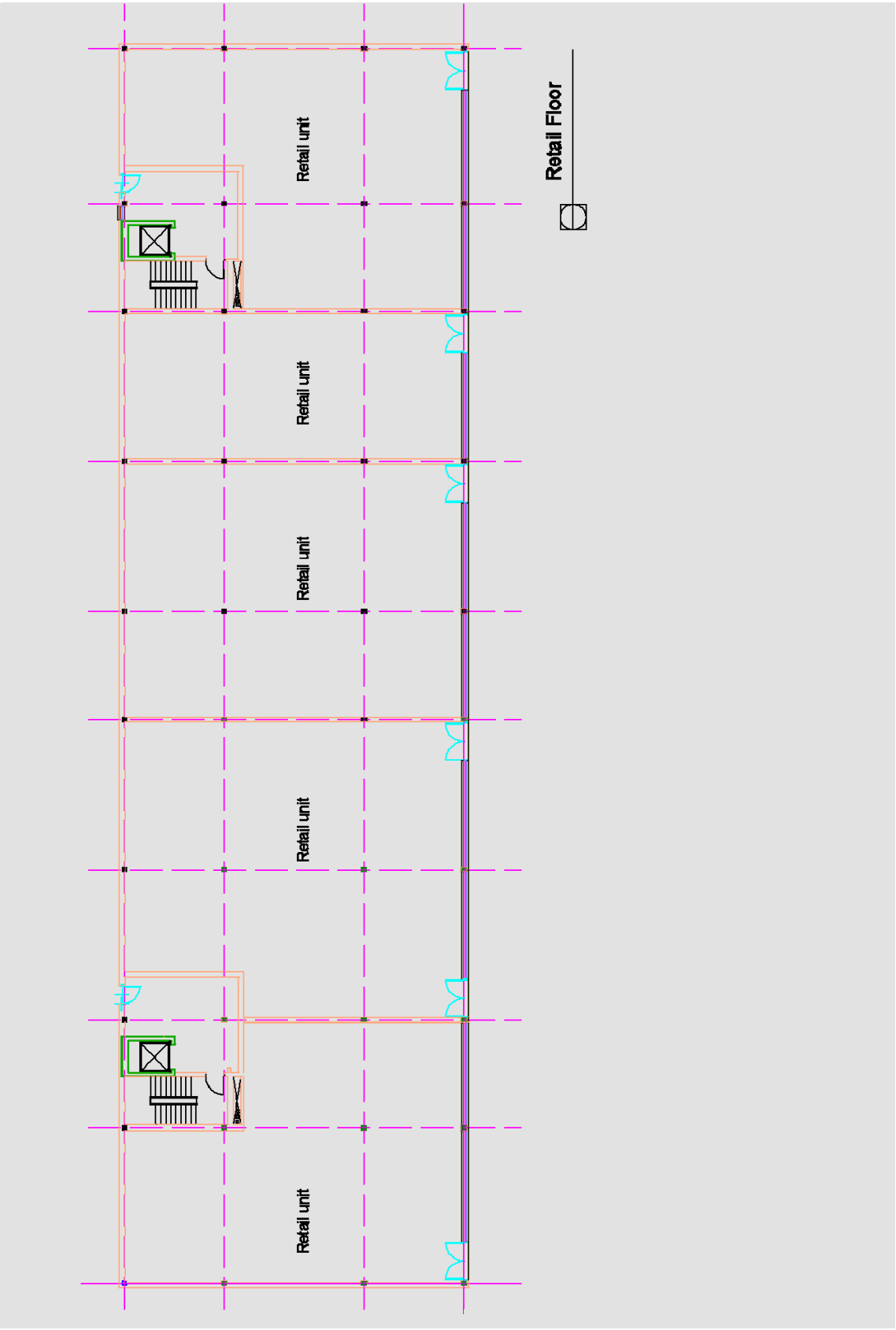

Figure 2.2 Plan form of ground floor retail area

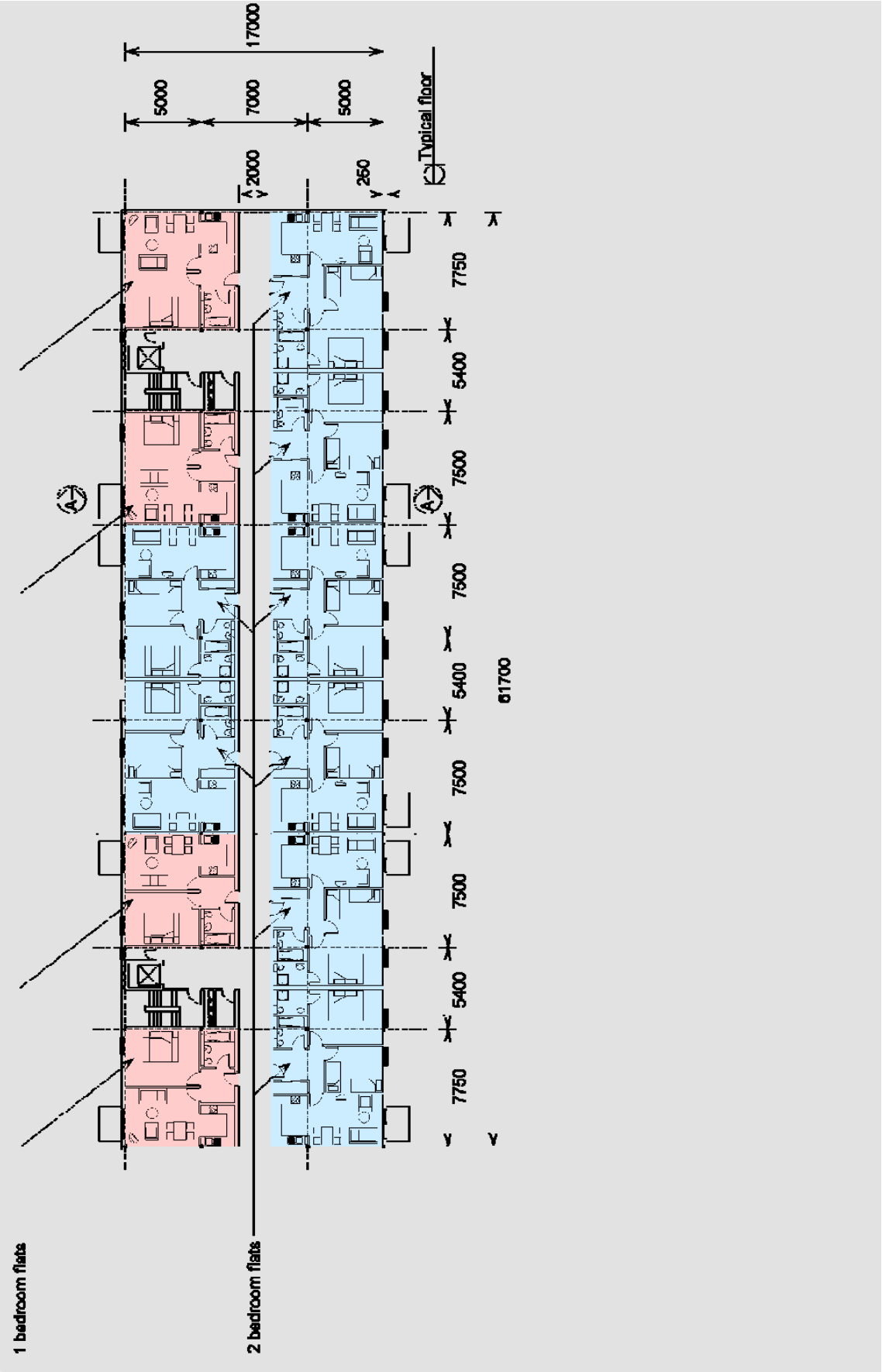

Figure 2.3 Plan form of residential levels – with dimensions

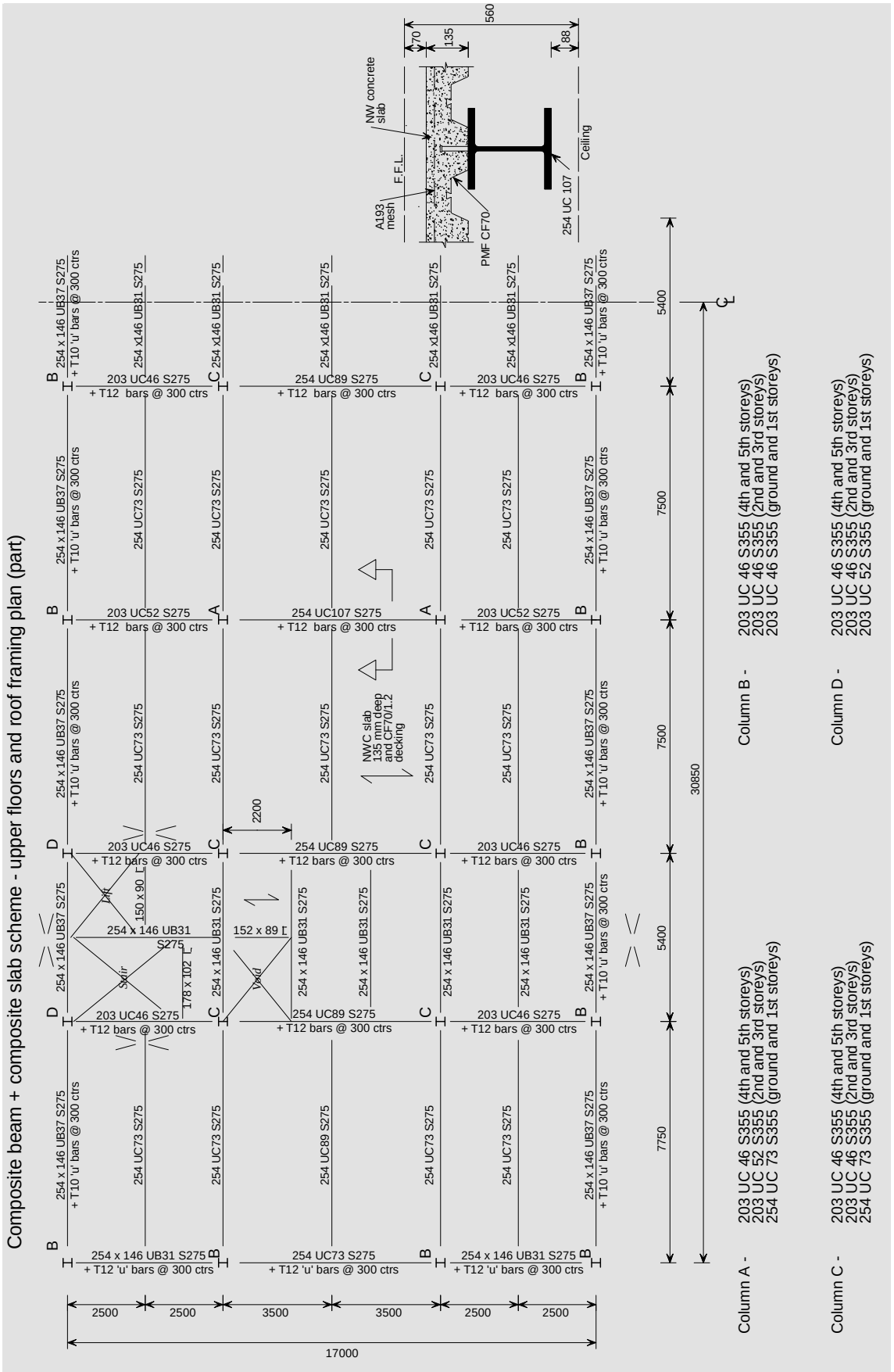

Figure 2.4 Steelwork framing (part) plan for the residential levels

2.4 Design data

A summary of the key design data is given in Table 2.2.

Table 2.2 Summary of design data

	Item	Quantity	Comment
1.	No of storeys	5 + 1 commercial	6 floors in total
2.	Floor zone	550 mm approx	Includes slab depth plus acoustic floor above and suspended plasterboard ceiling below
3.	Floor-ceiling zone	2500 mm	Residential levels
		3100 mm	Retail level
4.	Building height	18.3 m approx	Excluding roof pitch
5.	Fire resistance	R60	One hour on all levels
6.	Imposed floor loading	1.5 +1kN/m2	Residential - generally in apartments
		2.5 +1kN/m2	Residential - communal area
		4.0 +1kN/m2	Retail (ground floor)
7.	Wind loading	0.8 kN/m2	Generally on façade
8.	Cladding	75% of façade area	Insulated render
		25% of façade area	Double glazing
		Ground floor (retail)	Full height glazing

2.5 Schedule of key components

A schedule of key construction components is given in Table 2.3.

Table 2.3 Key components

	Item	Construction
1.	Superstructure	Composite downstand beams, UC columns and a braced steel core.
2.	Foundation construction	Piles, reinforced concrete pile caps and ground floor.
3.	Residential floors	Structural floor, plus a battened floor (70 mm overall) and suspended single layer plasterboard ceiling with 75 mm void (88 mm overall).
4.	Walling	See specification below:
	Separating Walls	Double layer light steel wall (250 mm width and 8 kg/m2 steel weight per unit wall area) consisting of two C-sections 75 mm deep with a 50 mm gap between and a double layer of 12 mm fire resisting plasterboard on each side. 75 mm mineral wool batts in each leaf between the vertical sections.
	External Walls	Insulated render (on 100 mm EPS insulation) attached to 10 mm cement particle board (CPB), screw-fixed to single layer light steel wall (125 mm width and 5 kg/m2 steel weight per unit wall area), with a 15 mm cavity between the CPB and the C-sections. The single layer wall comprises two layers of 12 mm fire resisting plasterboard on the inside, attached to 100 mm deep C-sections, with 100 mm mineral wool batts in the depth of the sections. Wall 250 mm o/a.
	Partitions	Single layer light steel wall (125 mm width and 3 kg/m2 steel weight per unit wall area) comprising one layer of 12 mm plasterboard on each side.
5.	Stairs	Pre-cast concrete
6.	Fire protection and acoustic insulation	Beams and secondary steelwork ~15 mm thick board fire protection Columns ~ Residential floors – 30 mm mineral wool + 2 layers 13 mm plasterboard Columns ~ Retail floor – concrete encased
7.	Roofing	Flat roof as floor construction but with built-up adhered roofing system laid to falls

2.6 Schedule of quantities and prices

The full schedule of quantities and prices for the building are given below.

Residential Building *Steel framed composite beam & composite slab structure*			GFA=	6,293	m^2
Code	Description	Qty		Rate	Cost
1.0	SUBSTRUCTURE (excluded) *Note: foundations and ground floor slab - not included*				0
			Total	£	0
			Rate GFA	£/m^2	0.00
Code	Description	Qty	Unit	Rate	Cost
2.0	FRAME AND UPPER FLOORS				
	Structural Steelwork				
	Universal Beams (S275)	54.9	t	1,480.00	81,280
	Universal Columns. g S355	217.0	t	1,505.00	326,585
	Joists; channels; angles; tee section (S275)	0.8	t	1,570.00	1,256
	Flats (S275)	9.2	t	1,865.00	17,158
	Fire Protection				
	Mineral wool	456	m^2	9.50	4,332
	Fire protection to columns - 2 layers plasterboard	456	m^2	22.00	10,032
	Beamclad (was Conlit 150)	2,896	m^2	11.40	33,014
	300x300 mm concrete encasement incl light mesh	13	m^3	140.00	1,820
	Other structural items				
	PMF CF70	6,015	m^2	25.00	150,375
	Concrete slab, pumped, g35	660	m^3	130.00	85,800
	100 x 19 dia shear connectors	15,438	Nr	1.40	21,613
	A193 reinforcement mesh	6,015	m^2	4.50	27,068
	Reinforcement bars	3.9	t	1,030.00	4,051
	Balcony support steel and decking	60.0	Nr	600.00	36,000
			Total	£	800,384
			Rate GFA	£/m^2	127.19
Code	Description	Qty	Unit	Rate	Cost
3.0	ROOF				
	20 mm thick polymer modified asphalt roofing including felt underlay, insulation and either breather membrane or vapour barrier	1,129	m^2	95.00	107,255
	Rainwater goods	161	m	85.00	13,685
	Access hatch	2	Nr	2,000.00	4,000
	Note: Roof slab measured in "Upper floors and Frame".		Total	£	124,940
			Rate GFA	£/m^2	19.85

Code	Description	Qty	Unit	Rate	Cost
4.0	EXTERNAL WALLS, DOORS AND WINDOWS				
	Insulated render on 100 mm EPS insulation, 2 layers of 15 mm plasterboard internally	2,723	m^2	130.00	354,016
	Cavity barrier	944	m	7.80	7,366
	Double glazed polyester pc aluminium windows - Retail	163	m^2	650.00	105,950
	Windows - Flats				
	1200x1200	100	Nr	615.00	61,500
	1200x2000	60	Nr	1,020.00	61,200
	Doors - Flats				
	Balcony access - glazed	60	Nr	1,000.00	60,000
	Entrance doors - solid, fire door	60	Nr	830.00	49,800
	Entrance door - Retail, glazed	6	Nr	1,500.00	9,000
	Rear door - Retail, solid, security	6	Nr	1,320.00	7,920
	Entrance door - Flats at ground level, solid, security	2	Nr	1,000.00	2,000
	Stairwell access doors - solid with vision panels, fire door	16	Nr	830.00	13,280
			Total	£	732,032
			Rate GFA	£/m^2	116.32

Code	Description	Qty	Unit	Rate	Cost
5.0	INTERNAL PARTITIONS, FINISHES & STAIRS				
	Light steel frame studs, 2 layers of plasterboard & 1 layer of 15 mm plywood both sides, mineral wool in cavity - Retail level	458	m^2	90.00	41,258
	Light steel frame studs, 2 layers of acoustic plasterboard, mineral wool in cavity - Flats compartment walls	3,007	m^2	60.00	180,438
	Light steel frame studs, 1 layer of plasterboard, mineral wool in cavity - Flats partition walls	3,455	m^2	52.00	179,660
	Internal doors FD 20, ironmongery, architrave, decoration - Flats	340	Nr	720.00	244,800
	Internal walls - mist coat & 2 full coats emulsion - Retail & Flat entrance corridor	917	m^2	3.70	3,392
	Mist coat & 2 full coats emulsion - Flats	11,690	m^2	3.70	43,253
	Ceramic wall tiling	974	m^2	45.00	43,830
	Stairs -				
	Concrete staircase with mild steel balustrades and handrail, including all finishes	16	Nr	4,500.00	72,000
	Stair access to roof	2	Nr	2,700.00	5,400
	Balustrade to balconies	264	m	200.00	52,800
	Floor finishes -				
	Sand cement screed to hall, corridors, stairs	887	m^2	19.00	16,853
	Carpet to hall, corridors, stairs	887	m^2	25.00	22,175
	Battened raft floor, 18th t&g chipboard, insulation - Flats	3,702	m^2	31.00	114,762
	Carpet - bedroom, living	2,439	m^2	20.00	48,784
	Ceramic tile - bathroom, kitchen	482	m^2	40.00	19,280
	Timber - hall	297	m^2	22.00	6,530
	Timber skirting	3,040	m	10.00	30,400
	Ceiling finishes -				
	Plasterboard suspended ceiling, fixed to ceiling support system - Flats with skimmed finish & emulsion paint	3,702	m^2	27.00	99,954
			Total	£	1,225,569
			Rate GFA	£/m^2	194.75

Code	Description	Qty	Unit	Rate	Cost
6.0	SERVICES				
	Mechanical services -				
	Heating & hot water - Retail	920	m^2	52.00	47,840
	Heating & hot water - Flats	3,702	m^2	85.00	314,670
	Ventilation to kitchens & bathrooms - Flats	60	Nr	500.00	30,000
	Common areas - 2 no cleaners cupboards	2	Nr	500.00	1,000
	Incoming mains service - Retail (water)	6	Nr	1,500.00	9,000
	Incoming mains service- Flats (water)	80	flats	600.00	48,000
	Electrical services -				
	Lighting & power distribution - Retail	920	m^2	57.00	52,440
	Lighting and power installation - Common Areas		Item	2,240.00	2,240
	Lighting and power distribution - Flats	3,702	m^2	38.00	140,676
	Communications - Flat entry system	60	flats	290.00	17,400
	Incoming mains service - Retail (electricity)	6	Nr	1,000.00	6,000
	Incoming mains service - Flats (electricity)	80	flats	250.00	20,000
	Sanitary services - fittings and disposal -				
	Bathroom - standard 3 piece suite	60	Nr	1,500.00	90,000
	En-suite - shower, basin, w.c.	40	Nr	2,000.00	80,000
	Cleaners cupboard - Belfast sinks	2	Nr	250.00	500
	Soil & waste drains - Flats	3,702	m^2	8.50	31,467
	Other fittings -				
	Kitchen units - 1-bed flat, include stainless steel sink	20	Nr	5,000.00	100,000
	Kitchen units - 2-bed flat, include stainless steel sink	40	Nr	6,000.00	240,000
	Cooker, extractor	60	Nr	500.00	30,000
	Mail boxes to entrance foyer	60	Nr	125.00	7,500
	Building signage		Item	2,500.00	2,500
	Lift installation -				
	Passenger lift, 6-10 persons, 8 storeys. Standard fit-out	2	Nr	85,000.00	170,000
	Builder's work in connection with the mechanical, electrical and sanitary services			5%	44,600
			Total	£	1,485,833
			Rate GFA	£/m^2	236.11

Code	Description	Qty	Unit	Rate	Cost
7.0	EXTERNAL WORKS (excluded)				0
			Total	£	0
			Rate GFA	£/m^2	0.00

SUMMARY

SUBSTRUCTURE (Excluded)	0
FRAME AND UPPER FLOORS	800,384
ROOF	124,940
EXTERNAL WALLS, DOORS AND WINDOWS	732,032
INTERNAL PARTITIONS, FINISHES & STAIRS	1,225,569
SERVICES	1,485,833
EXTERNAL WORKS (Excluded)	0
SUB-TOTAL	4,368,758
PRELIMINARIES @ 13%	567,939
TOTAL	4,936,697

Note: preliminaries include fixed items and time-related items, including, the cost of site set up, site management, services, buildings, facilities, security, craneage and insurance, etc. They also include the contractor's overhead and profit.

3 COMMERCIAL BUILDING

This commercial building has been constructed and is the Centre Acier ArcelorMittal (CAAL) in Liège, Belgium. It is an administrative office building for ArcelorMittal and is built along the river Meuse. It has five-storeys (ground floor, plus four storeys). Figure 3.1 shows an artistic impression of the completed building.

The main features are:

- Rectangular plan form of approximately 18 m depth and 80 m length
- Steel structure
- Glazed façade

The construction of the building started in April 2007 and was completed in September 2008. Key requirements for this building were:

- Security
- Sustainability
- Flexibility and adaptability of the building
- Intensive use of steel as a showcase for ArcelorMittal

3.1 Architecture

The building provides 7000 m² of offices area and accommodates 300 people. One lift and two stairwells are distributed along the length of the building. The ground floor consists of the reception, waiting room, canteen and technical rooms (Figure 3.2). The upper floors are dedicated to the offices and meeting rooms (Figure 3.3). The meeting rooms are mainly grouped on the first floor. Each floor also includes a communal space for relaxation during lunch breaks etc.

The offices are located on the four floors, either in individual rooms or in shared spaces. In order to provide flexibility, the offices are separated by removable partition walls; electrical points are located in the raised floor to maximise adaptability.

The building is designed for a fire resistance of one hour (in accordance with ISO-fire, Eurocode 1 Part 1-2). Structural elements are protected with beam flocking (one in three beams is protected). Security measures such as firebreak doors and fire insulated walls complement other fire safety devices, such as fire detection, fire extinguishers, *etc*.

Heating, cooling and ventilation (HVAC) are provided by a heat pump. The services located within the floor system. Solar panels are installed on the building roof in order to heat sanitary water.

Office furniture and the removable partition walls contribute to the acoustic insulation.

Figure 3.1 Commercial building – Centre Acier ArcelorMittal Liège

3.2 Main structure

The building structure is a steel frame designed according to Belgian Standards NBN B51 001 and 002 and Eurocode ENV1993-1-1. It comprises:

- Composite beams (hot rolled I-profiles and cellular beams)
- Concrete slab on ground floor
- Composite floors with steel decking and concrete slab for the upper floors. The floor is supported by steel cellular beams. Shear studs provide composite action between the cellular beams and the floor slabs.
- Columns are concrete-filled steel tubes.
- Five concrete cores over the full height of the building provide the lateral stability; One core houses the lifts, two cores house the stairwells and two cores house sanitary blocks.

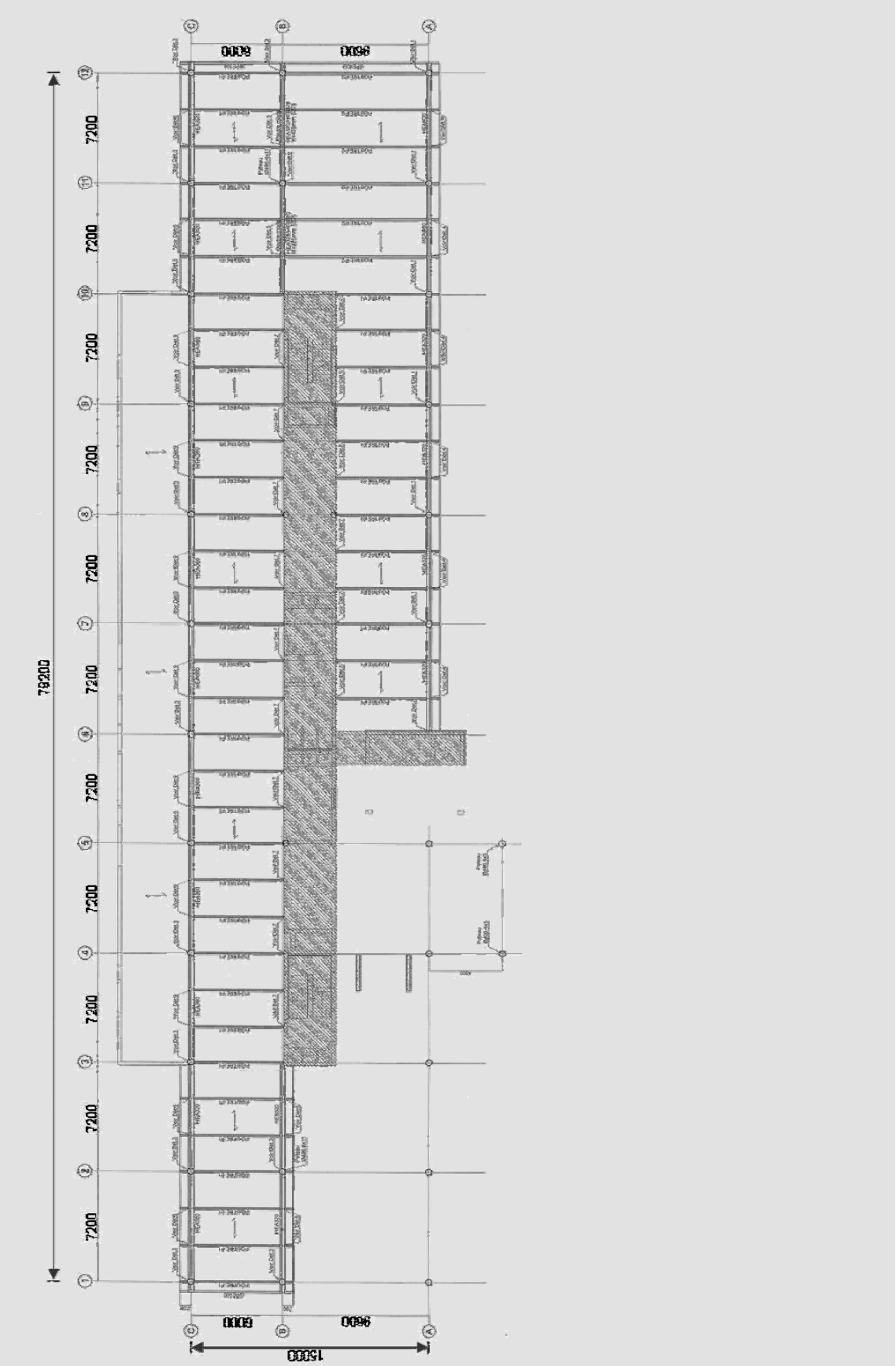

Figure 3.2 Ground floor plan

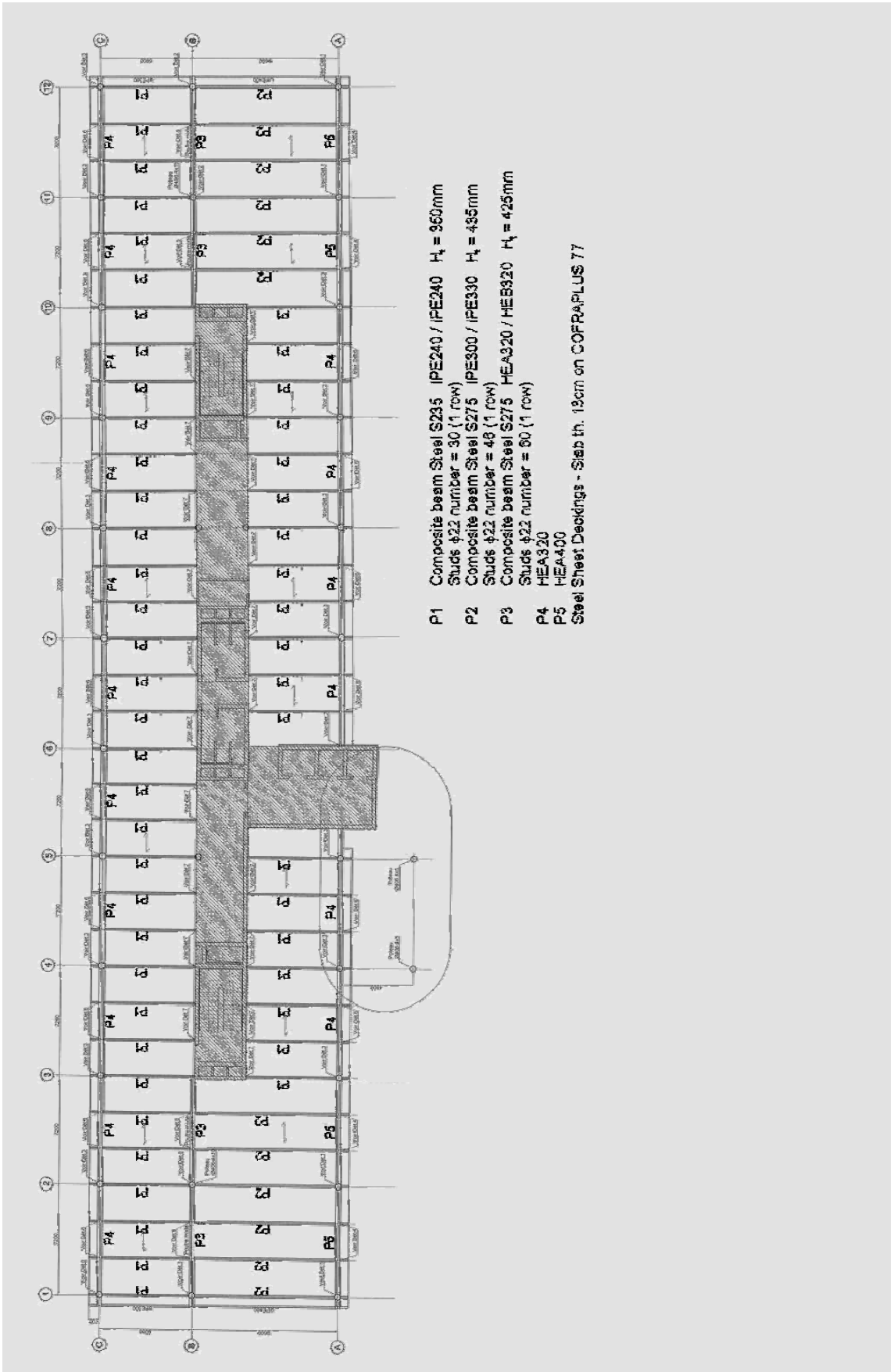

Figure 3.3 Second floor plan

3.3 Foundations

The building is supported on eighty piles which are founded on firm gravel (of the river Meuse).

3.4 Design data

A summary of the key design data is given in Table 3.1.

Table 3.1 Summary of design data

	Item	Quantity	Comment
1	N° of storeys	4 + 1 office	5 floors in total
2	Floor zone	0.5 m approx	including slab depth, acoustic floor above and false ceiling below
3	Floor-Ceiling zone	2.80m	height under false ceiling
4	Building height	20.80 m approx	including plant rooms on the roof
5	Fire resistance	R60	one hour on all levels
6	Imposed floor loading	3kN/m² variable loads 2kN/m² screed 1kN/m² partition walls	
7	Wind loading	0.89 kN/m²	building height > 10m
8	Cladding	75% façade area 25% façade area	steel curtain wall and insulated glass steel and brick cladding

3.5 Schedule of key components

A schedule of key construction components is given in Table 3.2.

Table 3.2 Key components

	Item	Construction
1	Structural steel	290 tons of rolled section beams and columns 7 tons of decking 133 tons of reinforcement
2	Sheet steel	75 tons of cladding, curtain walling and sheet piling
3	piping, partition walls and wall-coverings	65 tons of steel
4	Furniture	7 tons of steel
5	Pipes, priming tubes, false ceiling, cable paths, lights, etc	90 tons of steel
6	Internal coverings	50 tons of steel
7	Glass	3500 m² of glazed surfaces
8	Concrete walls	Core walls, other walls, stair wells, lift shafts
9	Concrete slabs	Composite slabs; ground floor slab
10	Brickwork	North and west walls of ground floor

3.6 Schedule of quantities and prices

The full schedule of quantities and prices for the building are given below.

Office Building			**GFA=**	**7,000**	**m^2**
	Centre Acier ArcelorMittal Liège				
Code	**Description**	**Qty**	**Unit**	**Rate**	**Cost**
2	**FRAME AND FLOORS (Ground floor included)**			**€/Unit**	**€**
2.1	**CONCRETE WORKS**				
	Preparation of the laying of the foundations				
	(poor concrete thick. 5cm)				
	Foundation beams	67.0	m^2	9.47	634
	Lifts	14.0	m^2	9.46	132
	Peripheral plinth	21.0	m^2	9.46	199
	Concrete for in-situ casted concrete				
	Soles of foundations	6.2	m^3	165.62	1,027
	Foundation beams	47.0	m^3	129.53	6,088
	Raft lifts	4.2	m^3	145.75	612
	Wills lifts	7.0	m^3	147.56	1,033
	Walls poured on site	114.0	m^3	129.55	14,769
	Beams, lintels	18.1	m^3	147.59	2,671
	Rectangular columns	1.7	m^3	165.59	282
	Slabs in elevation	16.1	m^3	129.53	2,085
	Bases	10.0	m^3	206.21	2,062
	Heightenings	7.1	m^3	206.16	1,464
	2d phase pre-slabs	104.0	m^3	129.55	13,473
	Other uses	10.0	m^3	206.21	2,062
	Casing for reinforced concrete				
	Soles of foundations	12.0	m^2	61.88	743
	Foundation beams	219.0	m^2	43.83	9,599
	Raft lifts	5.2	m^2	80.50	419
	Wills lifts	62.0	m^2	64.86	4,021
	Walls poured on site	991.0	m^2	50.40	49,946
	Beams, lintels	216.0	m^2	73.87	15,956
	Rectangular columns	23.0	m^2	84.69	1,948
	Slabs in elevation	94.0	m^2	46.79	4,398
	Bases	54.0	m^2	102.17	5,517
	Heightenings	71.0	m^2	100.98	7,170
	Other uses	100.0	m^2	120.24	12,024
	Steel for reinforced concrete				
	Total bars	40,000.0	kgs	1.24	49,600
	Total meshes	22,500.0	kgs	1.11	24,975
	Steel for waterproof concrete				
	Soles of foundations	6.2	m^3	6.56	41
	Foundation beams	47.0	m^3	6.55	308
	Raft lifts	4.2	m^3	6.55	28
	Wills lifts	7.0	m^3	6.56	46
	Walls poured on site	76.0	m^3	6.56	499
	Rectangular columns	1.7	m^3	6.55	11
	Bases	10.0	m^3	6.56	66

Office Building			GFA=	7,000	m^2
	Centre Acier ArcelorMittal Liège				
Code	Description	Qty	Unit	Rate	Cost
	Prefabricated concrete				
	Plinth BA 20 x 85 cm	101.0	Mct	69.19	6,988
	Stairs : Landing type 1	10.0	Pce	818.02	8,180
	Stairs : Landing type 2	8.0	Pce	818.02	6,544
	Stairs : Landing type 3	2.0	Pce	818.02	1,636
	Stairs : Flight of stairs type 1	2.0	Pce	1,158.37	2,317
	Stairs : Flight of stairs type 2	10.0	Pce	1,158.49	11,585
	Stairs : Flight of stairs type 3	8.0	Pce	1,158.49	9,268
	Foundation for base slab				
	Ground compacted and overlain with 250mm thick compacted stones, 50mm sand and a damp proof membrane.				
	Base slab	1,233.0	m^2	13.15	16,214
	Base slab				
	(ground slab thick. 15cm - including concrete, reinforcement, shrinkage joints, expansion joints)				
	Base slab	1,233.0	m^2	29.20	36,004
	Drain DN 110mm PVC	220.0	Mct	35.51	7,812
	Insulation sheet				
	Lifts	16.3	Mct	29.40	479
	Prefabricated reinforced concrete walls				
	Pre-walls thick. 30cm	156.0	m^2	90.62	14,137
	Pre-walls thick. 24cm	1,394.0	m^2	95.47	133,085
	Concrete 2d phase pre-walls thick. 30cm	28.1	m^3	145.92	4,100
	Concrete 2d phase pre-walls thick. 24cm	167.3	m^3	145.98	24,422
	Reinforced concrete pre-slabs thick. 6cm min (rebars included)				
	Pre-slab thick. 6cm (reinforcement included)	914.0	m^2	37.02	33,836
			Total 'CONCRETE WORKS'	**€**	**552,514**
			Rate GFA	**€/m^2**	**78.93**
	FRAME AND FLOORS (Ground floor included)			**€/Unit**	**€**
2.2	**STEEL STRUCTURE (incl. connections)**				
	Steel structure (non RF structure)	**320,038.0**	**kgs**	**2.11**	**675,318**
	Steel cellular beams with connection flats (S235 - stud connectors included)				
	Steel cellular beams with connection flats (S275 - stud connectors included)				
	Rolled steel beams with connection flats (S235)				
	Steel columns with connection flats (S235)				
	Other elements (angles, flats,...)				
	Intumescent painting protection RF 1h				32,676
	Steel columns with connection flats (S235)				
	Reinforced concrete-filled columns				
	Coating protection RF 1h				
	Steel cellular beams with connection flats (Steel S235)	1,667.9	m^2	20.48	34,159
	Steel cellular beams with connection flats (Steel S275)	823.4	m^2	20.49	16,871
	Rolled steel beams with connection flats (Steel S235)	2,680.0	m^2	20.48	54,886
	Other elements (angles, flats,...)	96.2	m^2	20.48	1,970
	Composite steel floors				

Office Building			GFA=	7,000	m^2
	Centre Acier ArcelorMittal Liège				
Code	Description	Qty	Unit	Rate	Cost
	Reinforced concrete slab with steel formwork (including steel deck COFRA+ 77, concrete, rebars, fixation,...)	5,604.0	m^2	48.74	273,139
	Steel box				
	Lifts (S235)	39.9	m^2	84.29	3,363
	Total 'STEEL STRUCTURE (incl. connections)'			**€**	**1,092,383**
			Rate GFA	**€/m^2**	**156.05**
3.0	**ROOFS**			**€/Unit**	**€**
	Slope shape in light concrete	1,597.7	m^2	18.94	30,260
	Roof openings				
	Smoke outlet	2.0	Pce	1,248.64	2,497
	Roof finishings				
	Multi layer insulation and insulation on concrete	1,597.7	m^2	47.50	75,891
	Ballasting gravel	261.31	m^2	8.53	2,229
	Roof throat	20.0	Pce	93.11	1,862
	Gravel stop	5.0	Pce	20.00	100
	External floor in Bankirai	53.241	m^2	98.28	5,233
	Reinforced concrete supports 25x25x25	100.000	Pce	108.00	10,800
			Total 'ROOFS'	**€**	**128,872**
			Rate GFA	**€/m^2**	**18.41**
4.0	**EXTERNAL WALLS, DOORS AND WINDOWS**			**€/Unit**	**€**
	Basement in blue stone ("petit granit")	1.57	m^3	7,228.85	11,349
	Automatic sliding glazed door				
	Entry vestibule	2.0	Pce	7,536.00	15,072
	Canteen	1.0	Pce	8,525.00	8,525
	Door frame in coated steel in brick façades				
	Doors				
	0 EXT 1 : door technical room (hot air pump) 0 EXT 2 : access door CODIR + delivery 0 EXT 4 : access door EAST (kitchen, corridor)	3.0	Pce	4,924.00	14,772
	0 EXT 8 : porte de secours escalier 1	1.0	Pce	2,682.00	2,682
	Windows				
	0.07-1 and 0.10-1	2.0	Pce	5,577.00	11,154
	0.11-1 to 3	3.0	Pce	597.00	1,791
	0.14-2to7 ; 0.14-1&8 ; 0.16-1to4 ; 0.20-1to3 ; 0.24-1to6	21.0	Pce	632.00	13,272
	0.15-1	1.0	Pce	1,225.00	1,225
	0.16-5	1.0	Pce	715.00	715
	Door frame in coated steel in curtain wall				
	0 EXT 6 110x220	1.0	Pce	3,230.00	3,230
	0 EXT 7 97x220	1.0	Pce	2,906.00	2,906
	1,2,3,4 EXT 1 110x220	6.0	Pce	3,159.00	18,954
	External openings	3.0	Pce	420.00	1,260
	Metallic door in technical rooms				
	5 EXT 1 to 3	3.0	Pce	2,786.00	8,358
	5 EXT 4	1.0	Pce	3,829.00	3,829
	5.26 et 27	2.0	Pce	2,541.00	5,082
	Door system with ventilation room HT	1.0	FF	7,871.00	7,871
	Duckboards floor in galvanized steel for access to the terrace (3d floor)	1.0	FF	1,837.00	1,837
	Steel curtain walls				

Office Building			GFA=	7,000	m^2
	Centre Acier ArcelorMittal Liège				
Code	Description	Qty	Unit	Rate	Cost
	Office façades East Nord West				
	1A - insulated glazing	1,792.1	m^2	448.00	790,856
	2 - opaque barrier	7.9	m^2	221.00	1,744
	3A&B - beam covering	22.3	m^2	461.00	10,280
	Office façade South				
	1A - insulated glazing	1,101.2	m^2	504.00	555,005
	2 - opaque barrier	13.4	m^2	221.00	2,968
	3A&B - beam covering	23.0	m^2	461.00	10,598
	4 - cantilever	105.9	m^2	512.00	54,205
	5 - inox cladding	12.7	m^2	467.00	5,936
	6 - covering	27.9	m^2	341.80	9,519
	Cafeteria				
	A - glass curtain wall (double glass)	188.7	m^2	454.00	85,109
	B - opaque barrier	37.7	m^2	221.00	8,341
		84.5	m^2	485.00	40,987
	Entrance vestibule				
	A - façade (double glass)	167.3	m^2	521.00	87,184
	B - glass roof	23.8	m^2	571.00	13,590
	C - opaque elements	15.4	m^2	341.80	5,260
	Door step				
	Door step in galvanized steel				
	A - depth 35 cm	3.1	Mct	220.00	682
	B - depth 20 cm	2.7	Mct	210.00	567
	Window step in coated steel	26.5	Mct	120.00	3,174
	Solar protection				
	Sun breaker				
	Shades in coated steel	203.5	Mct	85.00	17,293
	Louvres	486.3	Mct	76.00	36,959
	Coated steel sheets	1.0	FF	12,407.00	11,489
	Rail and nacelle for maintenance				
	A - rail	1.0	FF	79,425.00	79,425
	B - motorized nacelle	1.0	FF	14,025.00	14,025
	C - rings on column	1.0	Pce	280.00	280
	External covering				
	External cladding in steel	104.5	m^2	417.30	43,616
	External cladding in metal	238.7	m^2	314.00	74,964
	Metallic covering of parapet on roof terraces - width 95cm	17.5	Mct	497.23	4,202
	Metallic roof on lifts				
	A - as ceiling	24.3	m^2	474.00	11,504
	B - as edge	2.6	m^2	229.00	605
	Metallic covering : cladding and roof				
	A - external ; installation in façade	13.7	m^2	451.64	6,165
	B - external ; installation in roof	4.3	m^2	451.64	1,951
	C - internal ; vertical installation	22.5	m^2	451.64	10,162
	D - internal ; horizontal installation	5.4	m^2	451.64	2,439
	E - internal ; in ceiling	9.0	m^2	451.64	4,065
	External false ceiling of under faces				
	Thin sheets width 200mm	461.9	m^2	394.00	169,515
			Total	**€**	**2,308,548**
			Rate GFA	**€/m^2**	**329.79**

4 INDUSTRIAL BUILDING

This industrial building is a flat roof building constructed in about 2005 and located in Emmen in the Netherlands. It is mainly a single storey building, but a small part for offices consists of two storeys. The rectangular plan form is approximately 56 m long by 20 m wide. The height of the building is 6 m.

4.1 Architecture

The rectangular ground floor has columns in the façades with no intermediate columns. The column spacing is 5 m. The façades are covered with metal cladding. There are no fire resistance requirements.

Figure 4.1 shows the building elevations and Figure 4.2 shows the building layout.

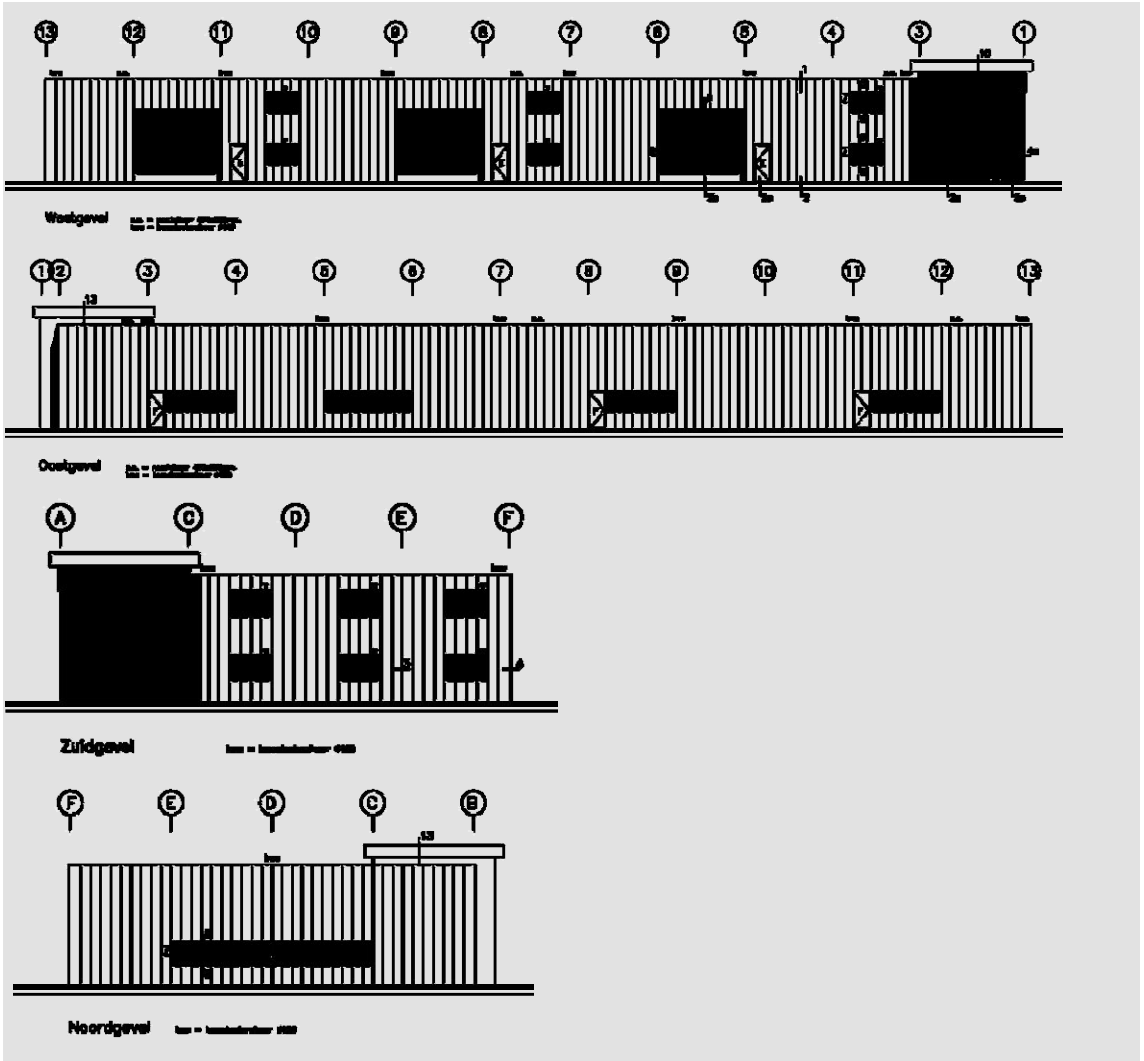

Figure 4.1 Industrial building elevations – Netherlands

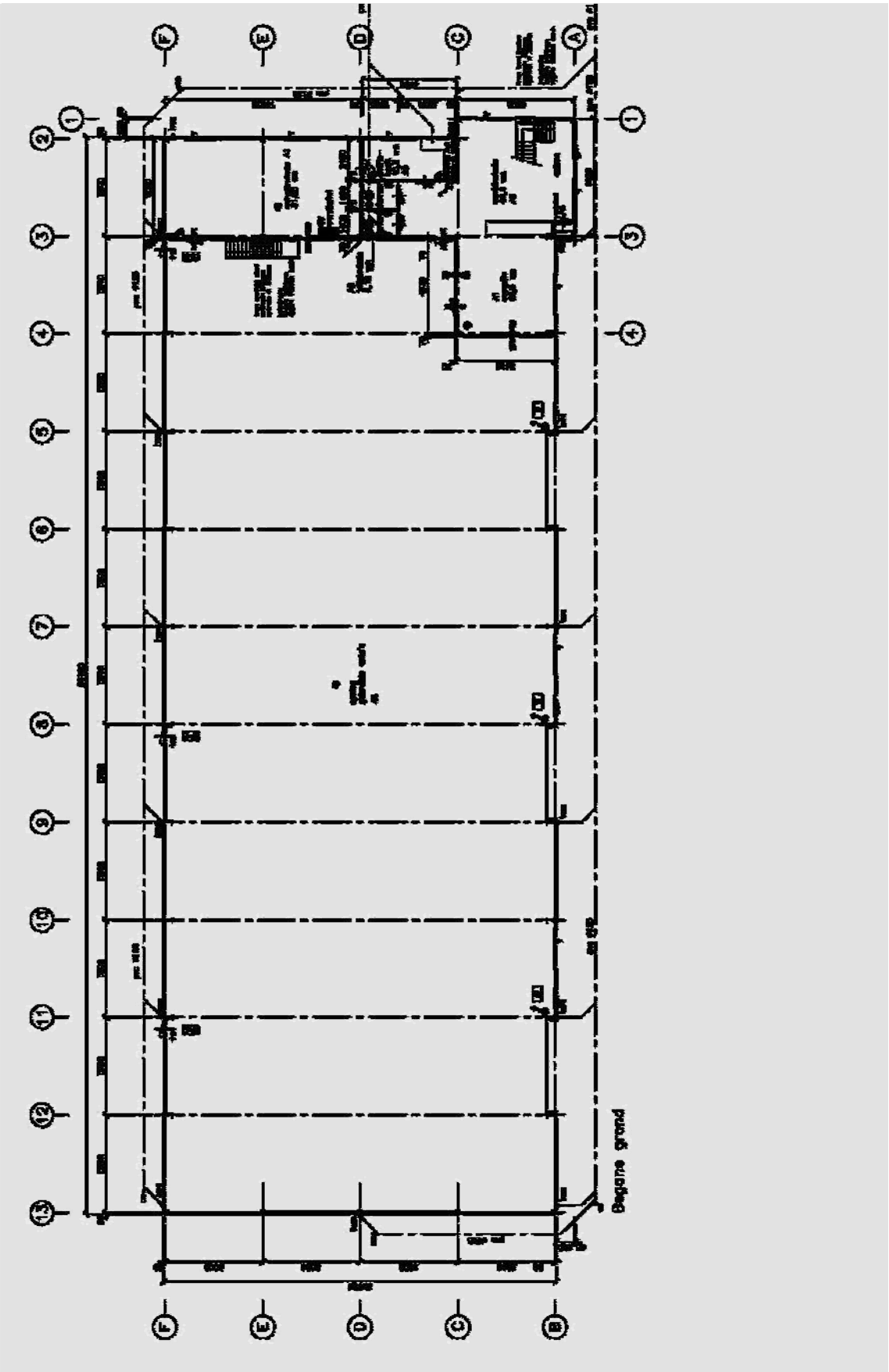

Figure 4.2 Building layout

4.2 Main structure

The main structure is made of portals of IPE 400 beams and columns. The portals provide stability against wind loads across the building. Stability in the other direction is provided by bracing (Figure 4.3). The building comprises 33 tonnes of structural steel.

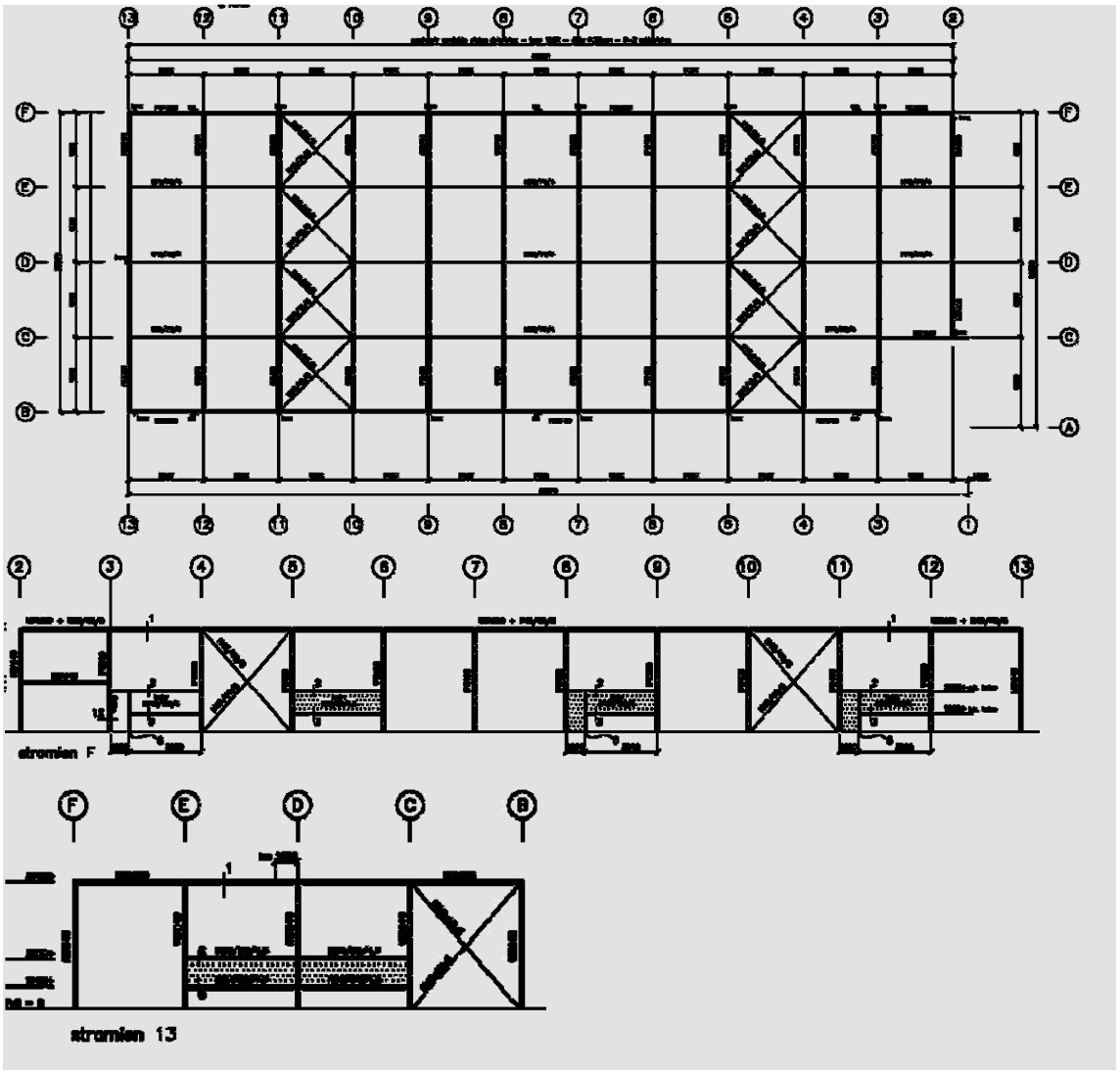

Figure 4.3 Structural plan

4.3 Foundations

Standard column footings are used for the foundations.

4.4 Design Data

Design data is presented in the following table.

	Item	Quantity	Comment
1.	No of storeys	1 / 2	Office part has two storeys
2.	Floor zone	400 mm approx	Office part
3.	Floor-ceiling zone	2600 mm	Office part
4.	Building height	6.0 m / 7,0 m	Office part is 7,0 m
5.	Fire resistance	—	There are no requirement for the main structure
6.	Imposed floor loading	10 kN/m^2	Ground floor Industrial part
		2.5 kN/m^2	Office part
7.	Wind loading	0.88 kN/m^2	Generally on façade
8.	Cladding	85% of façade area 15% of façade area	Sandwich panels openings/glazing

4.5 Schedule of quantities and prices

The schedule of quantities and prices is presented in the following table.

Industrial building				**GFA= 1,259 m^2**	
Code	**Description**	**Qty**		**Rate**	**Cost**
1	SUBSTRUCTURE (excluded) *Note: foundations and ground floor slab - not included* *Price level is 1 January 2009*				0
			Total Rate GFA	€ €/m^2	0 0.00
Code	**Description**	**Qty**	**Unit**	**Rate**	**Cost**
2	FRAME AND UPPER FLOORS				
2.1	Structural steelwork				
	Material				
	material	32,081	kg	0.87	27,863
	supporting and non-structural steel (3% of material)	962	kg	0.87	836
	bolts and so on	32.1	ton	15.00	481
	Fabrication				
	fabrication	310	h	40.00	12,415
	drawing	33,040	kg	0.05	1,652
	transport	2	pce	380	760
	Coating				
	coating	866	m^2	6.50	5,629
	transport	2	pce	380	760
	Erection				
	erection	5.04	day	1,760	8,870
	Profit and risk	3.0	%		2,960
2.2	Upper floor office				
	precast concrete floor	136.0	m^2	85.00	11,560
			Total Rate GFA	€ €/m^2	73,787 58.61

Industrial building				**GFA= 1,259 m²**	
Code	Description	Qty	Unit	Rate	Cost
3	ROOF				
	cladding roof SAB profile R106, normal thickness	1,123	m²	13.70	15,385
	bitumen roofing material	1,123	m²	28.70	32,230
			Total	€	47,615
			Rate	€/m²	37.82
			GFA		
Code	Description	Qty	Unit	Rate	Cost
4	EXTERNAL WALLS, DOORS AND WINDOWS				
	Steel cladding SAB (vertical), insulated	703.3	m²	77.50	54,506
	glass façade (office part)	98.0	m²	290.00	28,420
	overhead doors	3	pce	1,723	5,169
	windows, width 2 m	12	pce	670	8,040
	windows, width 5 m	3	pce	930	2,790
	door+window, width 5m	3	pce	1,490	4,470
	door	3	pce	710	2,130
			Total	€	105,525
			Rate	€/m²	83.82
			GFA		
Code	Description	Qty	Unit	Rate	Cost
				€/Unit	€
5	INTERNAL PARTITIONS, FINISHES & STAIRS (excluded)				0
			Total	€	0
			Rate	€/m²	0.00
			GFA		
Code	Description	Qty	Unit	Rate	Cost
6	SERVICES (excluded)				0
			Total	€	0
			Rate	€/m²	0.00
			GFA		
Code	Description	Qty	Unit	Rate	Cost
7	EXTERNAL WORKS (excluded)				0
			Total	€	0
			Rate	€/m²	0.00
			GFA		

SUMMARY

SUBSTRUCTURE (excluded)	0
FRAME AND UPPER FLOORS	73,787
ROOF	47,615
EXTERNAL WALLS, DOORS AND WINDOWS	105,525
INTERNAL PARTITIONS, FINISHES & STAIRS (excluded)	0
SERVICES (excluded)	0
EXTERNAL WORKS (excluded)	0
SUB-TOTAL	€226,927
PRELIMINARIES @ 13%	29,500
TOTAL	€256,427