City Gate Düsseldorf, Germany

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1 GENERAL INFORMATION

Client:
Engel Projektentwicklung GmbH & Co KG für GbR Düsseldorfer Stadttor mbH

Architect:
Overdiek, Petzinka und Partner (blueprint planning, approval planning)
Petzinka, Pink und Partner (implementation planning, realisation)

Planning of structural framework:
Stahlbau Lavis GmbH

Executive company:
ARGE Düsseldorfer Stadttor
Stahlbau Lavis GmbH
A. Heine Baugesellschaft

Fire protection expertise:
Prof. Dr.-Ing. W.Klingsch

Processing time:
1995 – 1997

Kind of building:
High-rise building with 19 floors (16 floors in the towers and 3 floors in the attic)

Total height:
72.55 m

Ground-plan:
51 × 68 m (rhomboid)

Foundation:
Foundation on the tunnel walls of the Rheinuferstrassentunnel

Figure 1. City gate Düsseldorf (Copyright by Engel Projektentwicklung GmbH & Co. KG)

2 INTRODUCTION

The high-rise building on top of the southern entrance of the highway tunnel along the Rhine marks the gateway to the city's new promenade. The rhomboid form of the building arises from the foundation on the tunnel and the main wind direction.

3 STRUCTURE

The high-rise building is founded on the tunnel walls of the Rheinuferstrassentunnel. Two 16-storey towers are founded on the two outer tubes of the tunnel and are connected by a 3-storey attic to a portal.

3.1 *Vertical loads*

Concrete slabs of 15 cm thickness and spans from 2.50 m to 4.60 m are carrying the vertical loads to composite beams with spans from 7.50 m to 7.60 m. The chosen system – with changing stress directions, short cantilevers, low beams without openings and higher beams with openings – leads to clearances between 2.50 m and 2.98 m. The Steel tubes with diameters of 40 cm, 55 cm and 90 cm are filled with concrete. Highly subjected columns are supported by a rolled profile inside the tube.

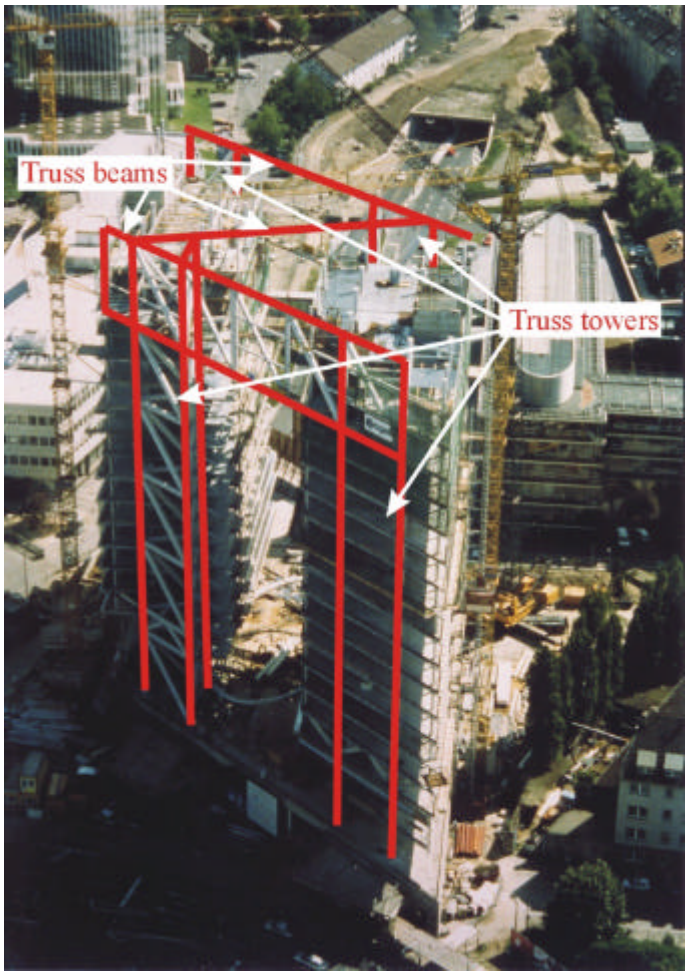

Figure 2. Truss frames of the City Gate Düsseldorf (Copyright by August Heine Baugesellschaft/ Prof. Jörg Lange)

3.2 *Horizontal Loads*

The horizontal loads are carried off by a system of the following members:

- 3-storey high truss beams are connected bending resistant with the approx. 70 m high truss towers, so the braced frame consists of 3 truss frames in z-shape.
- Two u-shaped staircases made of concrete are connected with the truss frames, so they can also take up horizontal loads.

However, these members have additional tasks. The staircases are the two needed escape staircases. The truss beams in the attic storey are carrying the loads of the middle of the building and the facade of the atrium to the truss towers.

4 FIRE SAFETY CONCEPT

A fire safety concept had to be developed to keep the transparency of the building. The opening outwards of the building by the facade made of glass should not be disturbed by massive walls, so active and passive fire protection measures were optimized for this building.

The arrangement of the sprinklers is concentrated near the facade. The sprinkler system is made of three redundant systems. The ways to the escape staircases are short and a fail-safe smoke exhaust system is developed. For these reasons, a fire safety class of R 90 could be achieved.

The balconies leading to the elevators are no necessary escape routes, so they are accomplished without any use of fire protection materials. The lobby level is held by an unprotected steel construction for the same reason. The 19th floor, which includes only machine rooms, is also made of a steel construction without any passive fire protection.

Figure 3. Atrium with lobby level (Copyright by ThyssenKrupp Stahl AG)

The hollow sections of the columns are filled with concrete. The beams of the main structure are partially encased with concrete. The small beams (heights between 180 mm and 270 mm) are protected by using conventional fire protection materials like contour encasement of plaster or hollow encasements of gypsum.

The truss frames are carrying vertical loads as well. For this, the vertical tubes of 90 mm thickness are also filled with concrete. The horizontal and diagonal tubes above the 3rd floor could be accomplished without any use of fire protection materials.

The technical basis of the calculations was the Eurocode 4, Part 1-2.

Figure 4. Truss tower made of hollow sections (Copyright by ThyssenKrupp Stahl AG)

REFERENCES

Bauen mit Stahl 2000. Brandsicher bauen mit Stahl. In *Bauen mit Stahl* documentation 608

Petzinka, Pink und Partner, 1997. Höher, weiter, leichter. In *Baumeister* vol. 12/97