De Karel Doorman, Rotterdam: An Ultra-Lightweight Vertical Extension Using Steel Beams and Stud Walls

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An Ultra-Lightweight Vertical Extension Using Steel Frame and Timber Floors

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Advanced Technology & Research
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## Involved Companies

**Owner:** Private owners (Owners’ Association)

**Client:** DW Nieuwbouw; WM Projectontwikkeling

**Architect:** Ibelings Van Tilburg Architecten

**Structural Engineer:** Royal HaskoningDHV

**MEP Engineer:** Wichers & Dreef

**Contractor:** Van Wijnen

**Consultant Acoustics:** Peutz Associes

**Consultant Fire Safety:** Peutz Associes

**Structural steel structure:** Oostingh

**Structural timber:** Forger Houtconstructies; Heko Spanten

See also: [https://www.skyscrapercenter.com/building/de-karel-doorman/5562](https://www.skyscrapercenter.com/building/de-karel-doorman/5562)
2002 - Architect’s question: “Can we do this?”
Functional Design

- 16 / 7 / 13 stories
- 105 apartments
- Multiple functions in existing building
  - Entrance
  - Parking
  - Shops
Functional Design

9e verdieping woongebouw met appartementen van 44,5 m² t/m 124 m² bvo

10e verdieping woongebouw met in het midden de gemeenschappelijke daktuin
Existing Building

Existing shopping Mall ‘Ter Meulen’
Realized between 1948 and 1951
Architect: Van den Broek & Bakema
Expansions

1948-1951
Concrete floor

Late 1970s
steel/concrete

2002-2012
Steel-Timber 250 kg/m²
Building System

- Steel braced frame
  - HE.. columns and beams, fire proofing
  - Strip steel diagonals
  - Square tubes as vibration blockers
- Timber floor with screed, on dampers
  - LVL beams 2 x 45x225 mm in both directions
  - Multiplex plates
  - Screed 55mm
- Metal stud walls, separated
  - Cold formed thin walled profiles
  - Double gypsum board
  - Insulation
- Suspended ceiling
  - Cold formed thin walled profiles
  - Double gypsum board
Fire Safety

- Fire resistance of main load bearing structure 120 minutes
- Fire proofing by fire proofing board around steel structure
- Fire resistance between apartments 60 minutes
  - Double gypsum board 12mm
- Escape Routes to concrete cores
Acoustic Isolation Between Apartments

- High requirement between apartments
- Acoustic separation of apartments
  - Floors on 25 mm CDM rubber dampers
  - Double separated walls
  - Suspended ceilings
- System tested in laboratory
Footfall Vibrations

- Own vs neighboring apartment
- Perception / nuisance
- Target values
  - 1.6 mm/s vs
  - 0.1-0.2 mm/s
Modelling, Testing & Calibration

Dynamic behaviour depends strongly on dynamic properties
- Dynamic damping ratios
- Dynamic behavior of
  - connections/nodes
  - interior walls and ceilings

Approach (in collaboration with TNO, Delft (NL))
- 3D dynamic FEM analyses
- Dynamic measurements in test apartment
- Calibration of FEM model
- Design adaptations
Modelling, Testing & Calibration
Results

Design adaptations
- Own apartment: reduce vibration level
- Neighboring apartment: energy transfer block

Results
- High level of comfort
- Sound isolation
- Low transfer of vibrations
- Sense of ‘concrete building’
Wind Vibrations

- Concrete cores
- Steel braced frame
- Most important parameters
  - Stiffness
  - Mass
  - Damping
    - Used materials
    - Friction details designed
Friction details
Balconies, facades and roof garden
Considerations and outlook

Considerations
- Prevent added mass to the timber and steel structure

Outlook/recommendations
- Research into more generally applicable ultra-light weight structures in steel-timber hybrids
- Validation & Calibration of Design is important to guarantee quality
- Develop design guidelines