# Wenko-Wenselaar headquarters, Hückelhoven

Michele Janner

1. Aerial view, March 1997.

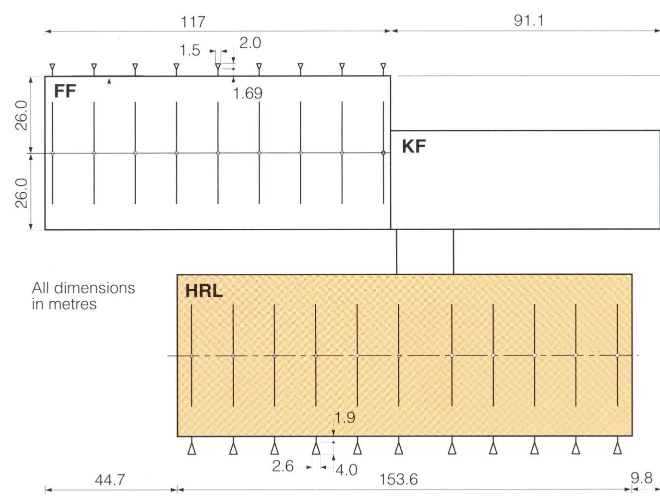
## Introduction

In the mid-1990s Wenko-Wenselaar, a leading German importer and repackager of household goods, planned a new headquarters building at Hückelhoven, a small town near Aachen, Westphalia. The project comprised an 18 000m$^2$ office, storage, packaging, and loading/unloading complex, and Wenko-Wenselaar commissioned Michael Juhr of Wuppertal as architect, with Arup GmbH as structural engineer for all seven phases. For two of the phases Arups was also asked to carry out a building physics analysis, advising on the performance of the building skin, etc.

Besides a requirement to produce a cost-efficient design with a high degree of flexibility, the client also specified the following facilities:

- a 16m high pallet storage area of about 8500m$^2$, with capacity for future expansion (building **H**och**R**egal**L**ager)
- a packaging area of c5000m$^2$ (building **F**unctions**F**läche)
- a loading / unloading area of about 3500m$^2$ (building **K**ommissionierungs**F**läche)
- some 1000m$^2$ of office space on two floors (within building FF).

The three buildings HRL, FF and KF form the total project. HRL and FF both have cable-suspended roofs whilst KF, due to its smaller span, has a different structural system. This article focuses mainly on the largest of the three buildings: HRL.




2. Location plan.

## Materials and fire safety

To achieve maximum flexibility, all areas had to be as column-free as possible, which necessitated long-span roof structures. The building was to be sprinklered, so there was no requirement for structural fire resistance, and as the local soil conditions were poor, a steel roof structure - relatively light in weight - was chosen. The structure of the office area, the 'building within a building', had to have 90 minutes' fire resistance. Here the walls were constructed of in situ concrete, with precast decks, and the columns and beams as composite sections to facilitate the structural connections to the main steel structure.

For the steel roof, various types of steel structure were analysed. A cable-stayed solution allowed the use of small roof beams which reduced the building's height (and thus its façade area and total volume). The final design established a compromise between the height of the roof beams and the amount of cable supports and consequent roof perforation.

## Soil conditions and roof structure

Packing pallets in racks up to 14m high, using automatic guidance systems for the lift trucks, required stringent design criteria for differential settlement of the floor slab. Because of the poor ground conditions the topsoil had to be removed and replaced over the total construction area, in some place to a depth of over 1.5m. By 'hanging' the roof, the number of foundation pads was reduced to a minimum, which also minimised the amount of ground improvement needed. Between the façade columns and the main central columns, however, differential settlement was still anticipated to the extent that it would cause significant change in the force distribution of the cable-supported roof structure. Settlement of both sets of columns is therefore being monitored to determine the amount of post-tensioning needed. To facilitate this, the tensioning devices of the rods are located just above roof level.

The theatrical lighting runs at 120/208V; three-phase, four-wire and dedicated stepdown shielded transformers supply the voltage. To achieve the strict noise criteria in the performance spaces, various noise reduction measures were employed, including:

- a slow rate of rise of the dimmer systems, making the filaments inside the theatrical lighting quieter during dimming
- electrical rooms outside the acoustic joints
- special low voltage transformers with dimmer facilities
- all penetrations from electrical rooms into auditoria organised and detailed to minimise sound transmission.

To keep the sound and electrical power systems apart, special attention by the design team and the contractor was paid to developing separate risers and routing throughout the building and identifying which equipment could be linked to the same electrical supply. Each hall has a sound control room and common sound rack that allow sound to be broadcast simultaneously in both halls.

For emergency purposes, the sound system is connected to the fire alarm system, for which separate speakers are used.

A unique aspect of the electrical design was the distribution to the hall ceiling; this consists of multiple panels, laid horizontally for concerts. In other performances, they are turned vertically for moving upstage and storage. Within the concert ceiling, there are over 170 2000W light fixtures, each with its own dimming circuit. There are nearly 400 wires between the dimmer panel and the concert lights. The panels need to be positioned rapidly and staff do not have time to plug in light fixtures, so the wiring to the lights has to be permanently linked to the panels. The bundles of flexible multi-core cables hang from a 'curtain track' attached in turn to the nearest structural beam. A terminal cabinet is provided about 54ft (16.5m) above the stage floor, where the circuits emerging from the dimming room terminate. From here the circuits are divided into groups which then terminate at multi-pin connectors. The flexible multi-core cables are plugged into the connectors and run up and down the stage along the track. As the concert ceiling turns into position, the tracks expand or retract in a similar manner, allowing the circuits to be connected to the concert ceiling in a permanent position without any site reconnection. The multi-pin connectors also allow for future circuit changes.

The building is networked via dedicated fibre cables to a central theatre hub for ticket sales. A central telephone switch is provided for the administration staff and sales office, carrying automatic pre-recorded news and messages, voice mails and other essential services.

### Plumbing design

These systems also reflect the strict noise criteria and tight distribution spaces. Pipes containing moving liquids had to be kept out of noise critical spaces, which led to acoustic hangers for both rainwater pipes and soil drains from the toilets being provided where it was impossible to locate the pipes completely away from noise-sensitive spaces. The drains are hung at their highest point and tied back to the slabs on the non-acoustically sensitive side of the acoustic joints. Rainwater from the auditorium roofs is guttered away to cascade onto lower roofs over non-sensitive spaces.

14. Interior of stage.

Domestic hot water is generated centrally and located in the mechanical tower adjacent to the kitchen, the heaviest point of use. To route hot water, chilled water, and heating hot water piping to the west side of the building without passing through the auditorium, an isolated crossover zone was created behind the stagehouse.

Fire protection is achieved via a variety of methods; with conventional charged sprinkler systems used in the majority of the spaces. The local BOCA code (Building Officials Code Administration) does not require auditoriums to be sprinklered. The stages are a different situation, having a combination of double-interlocked pre-action systems with 35-second delay and deluge devices. The delay enables the maintenance personnel to prevent activation in case of false alarm caused by a stage activity.

### Conclusion

On 18 October 1997 the Center's Gala Opening was held before a full house. The performance was extremely successful, with the Center's flexibility being demonstrated by the number of different performances and acts. After seven years' work on the project, it was extremely fulfilling to watch the patrons enjoy the facility and appreciate the architecture and engineering.The project would not have been such a success had it not been for the client's leadership and the spirit of co-operation and partnering by all who were involved. It is also very gratifying that the project has already received three awards: from the New York Consultant Engineers Council, from the American Consulting Engineers Council and one from the New Jersey Concrete Society.

### Reference

(1) JOFEH, C. Cerritos Arts Center, California. *The Arup Journal, 26*(2), pp17-21, Summer 1991.

### Credits

*Client:*
New Jersey Performing Arts Center

*Architect:*
Barton Myers Associates

*Consulting engineers:*
Ove Arup & Partners Tom Barker, Jonathan Bell, Peter Budd, Jacob Chan, King-Le Chang, Waylon Cheung, Yen Chong, Keith Chung, Tony Cocea, Carolyn Comer-Gmelich, Rolando Constantino, Phil Crompton, Bob Emmerson, Caroline Fitzgerald, Richard Gargaro, Mel Garber, John Gautrey, Kathleen Gibbons, Nancy Hamilton, Mike Hammer, John Hewitt, Richard Hough, Scott Hudgins, Morgan Lam, Alan Locke, Anait Manjikian, Josef Negat, Phoebe O'Brien, Alan Ravandi, Sharlene Silverman, Nuran Sinanyan, Melani Smith, Ian Stuart, Jose Tia, Jacob Tsimanis, Dan Ursea, Rodney Walden, Victor Wirth

*Construction manager*
Turner Construction

*Cost consultants:*
Donnell Consultants Inc

*Theatre design:*
Jules Fisher Associates

*Acoustic consultants:*
Artec Consultants

*Associate architect:*
Wilson Woodridge Architects

*Lighting design:*
Jules Fisher & Paul Marantz Inc

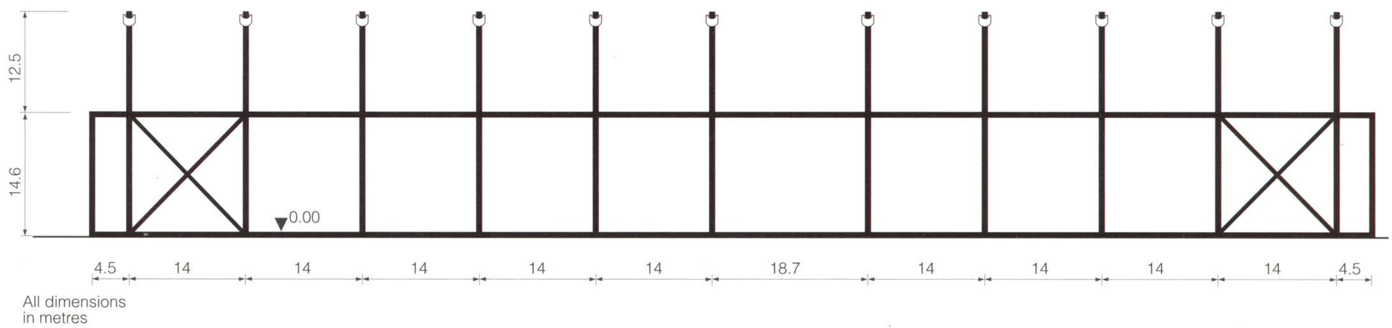
*Civil engineering:*
Paulus, Sokolwski and Sartor Inc

*Landscape architects:*
Benjamin Thompson & Associates

*Local engineering practice and code advice:*
DVL Consulting Engineers Inc

*Illustrations:*
2, 3: Barton Myers Associates
1, 10, 11, 13, 14: Fred Charles
4, 6, 8: David Street
7, 9: Scott Hudgins
5, 12: Ove Arup & Partners California

3.
Elevation of building HRL.




## Structural concept

This consists of separating the vertical load-carrying structure from the horizontal one, together with repetition of the structural system.

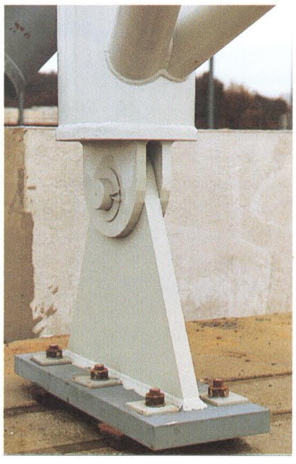
Longitudinally, horizontal stability and stiffness are provided by cross-bracing in the roof and the façades at both ends of the building. Across its width, however, the building is held every 14m by large spaceframe columns along one side, linked at roof level to the main roof beams. To maintain maximum flexibility inside, these spaceframe columns are located outside the building.

The building is therefore formed from repeating structural units 14m long and c56m wide, placed one after the other throughout the entire length of 154m. Such a structural unit is stiff and stable both vertically and across the width: all the vertical loading is carried by pairs of façade columns 56m apart plus one main column in the middle, each of the latter extending 12.5m above the roof and carrying the main roofbeam via four steel rods. For the snow loadcase the main roofbeam is sustained by this additional support; in the case of wind uplift the 30m unsupported span is adequate. The secondary roofbeams, supporting the roof metal deck, act as 14m long spacers between the structural units. If future expansion of the building is required, additional complete structural units can be added.

## Façade perforation

Since only horizontal forces are transferred between the façade column inside and the spaceframe column outside, the roofbeam could be split, separated by hard plastic isolators and connected by just two bolts in order to reduce the cold bridge that would otherwise formed by the continuous roofbeam. On the other hand, the transfer of only horizontal loads onto the spaceframe columns seemed to result in the need to design large foundation pads (10 x 4 x 1.5m) to take up the overturning moment. However, even if roof loading were carried down by the stabilising spaceframe columns, the large foundation pad remains necessary, since the roof loading on the façade columns almost reaches zero in the asymmetrical roof loading case.

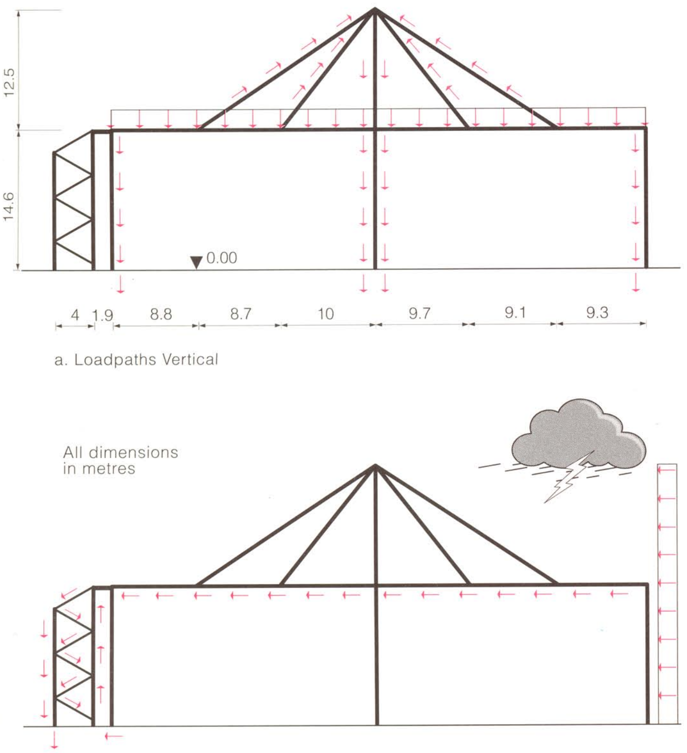
5.
Spaceframe column.



4.
Spaceframe column connection to foundation.

6.
Connection details at roof level before the exterior cladding was put in place.

7a & b.
Cross-sections of building HRL showing loadpaths.




9.
The clear internal height is 14.6m.

8.
The 12.5m main column extensions at roof level.

## Roof perforations

The main columns had to be continuous through the roof, because of the large bending moments and shear forces in these columns at roof level which occur in the asymmetrical roof loading case. Here, a special Arup study recommended the insulation of these columns beyond a height of 1m above roof level, to reduce the possibility of condensation on the interior steel structure.

## Main column top-detail

Special attention has been paid by the architect and Arups to what is probably the most important roof detail, the connection of the rods to the main column. The difficulty lay in the difference of proportions: how to connect a 57mm rod to a 762mm column in a sensible and elegant way. The combined horizontal and vertical solution was chosen to make the visual impression more individual. It should be noted that for the horizontal detail the lower of the two connecting plates had to be welded onto the column itself to take up the deadweight of the rod, as the rod is loaded in compression.

## Conclusion

Work began in August 1996, with the replacing of 51 400m$^3$ of soil. In November 1996 steel erection started, and was finished about three months later. In August 1997 the entire building was finished. The total cost of the project was about DM23M. Of this, the steel construction totalled approximately DM3M.

## Credits

*Client:*
Wenko-Wenselaar & KG PRODLOG

*Architect:*
Michael Juhr

*Structural and building physics engineers:*
Arup GmbH Düsseldorf
Monika Beyersdorff, Brian Cody, Michele Janner, David Lewis, Gary Thomas, Constant van Aerschot

*Mechanical engineers*
HTW

*Geotechnical engineers:*
Friedrich & Dr. Krämer

*Main contractor:*
Spannbeton-Oevermann GmbH & Co

*Principal sub-contractors:*
Steel: BMS
Metaldecking: Combau

*Illustrations:*
1: Hubert Harst
2, 3, 7: Peter Speleers
4-6, 8, 9: Michele Janner