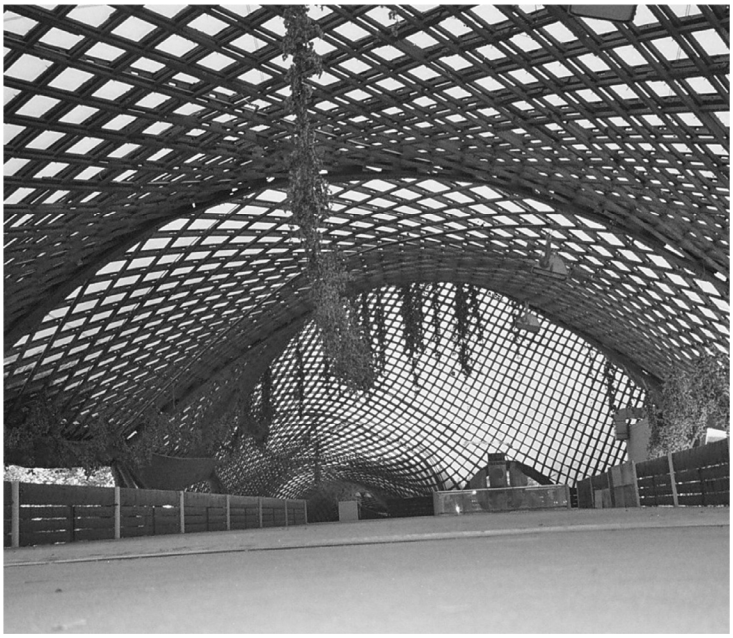
Wood Structures
Arch 544

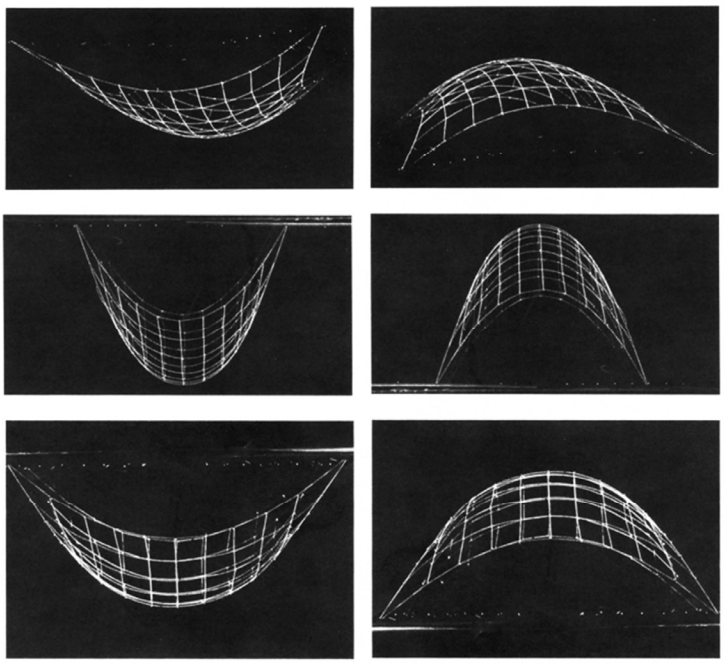
Grid Shells



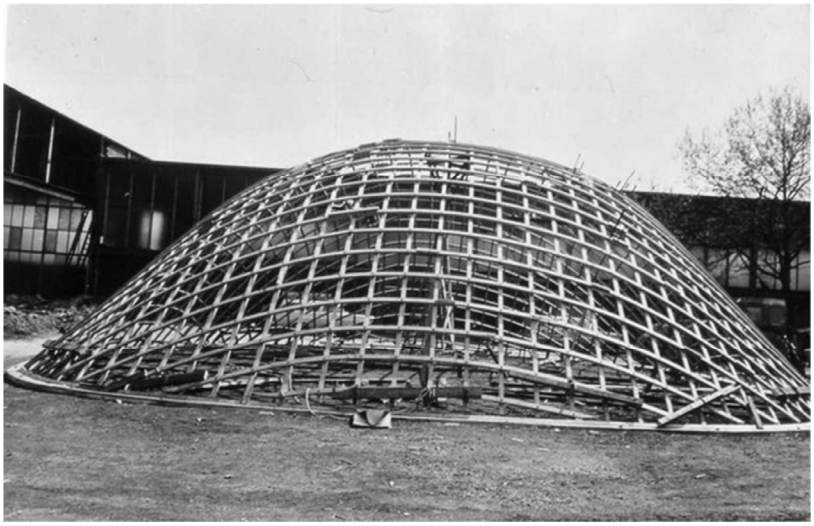
Grid Shells

based on catenary nets

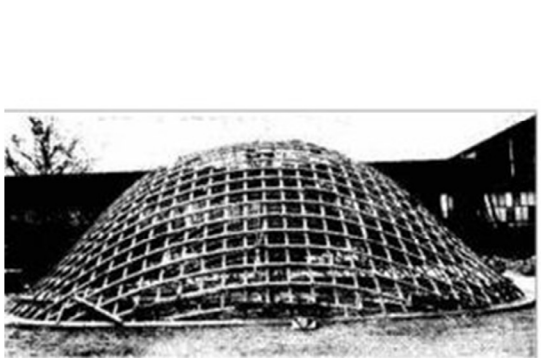
to minimize flexure

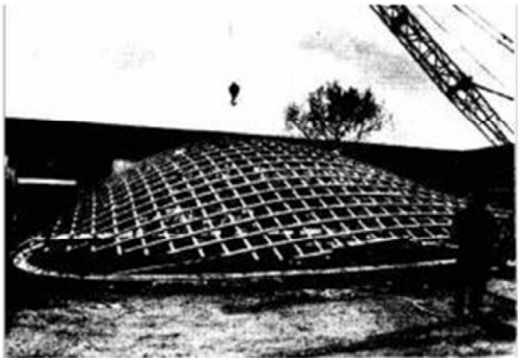


early grid shell
University of Essen
Frei Otto – 1962
15m x15m



Grid shell
University of Essen
Frei Otto - 1962





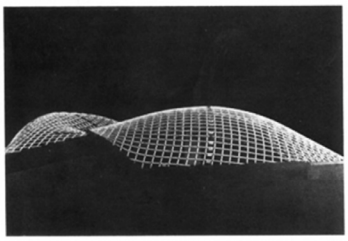
Grid Shells

initially straight members

elastically bent

deformed grid

fixed joints to hold form



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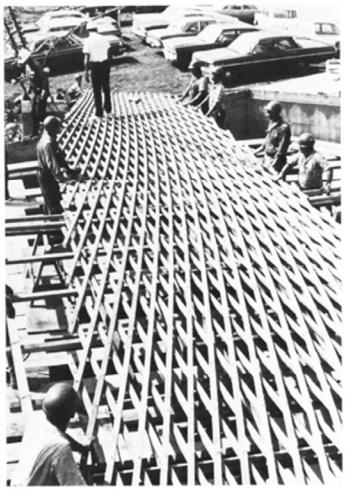

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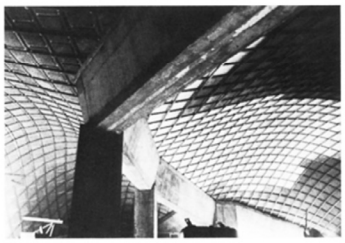

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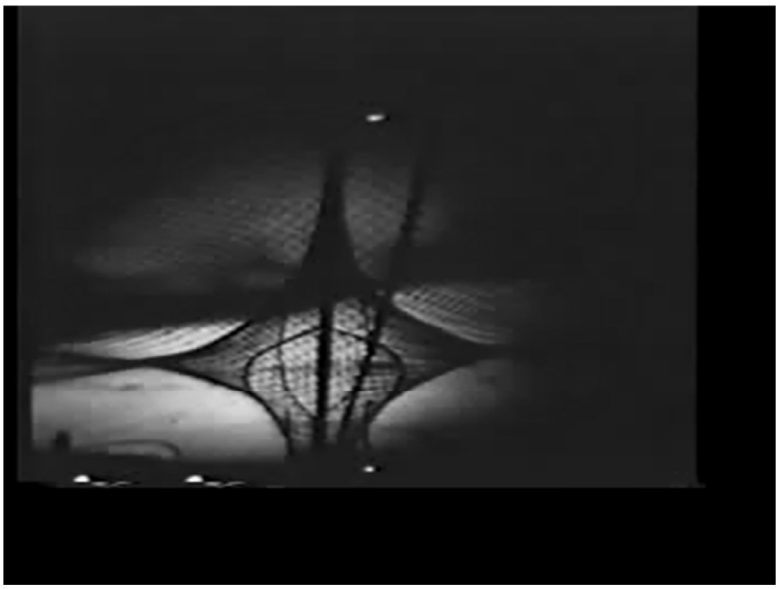
German Pavilion Montreal Expo 1967

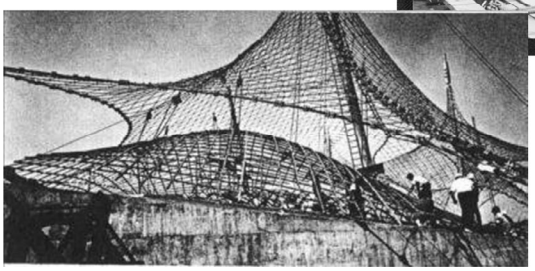
Frei Otto

German Pavilion Montreal Expo 1967
Frei Otto

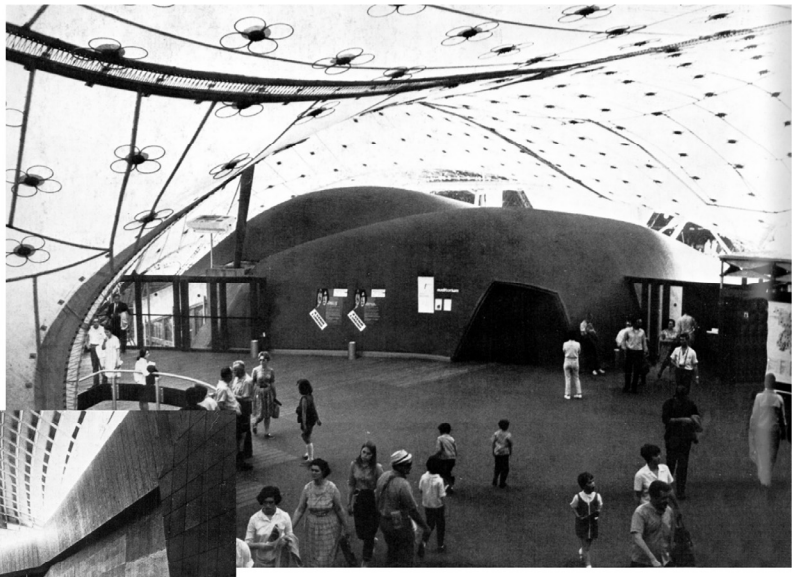


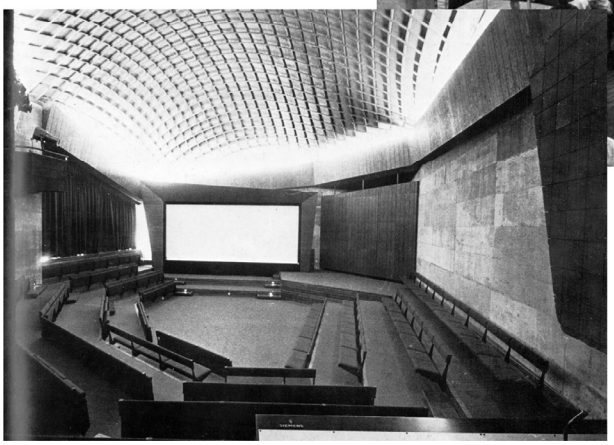
German Pavilion
Montreal Expo 1967
Frei Otto

Erection

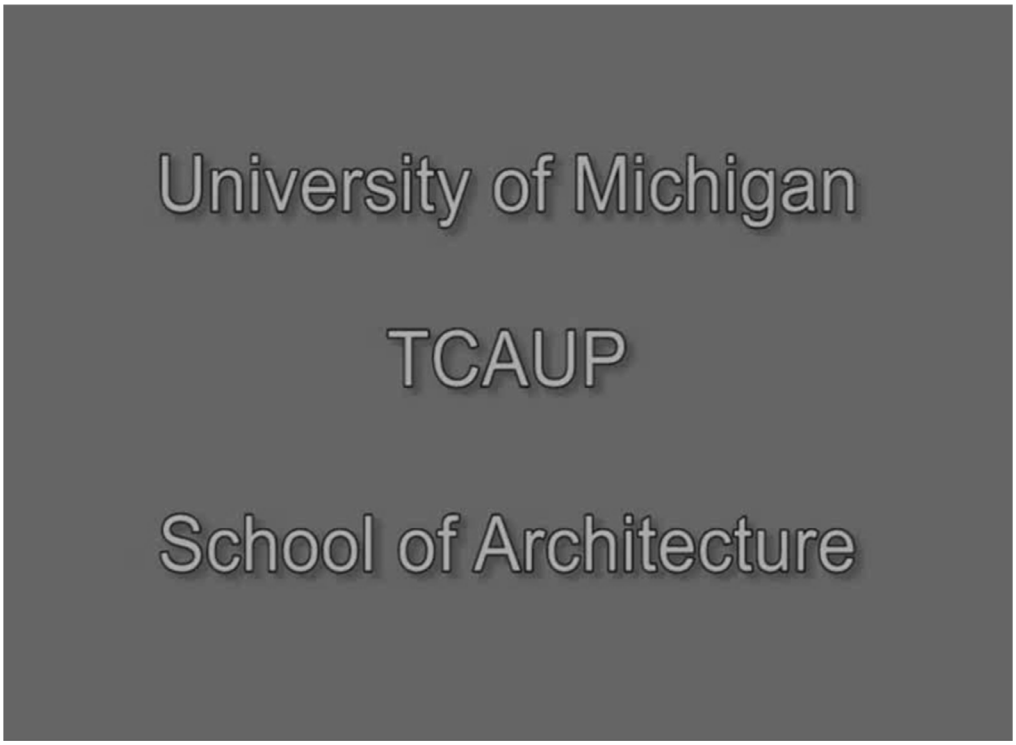


German Pavilion
Montreal Expo 1967
Frei Otto



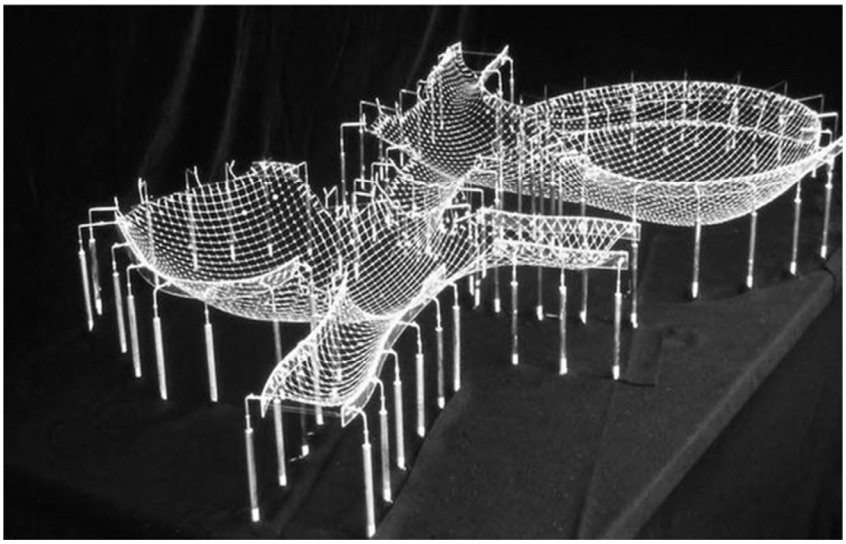


Design with models



Multihalle Mannheim

Designed and engineered by Frei Otto and Buro Happold
Built for the Bundesgartenschau in Mannheim in 1975
Design and initial analysis with models at IL Stuttgart
Computer force density analysis by Klaus Linkwitz



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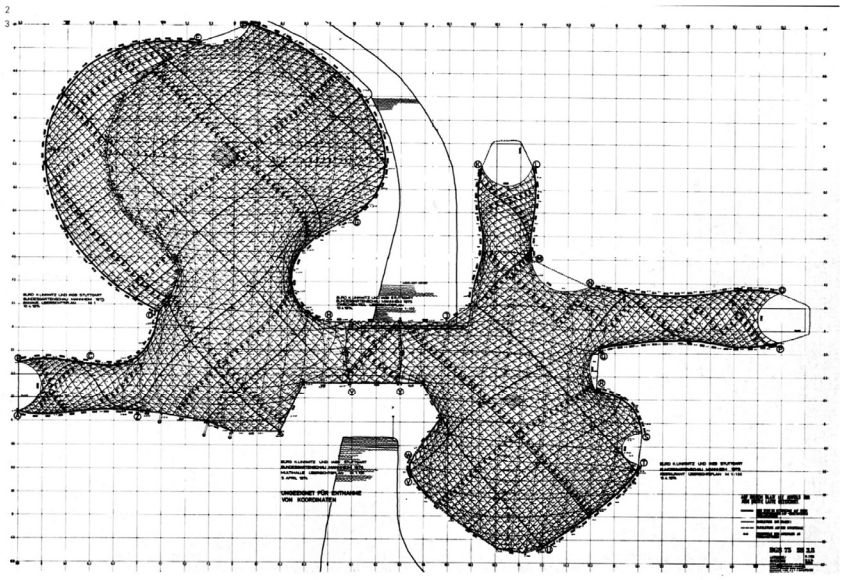
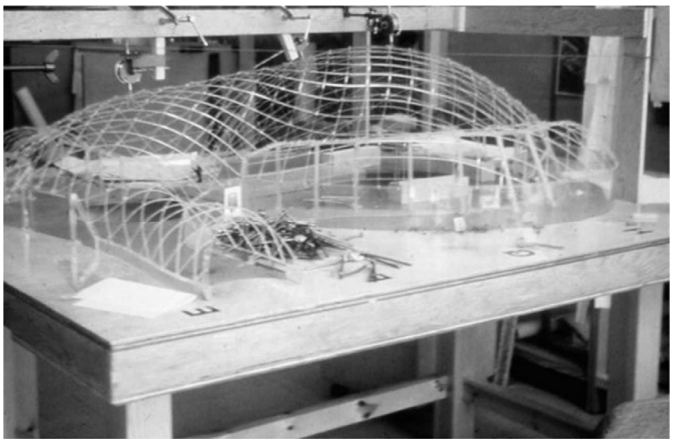


Multihalle Mannheim

testing for shear stiffness

model testing



Multihalle Mannheim

detail of grid construction

Multihalle Mannheim

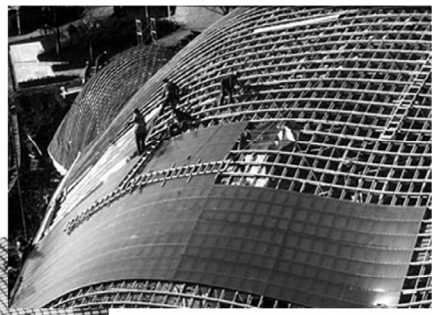
construction

Multihalle Mannheim

construction

Multihalle Mannheim

construction



Multihalle Mannheim

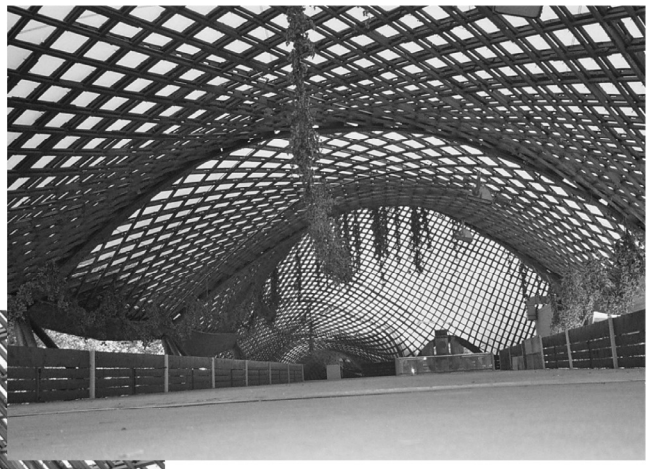
load testing

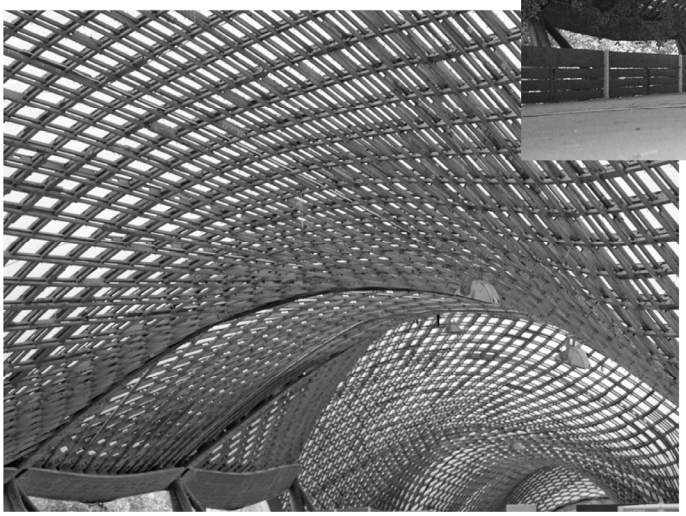
Multihalle Mannheim

renovation 1981

Multihalle Mannheim

renovation 1981





Other Examples

Japanese Pavilion
Hannover Expo 2000
Shigeru Ban and Frei Otto

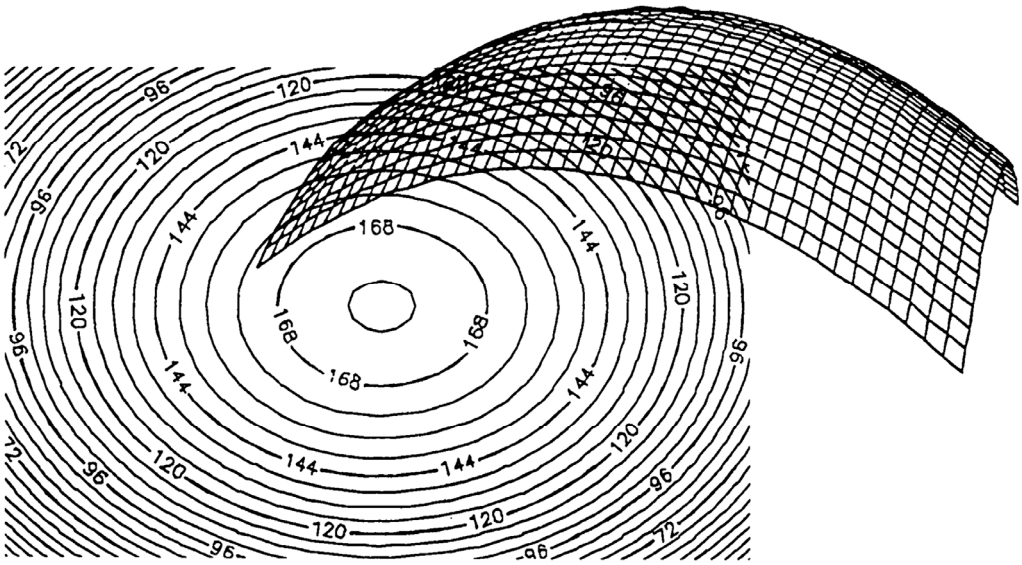
Japanese Pavilion - Hannover Expo 2000
Shigeru Ban and Frei Otto

Weald & Downland Open Air Museum – 2002

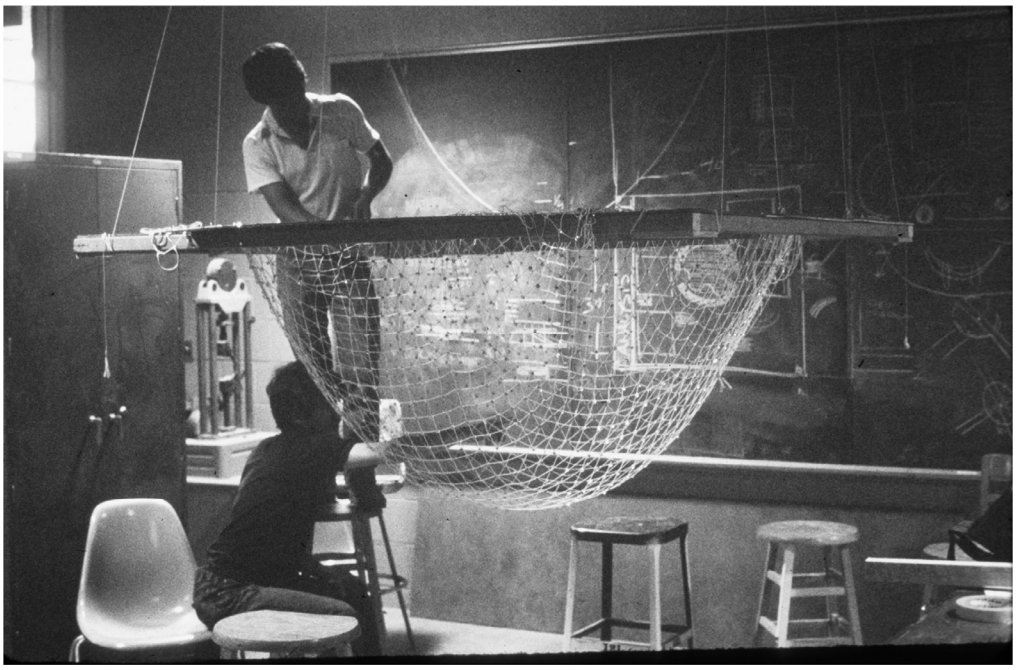
Edward Cullinan architects with Buro Happold

Wooden Grid Shell

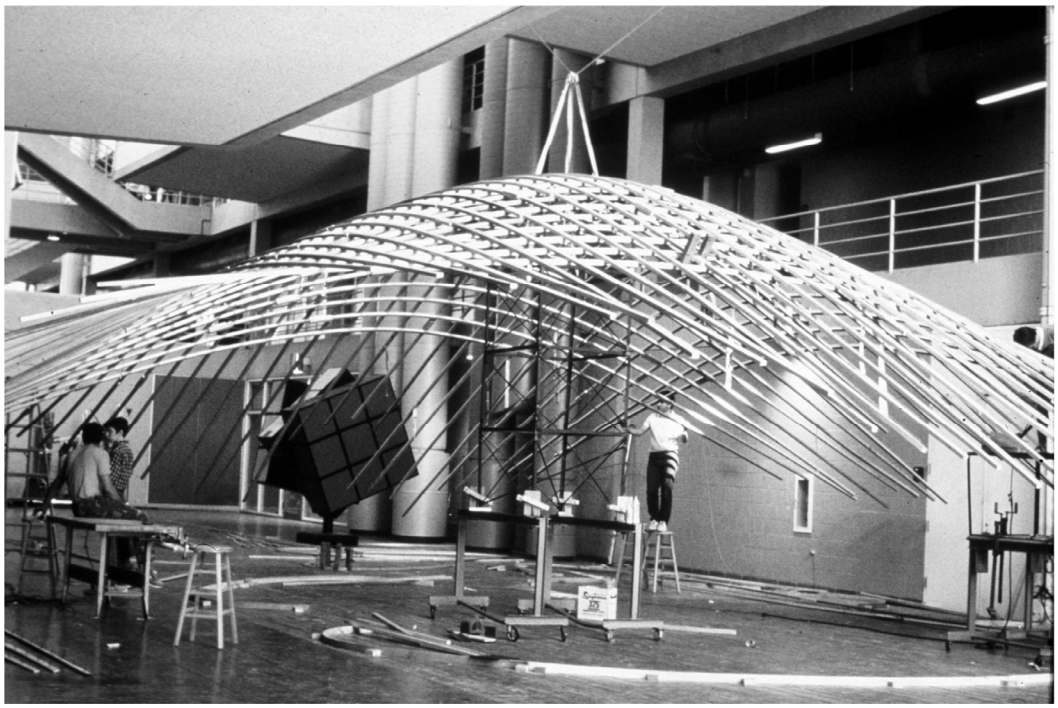
University of Tennessee - Structural Innovations Lab
Peter von Bülow, Dr.-Ing.



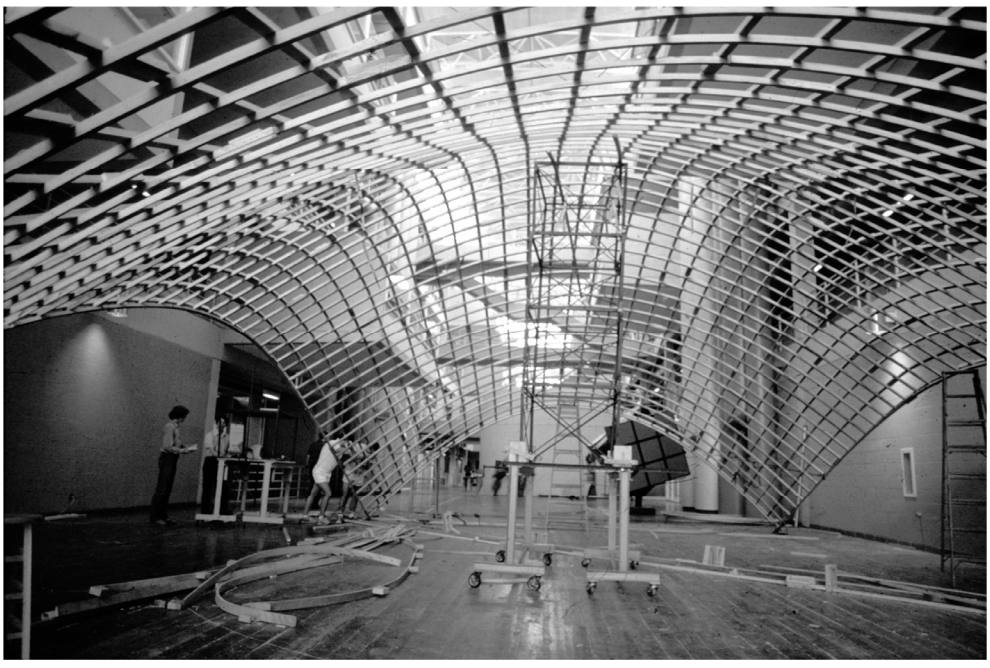
Centenary Form Finding Model



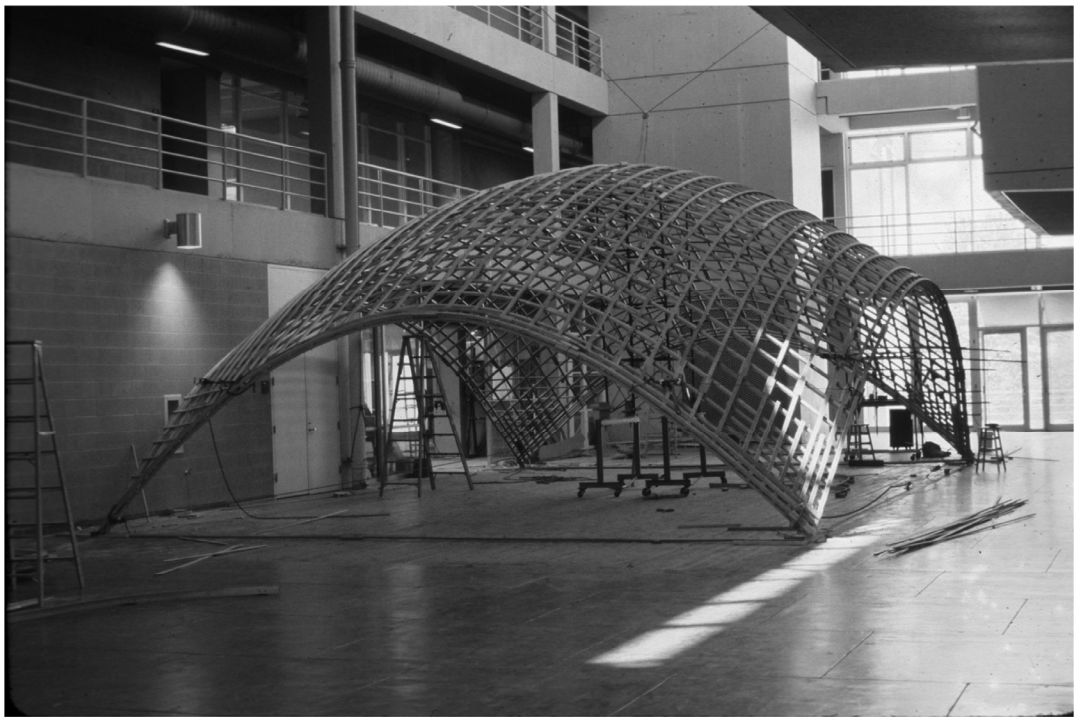
Construction



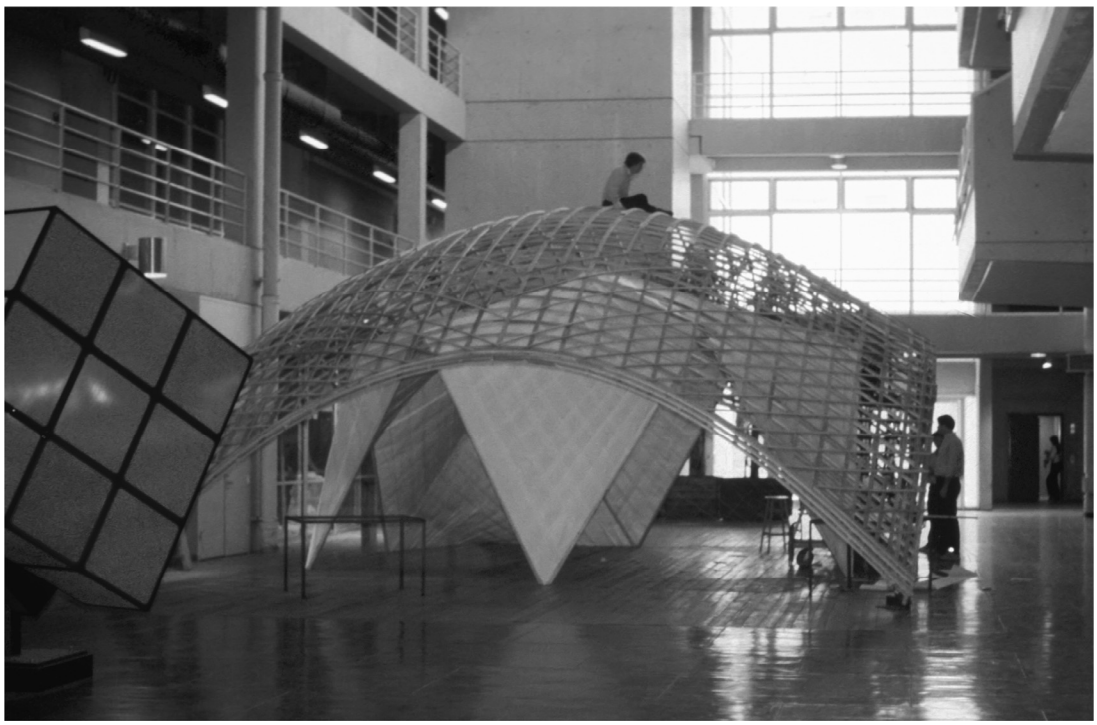
Construction



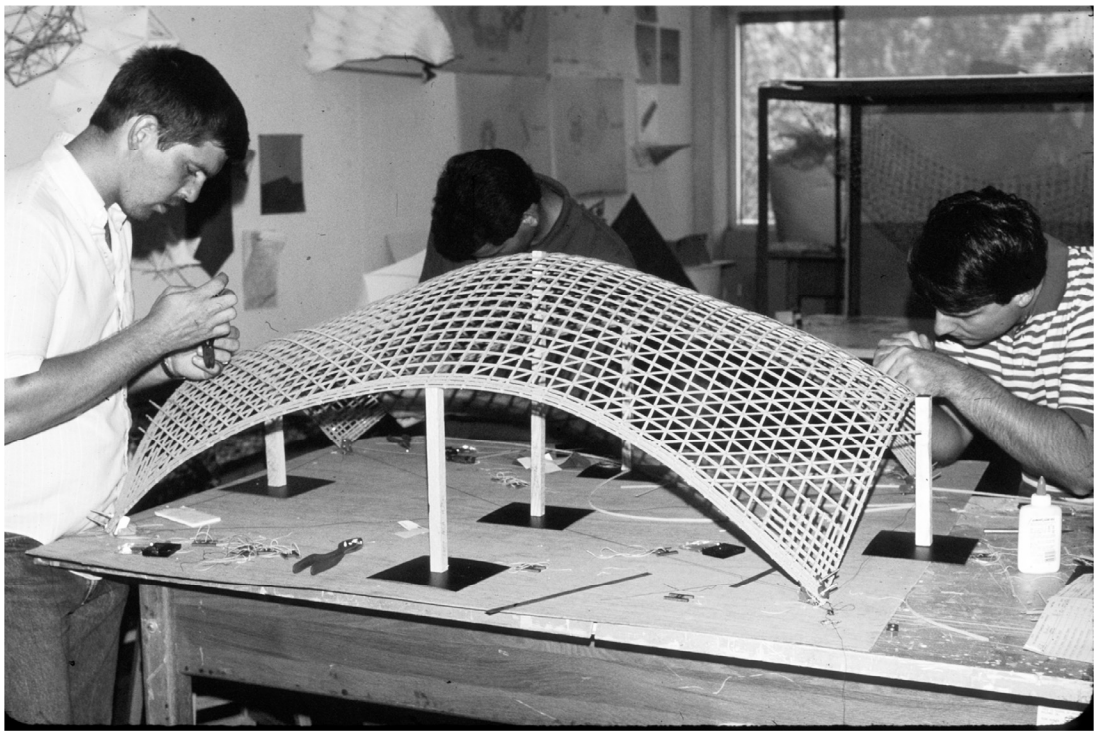
Adding bracing



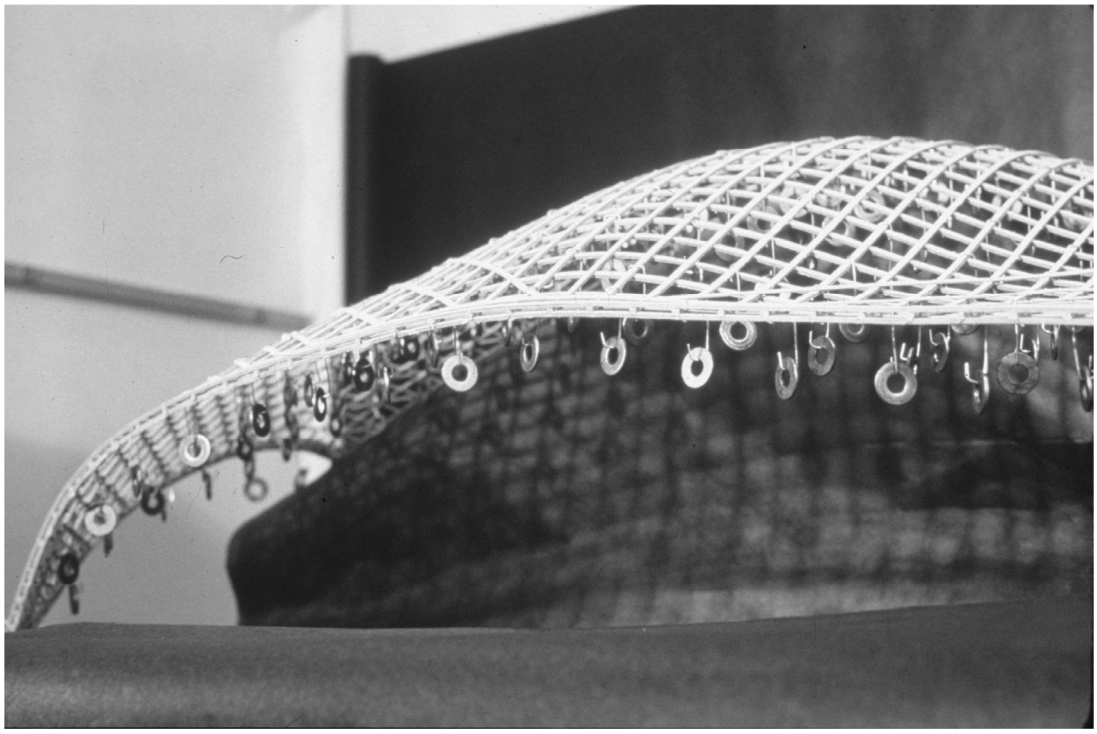
completed grid shell



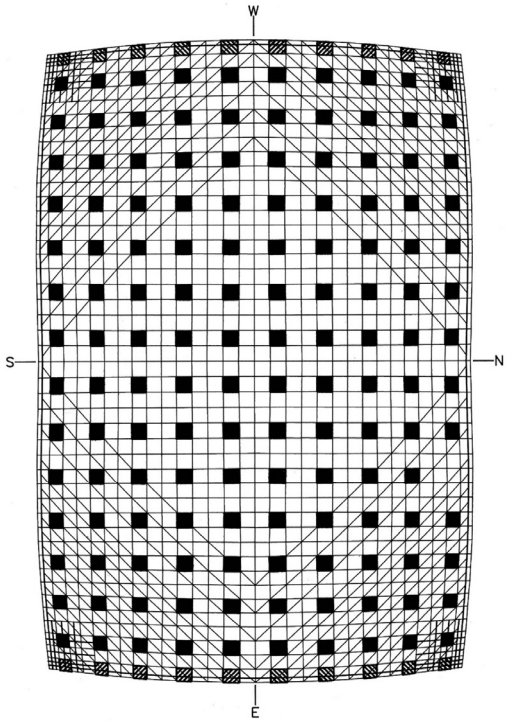
structural model

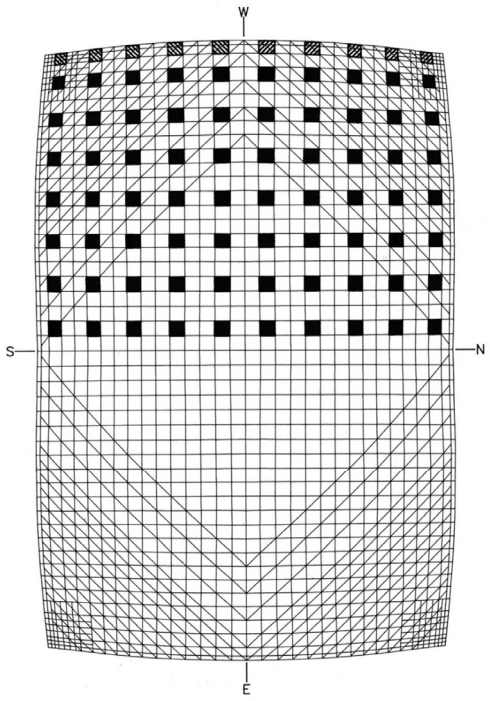


structural testing

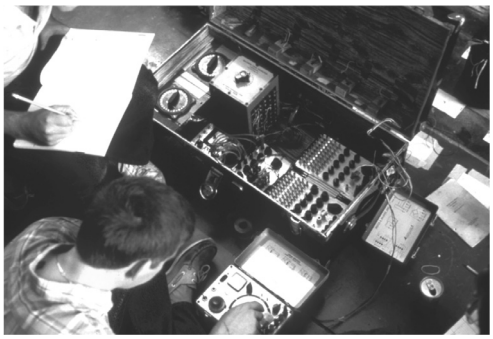


full scale test

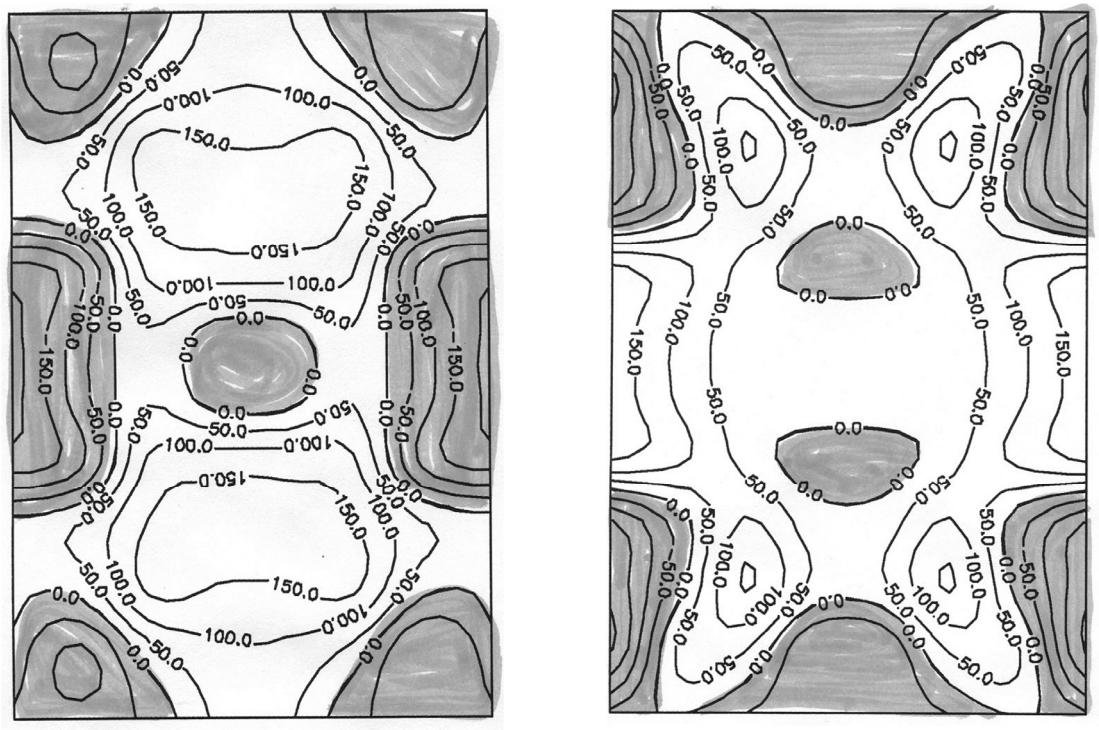




full scale test



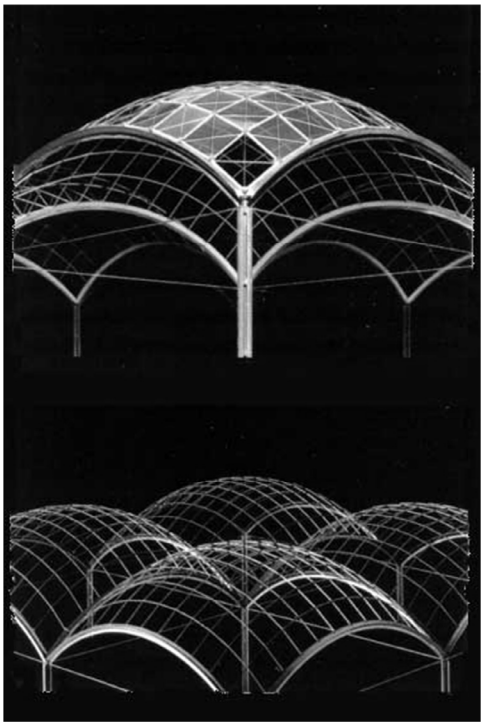
deflection



deconstruction

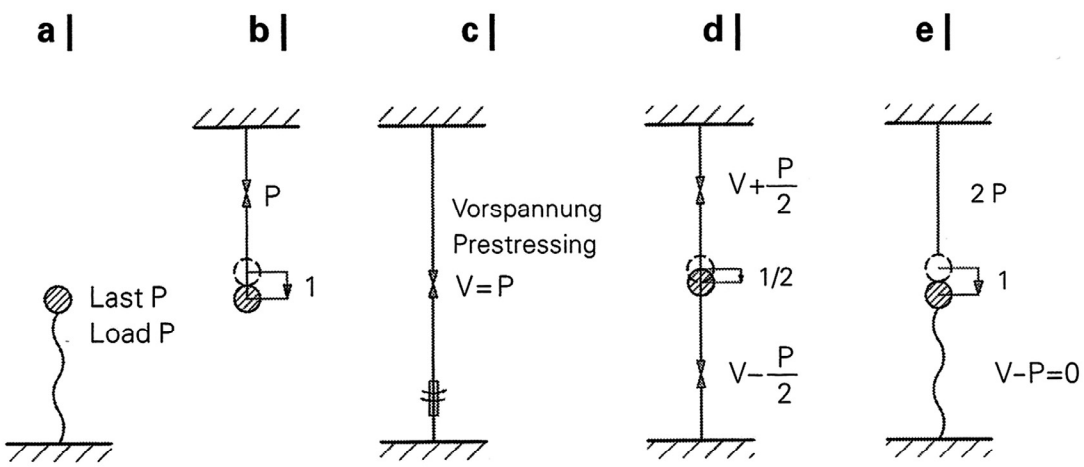
Schlaich Bergermann & Partners

Cover for Helsinki train station



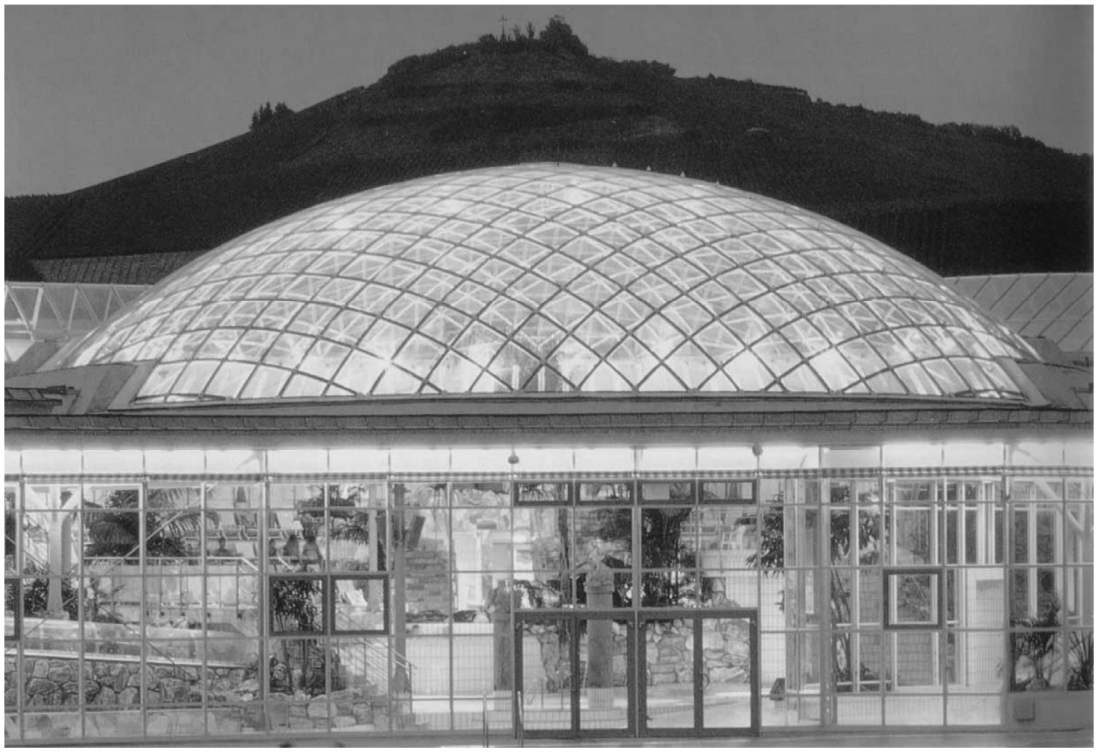
Pre-stressing

Reducing deformation



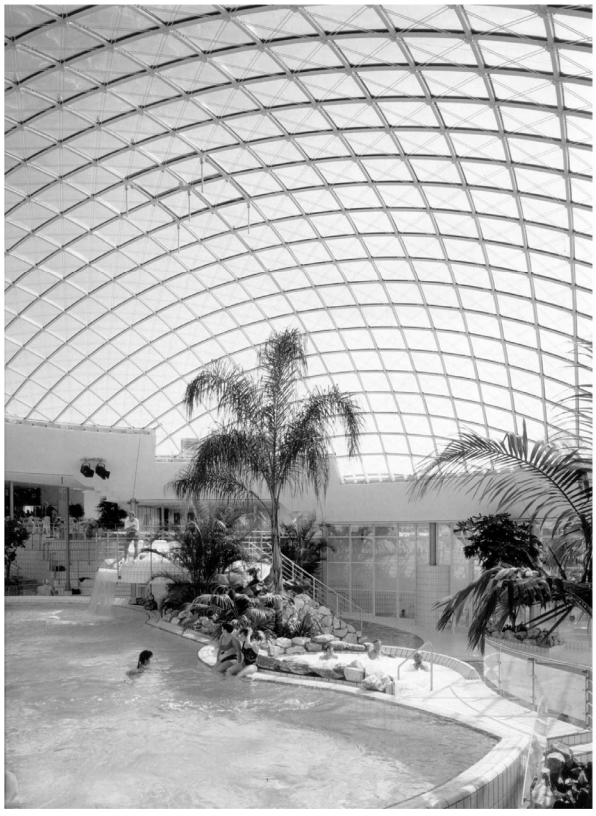
Jörg Schlaich, *Light Structures*

Schlaich Bergermann & Partners – Neckarsulm Swimming Pool



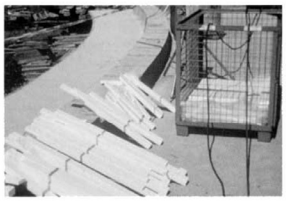
Schlaich Bergermann & Partners

Neckarsulm, 1989

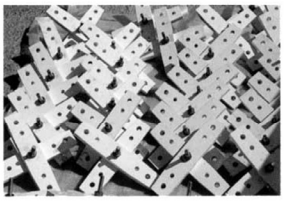


Schlaich Bergermann & Partners

Neckarsulm, 1989

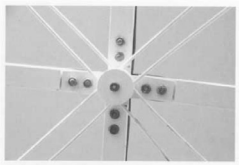


6.14
The slats

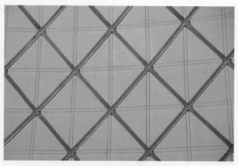


6.15
The rotatable joints

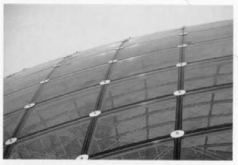
6.16
Assembly of the grid elements



6.17
Close-up of the joint assembly
with diagonal cables installed



6.18
A segment of the grid showing the double
pattern formed by the slats and cables



6.19
A segment of the completed roof
with the spherically-curved glass panes

6.20
Water barrels representing
partial snow load

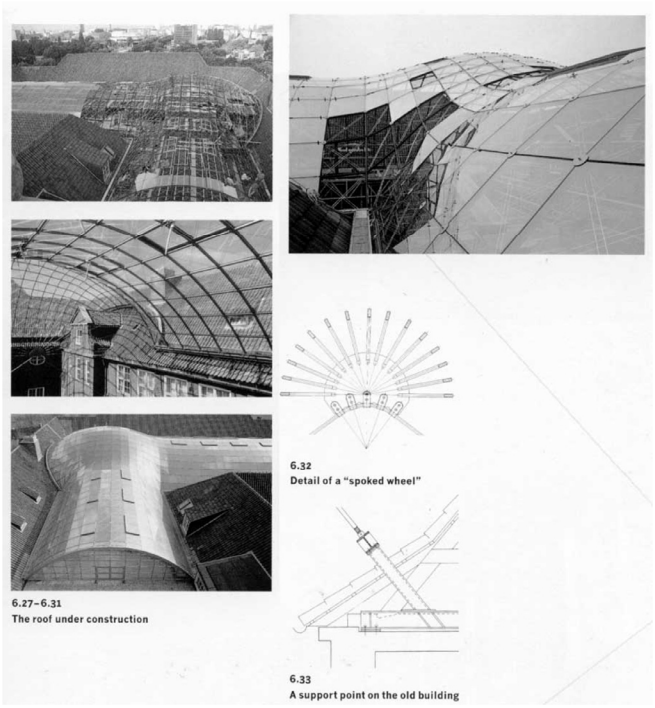
Schlaich Bergermann & Partners

History of Hamburg Museum

2017 restoration

Schlaich Bergermann & Partners

History of Hamburg Museum



6.27–6.31
The roof under construction

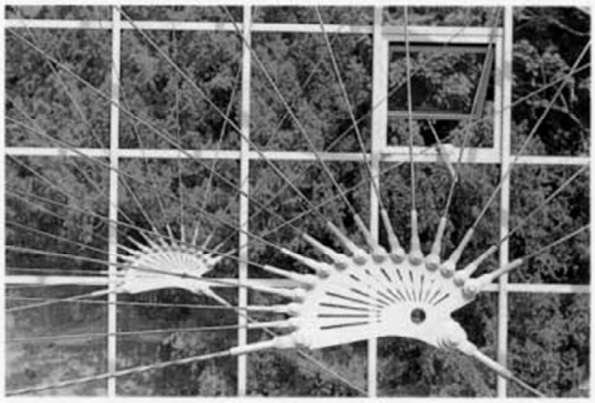
6.32
Detail of a "spoked wheel"

6.33
A support point on the old building

Schlaich Bergermann & Partners – Pool cover for mineral spa, Bad Cannstatt

Schlaich Bergermann & Partners – Stuttgart – Bad Cannstatt, 1993

6.41
Connections of the pretensioned cable "spokes" to the "rim"



6.40
The hub connections (see the drawing on the cover of this book)