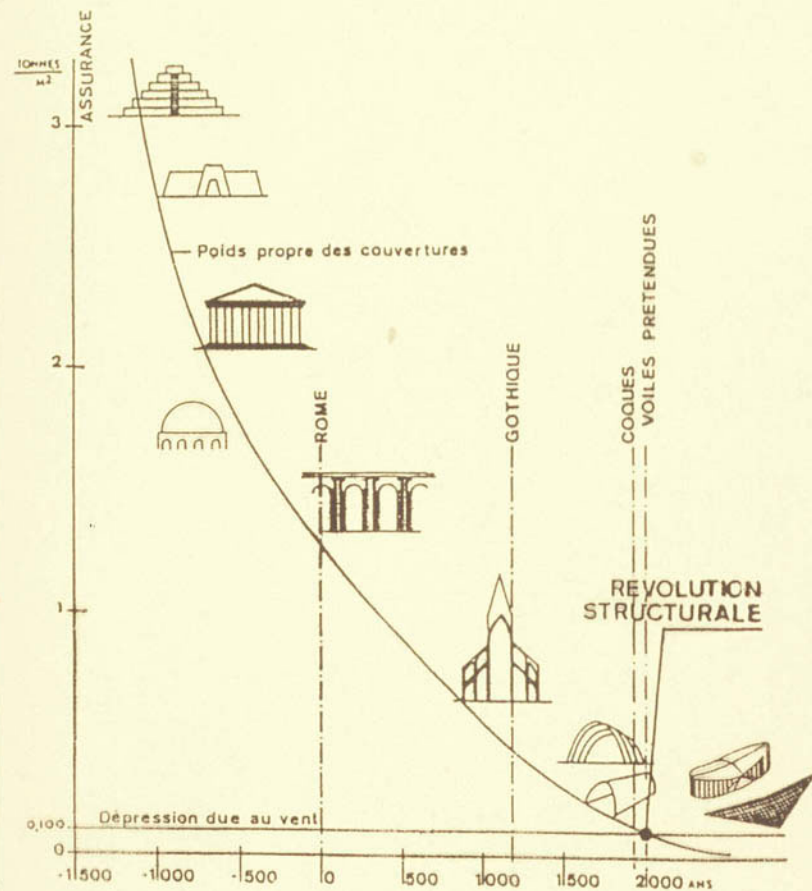


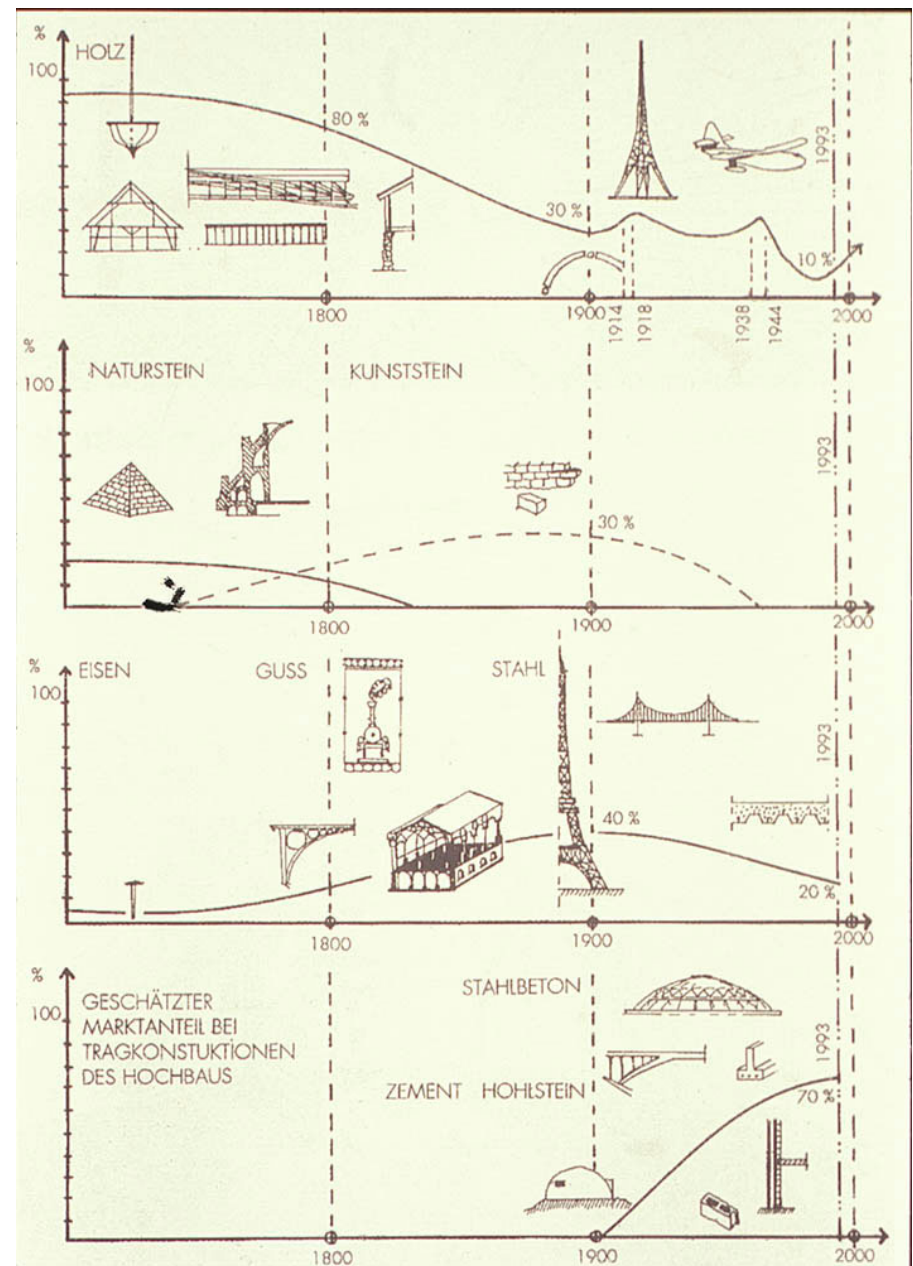
Spatial Structure in timber

Natterer Johannes

Ing. dipl. EPFL



L'évolution des coques par rapport à l'économie de matériaux et comparaison avec la forme naturelle d'un oeuf de poule



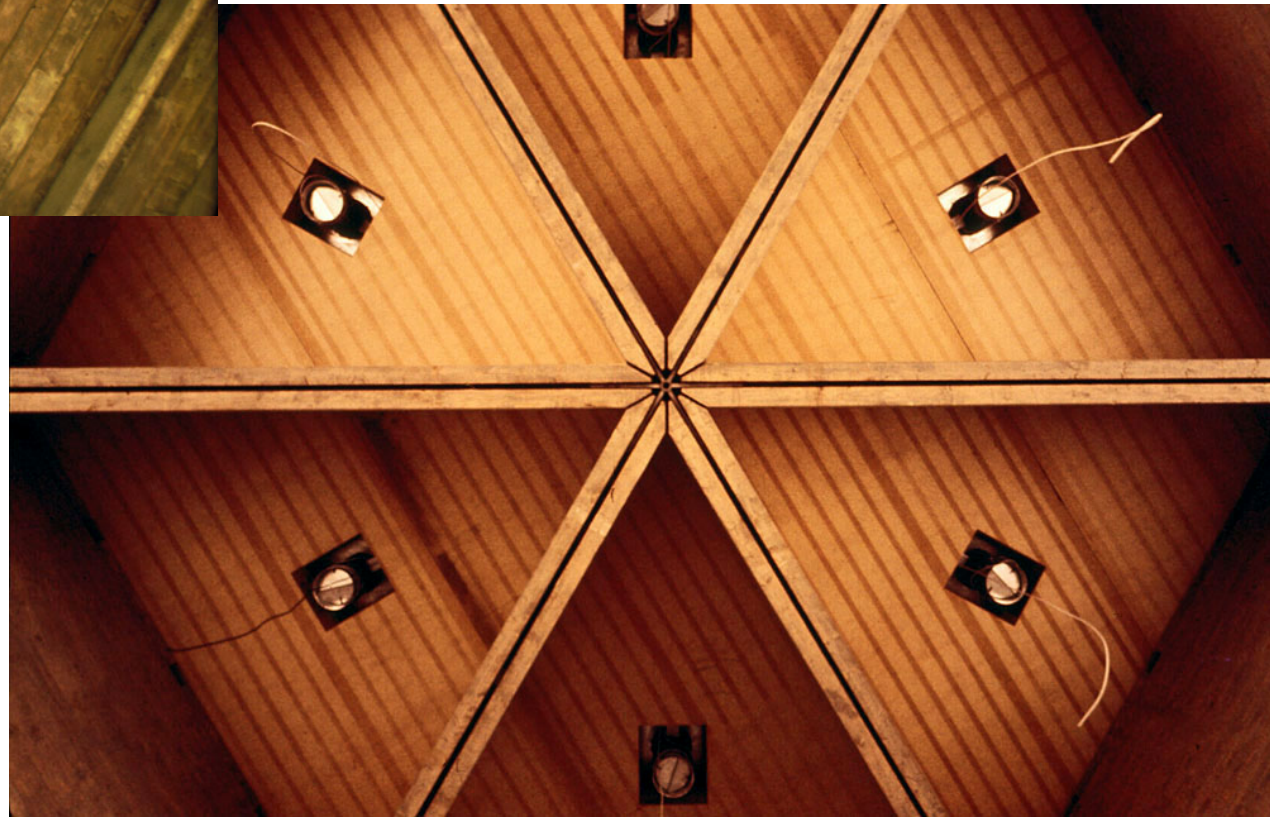
Beam Grids

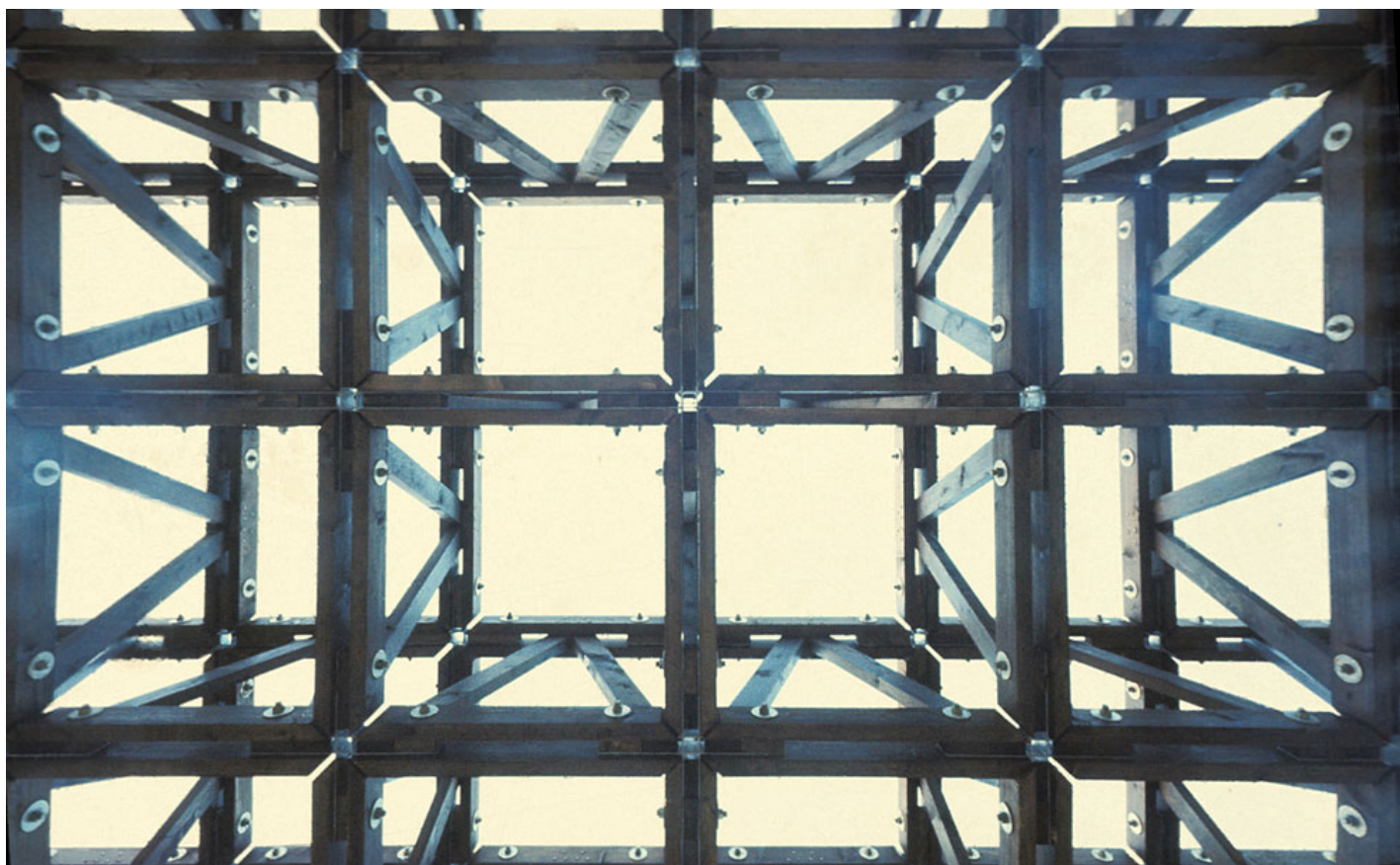












Hotel Palafitte - Monruz









Bus station in Sion



Carpenter : Deneriaz SA



Parasol - Sevilla



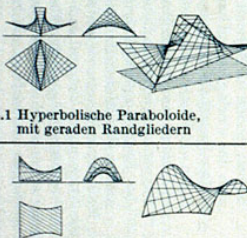
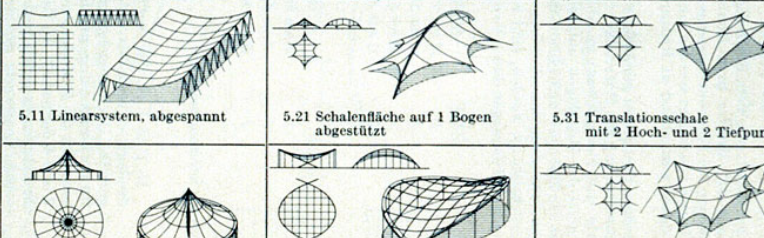
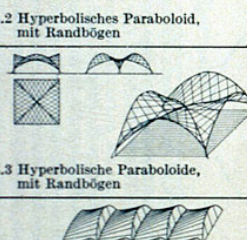
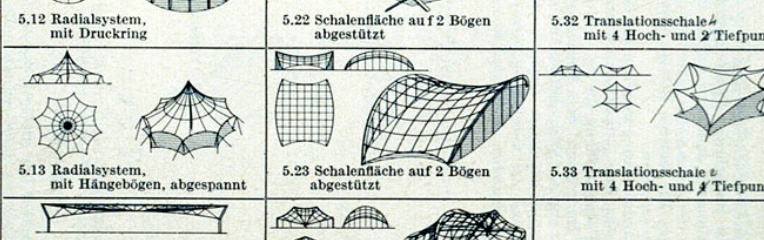
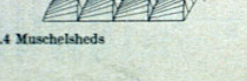
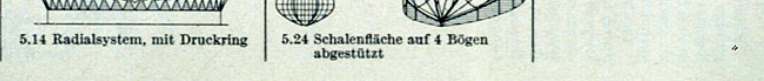
Parasol - Sevilla



Parasol - Sevilla

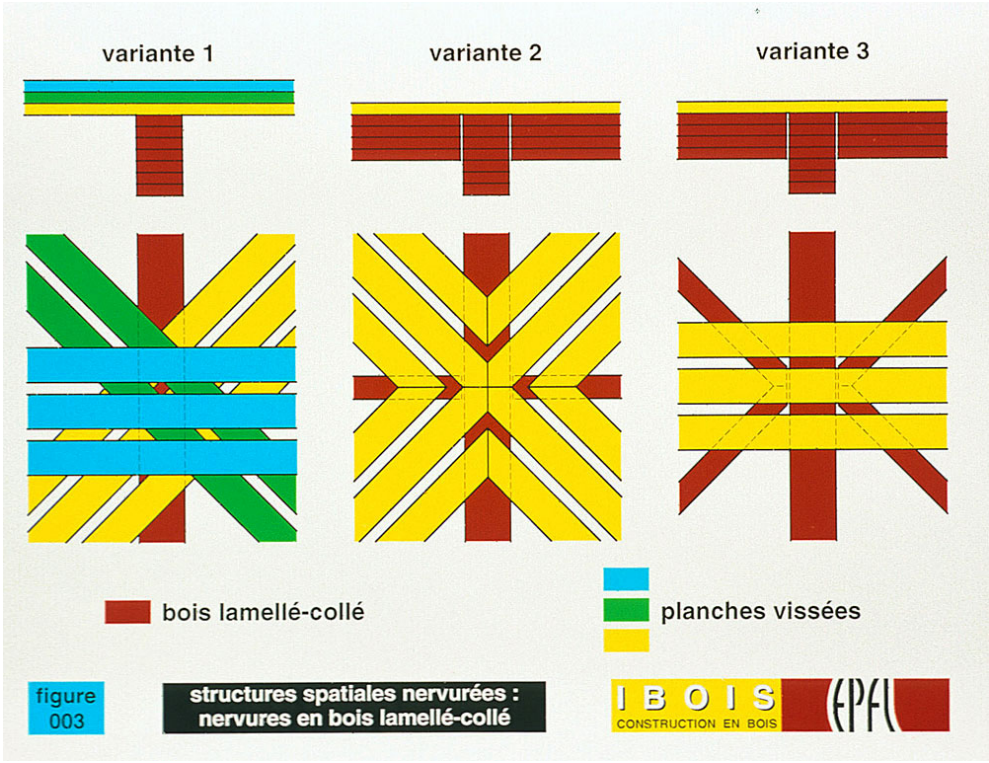


Shells

4. Sattelschalen		5. Hängeschalen	
Konstruktion aus: Brettlagen Brettschichtholz Sperrholzbänder		5.1 als Translations- bzw. Rotationsflächen Konstruktion aus: Brettlagen Brettschichtholz Sperrholzbänder	5.2 als Translationsflächen auf Druckbögen abgestützt Konstruktion aus: Brettlagen Brettschichtholz Sperrholzbänder
 4.1 Hyperbolische Paraboloid, mit geraden Randgliedern 4.2 Hyperbolisches Paraboloid, mit Randbögen		 5.11 Linearsystem, abgespannt 5.21 Schalenfläche auf 1 Bogen abgestützt 5.31 Translationsschale mit 2 Hoch- und 2 Tiefpunkte	
 4.3 Hyperbolische Paraboloid, mit Randbögen 4.4 Muschelschalen		 5.12 Radialsystem, mit Druckring 5.22 Schalenfläche auf 2 Bögen abgestützt 5.32 Translationsschale mit 4 Hoch- und 2 Tiefpunkte	
 5.13 Radialsystem, mit Hängebögen, abgespannt		 5.23 Schalenfläche auf 2 Bögen abgestützt 5.33 Translationsschale mit 4 Hoch- und 4 Tiefpunkte	
 5.14 Radialsystem, mit Druckring		 5.24 Schalenfläche auf 4 Bögen abgestützt	

Holz- und Holzwerkstoffeigenschaften für Holzlagerwerke

339



Geometric surfaces

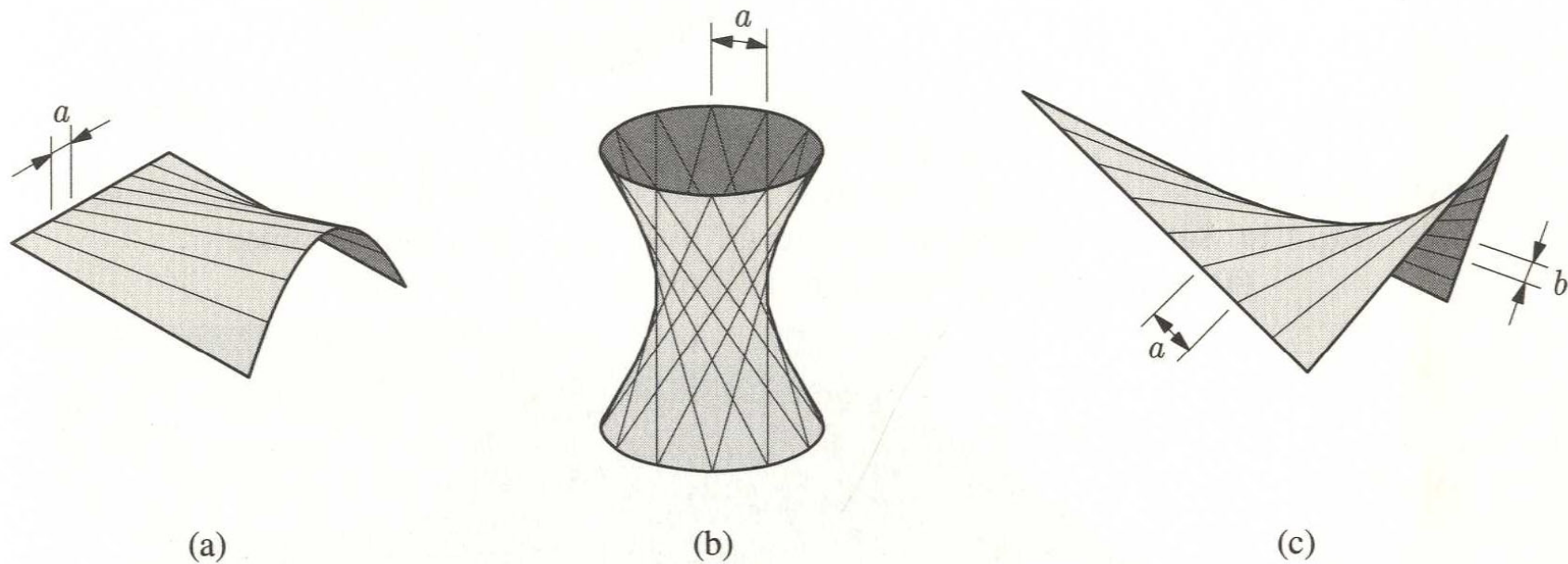


Fig. 1.13 Surfaces réglées : (a) conoïde ($K = 0$) ; (b) hyperboloïde à une nappe ($K < 0$) ; (c) paraboloïde hyperbolique ($K < 0$).

Geometric surfaces

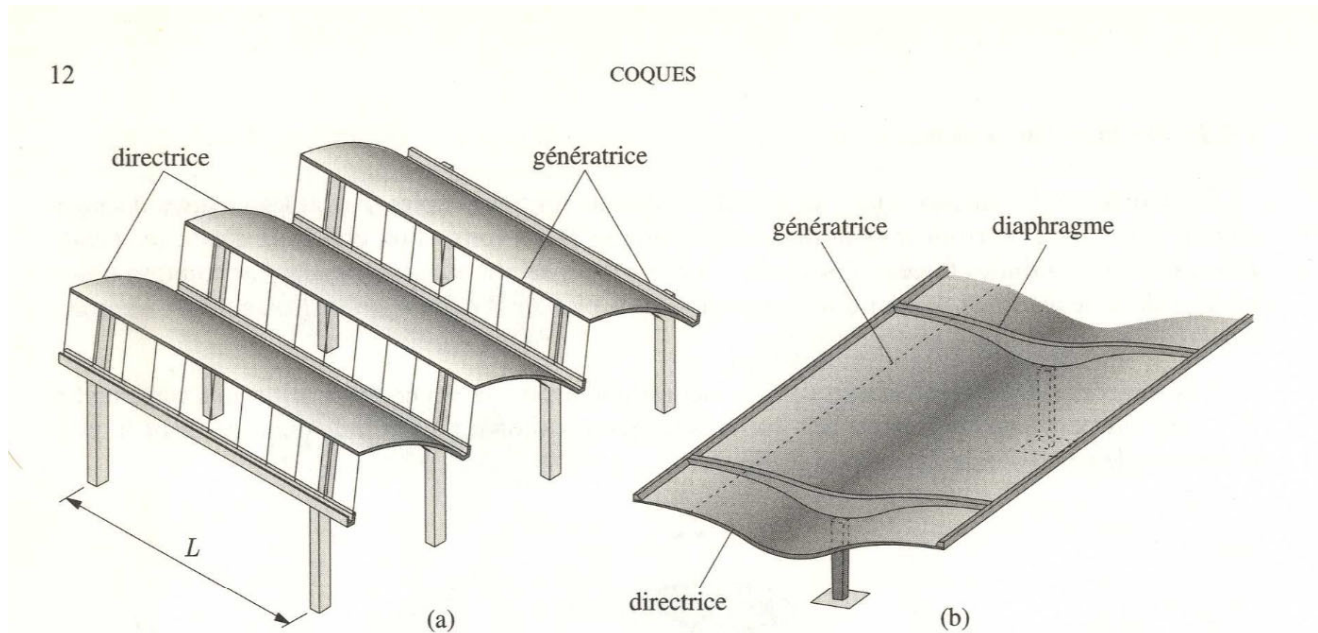


Fig. 1.14 Surfaces cylindriques ouvertes ($K = 0$) dites voûtes autoportantes :
(a) sheds (voûtes à simple portée L); (b) abri (voûte continue).

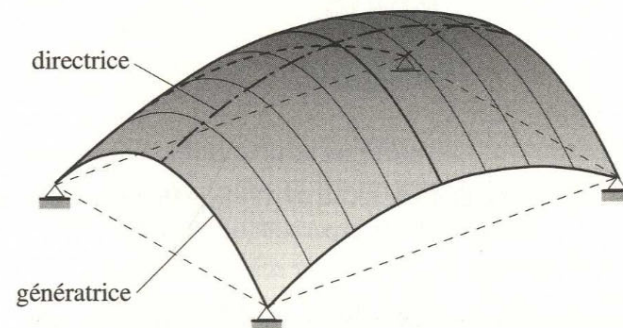


Fig. 1.15 Surface de translation ($K > 0$) utilisée comme couverture.

Form finding systems

- Heinz Isler

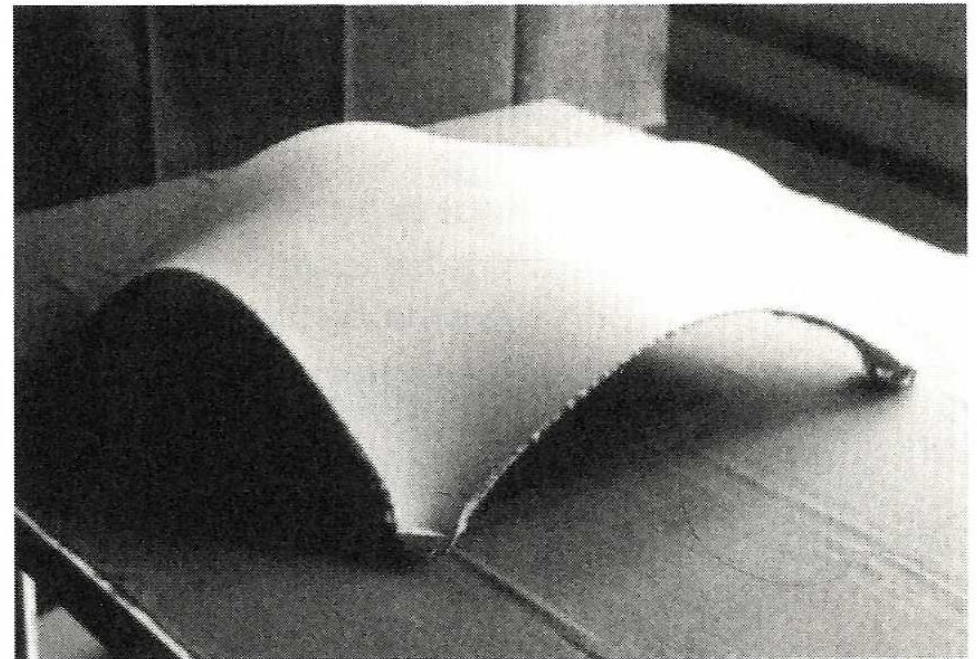
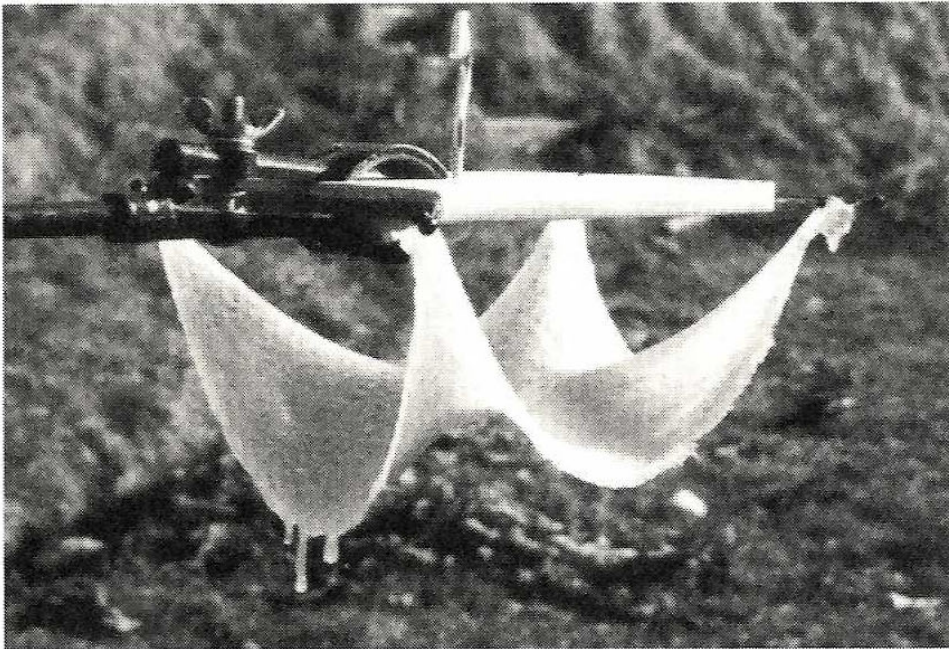
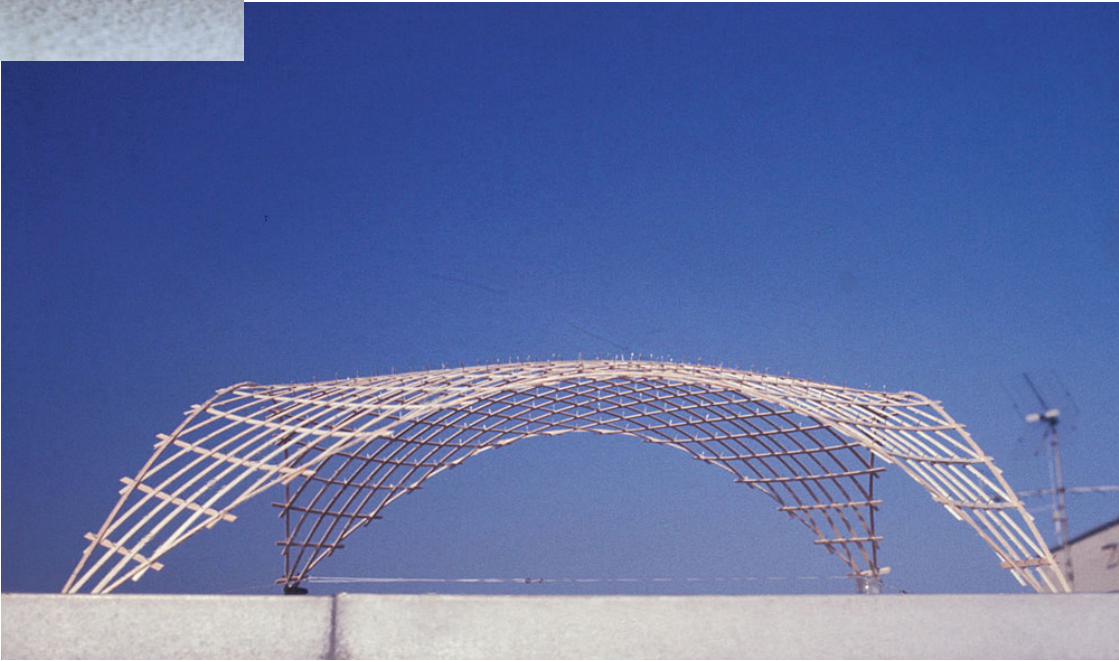
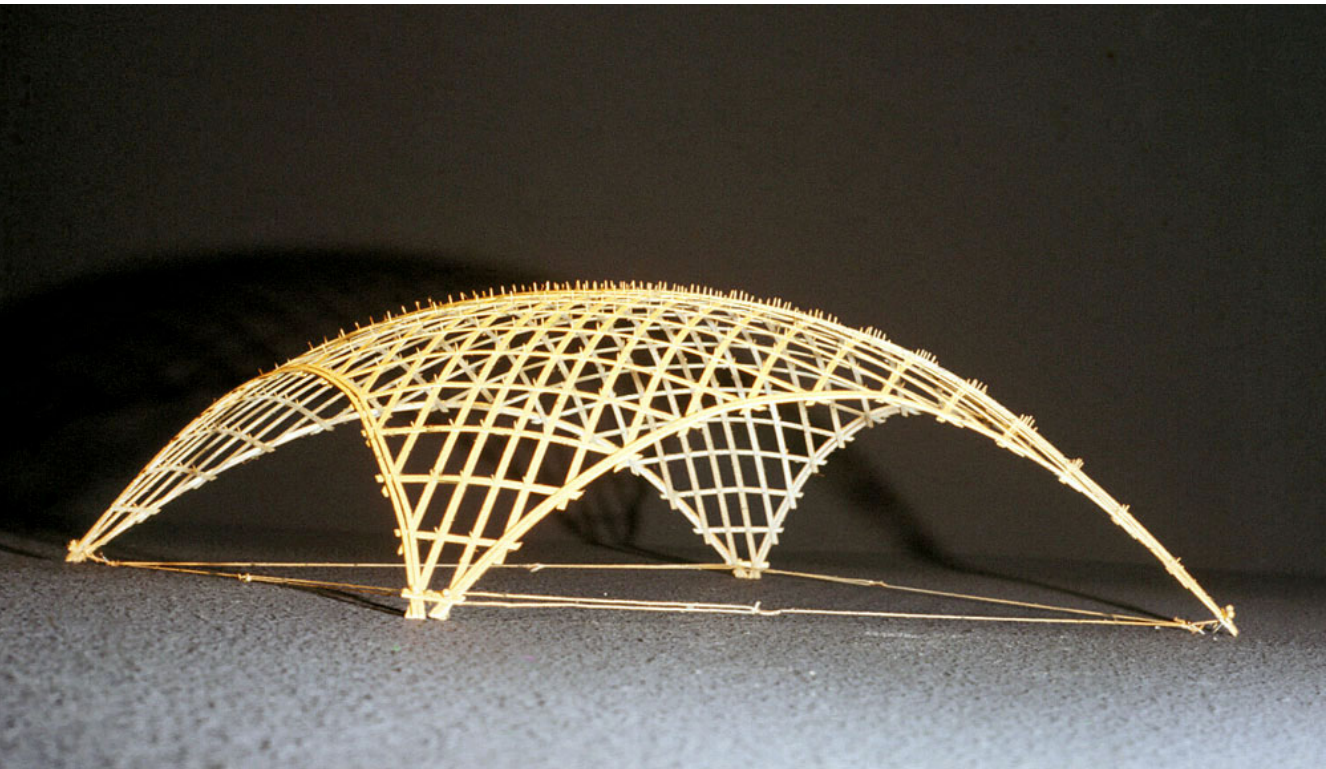


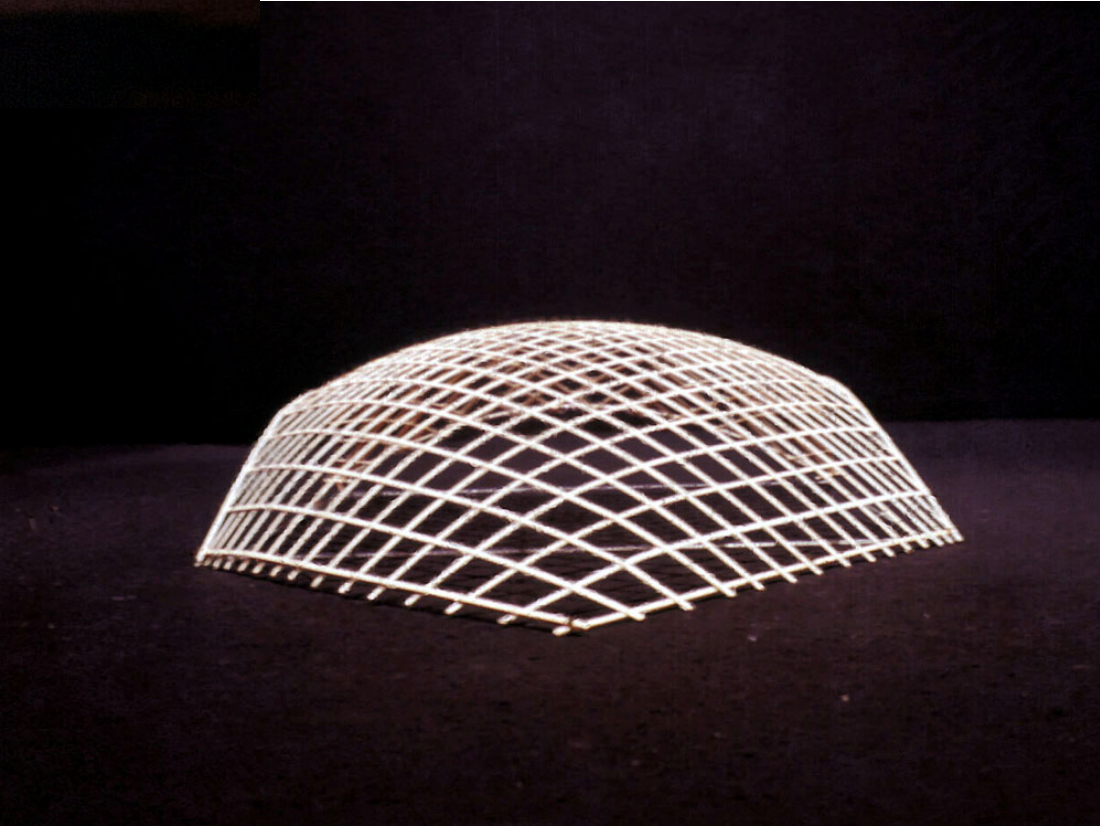
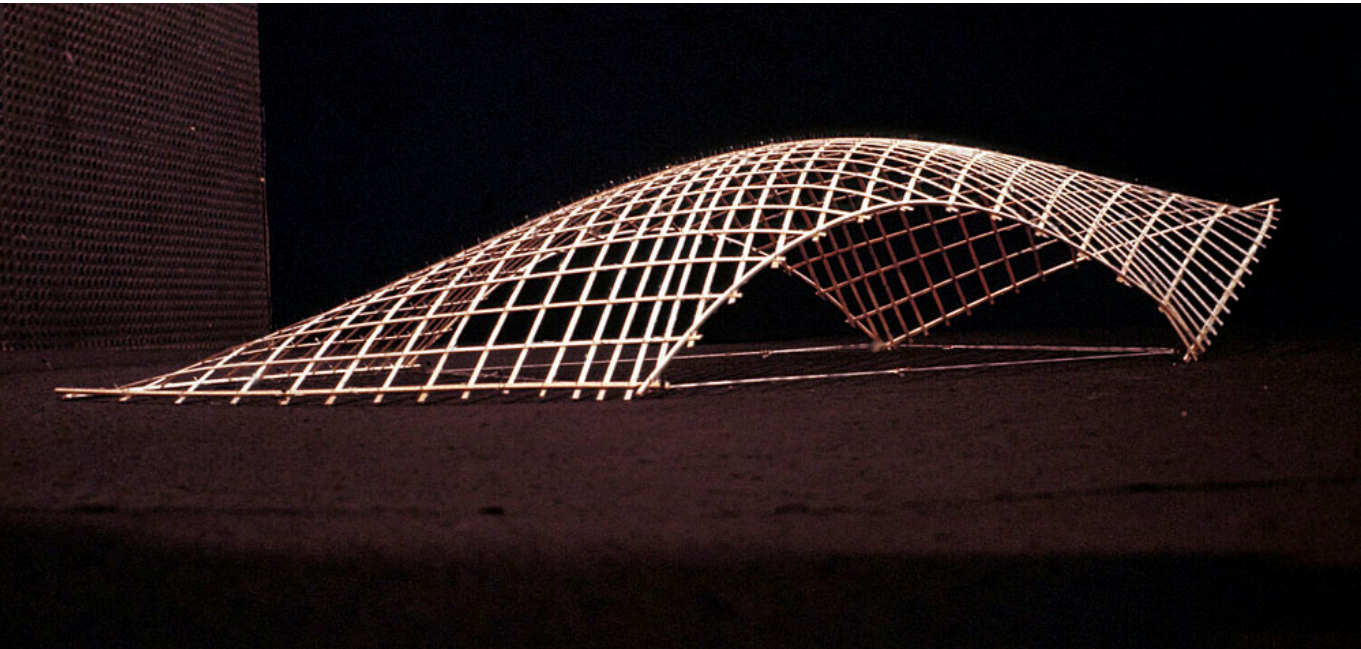
Fig. 1.19 Modèles de coque appuyée sur quatre points, obtenus d'un tissu trempé dans du polyester, solidifié et retourné. (Source : H. Isler, ingénieur ETHZ, Berthoud.)

Form finding systems

- Antonio Gaudi

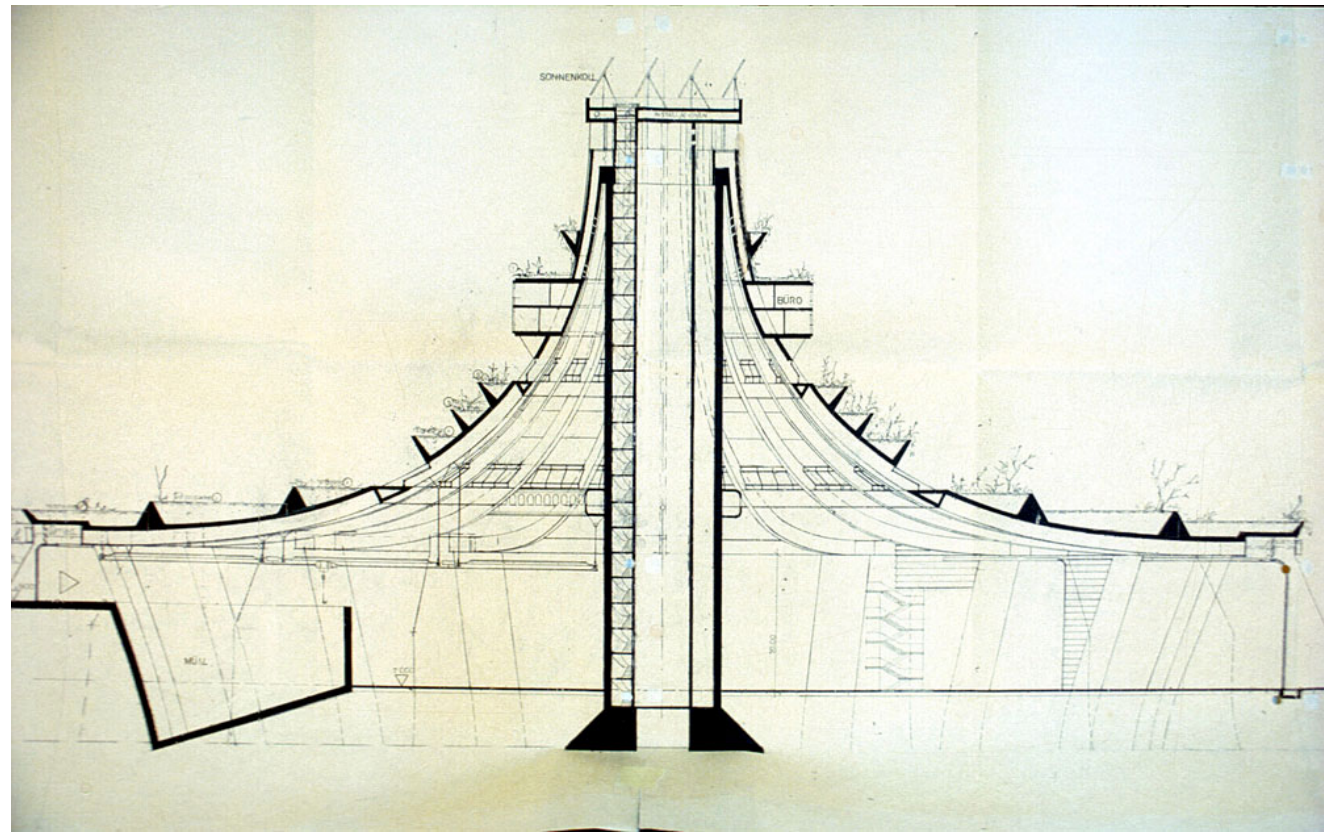
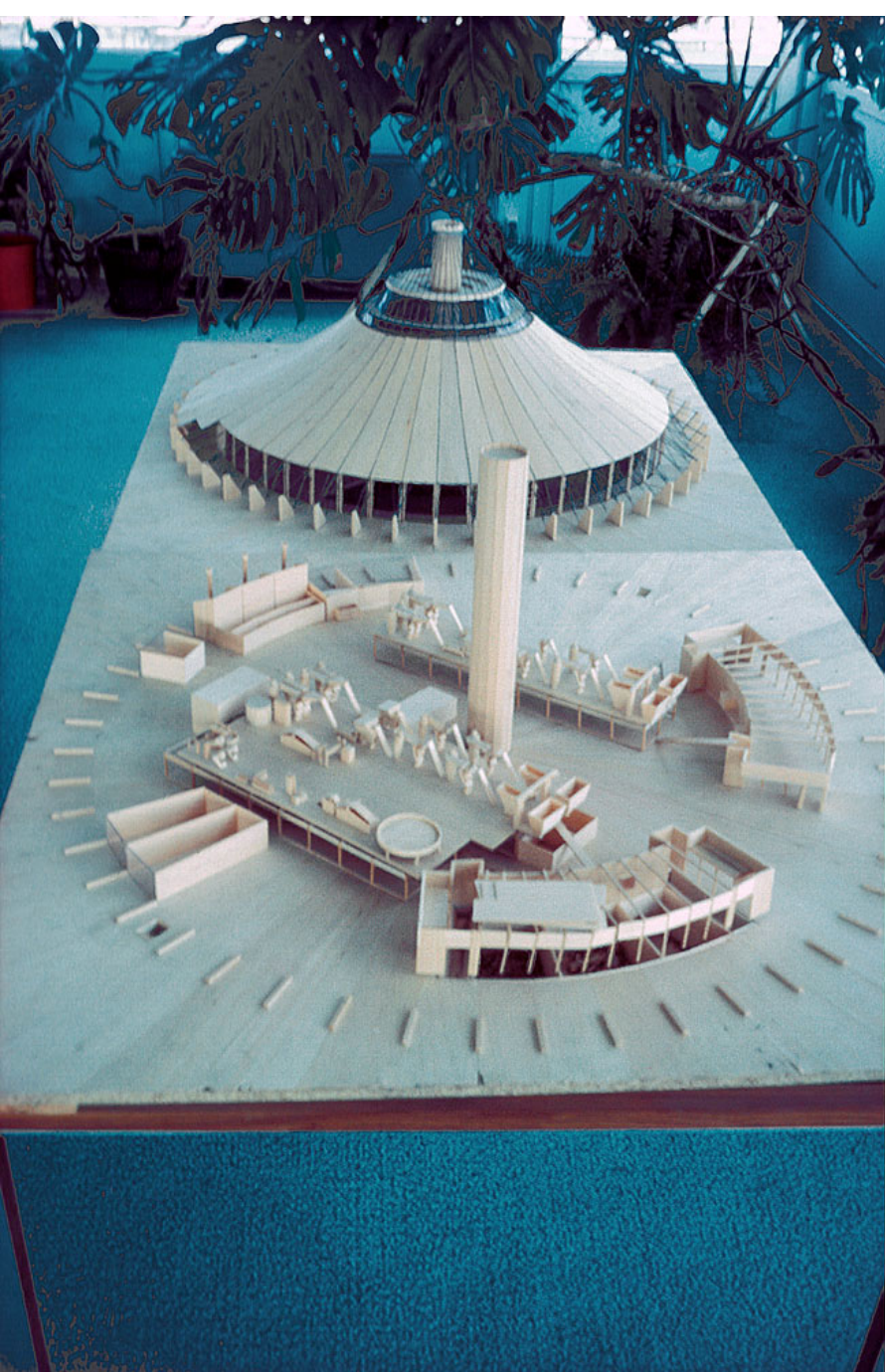


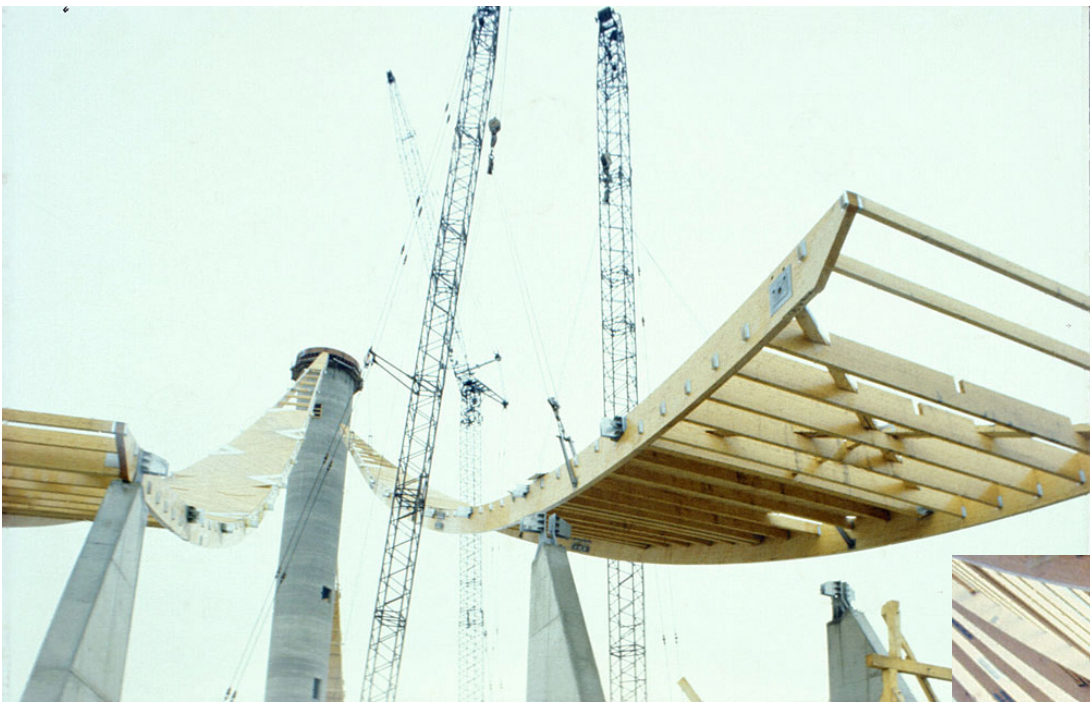


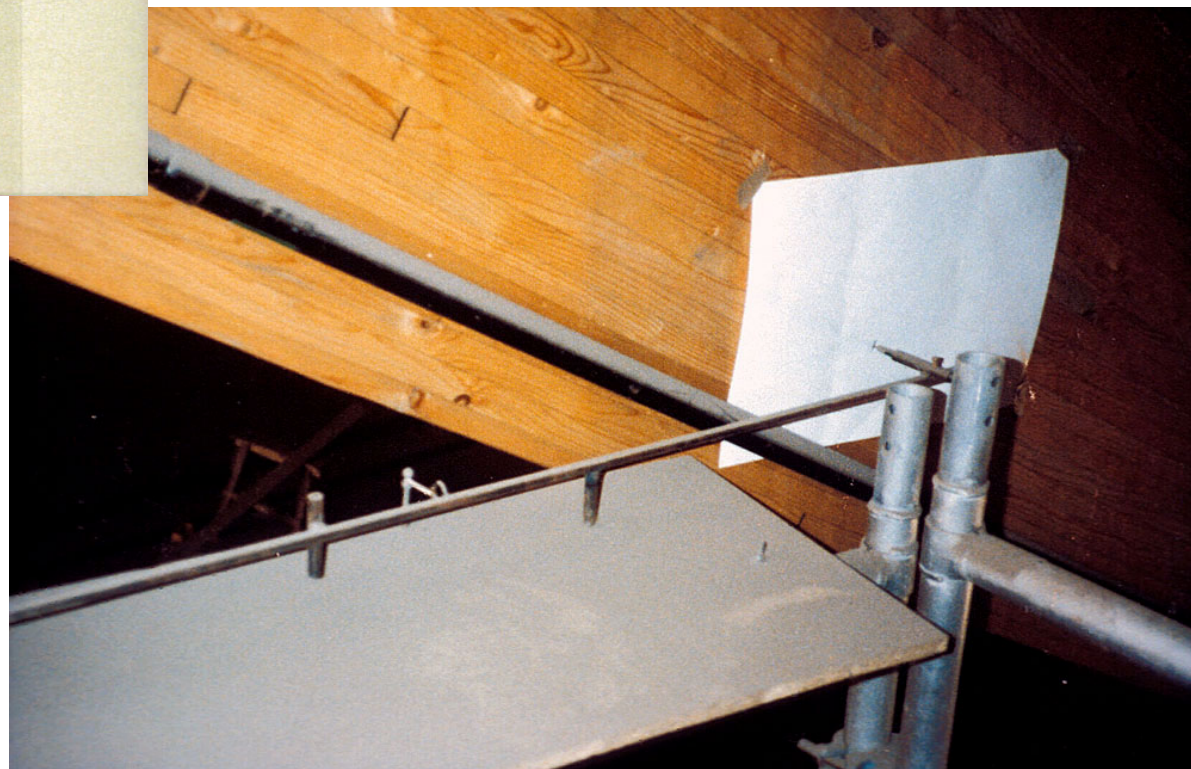
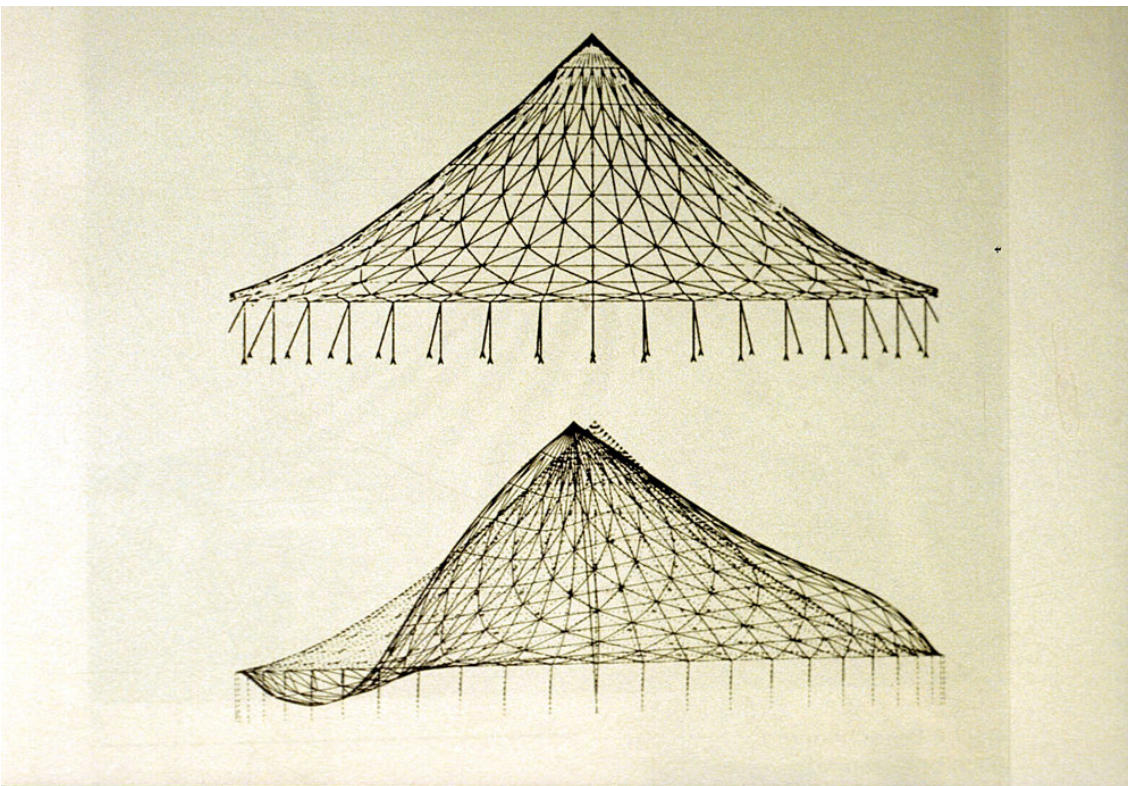


Rotation surfaces





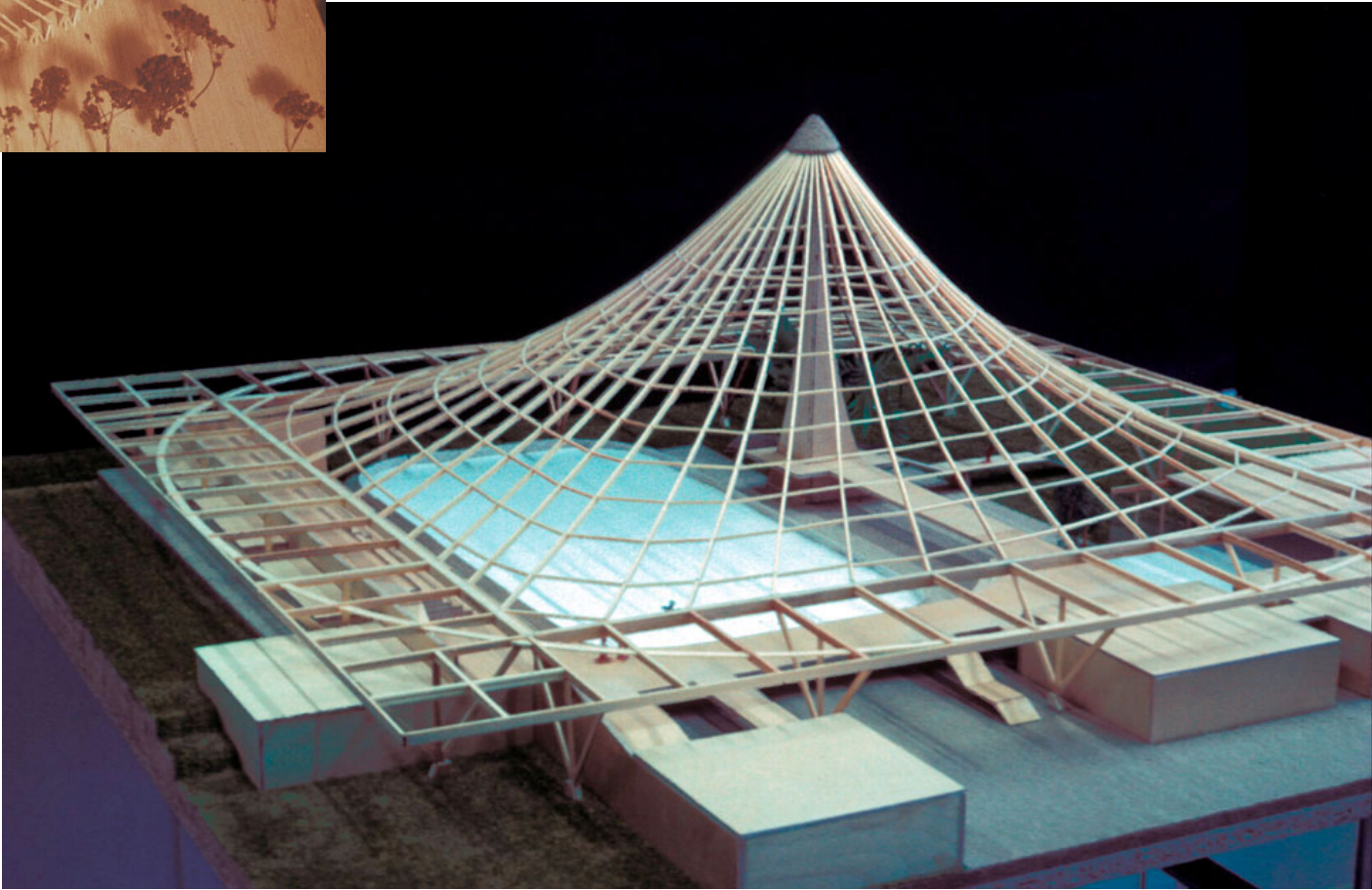
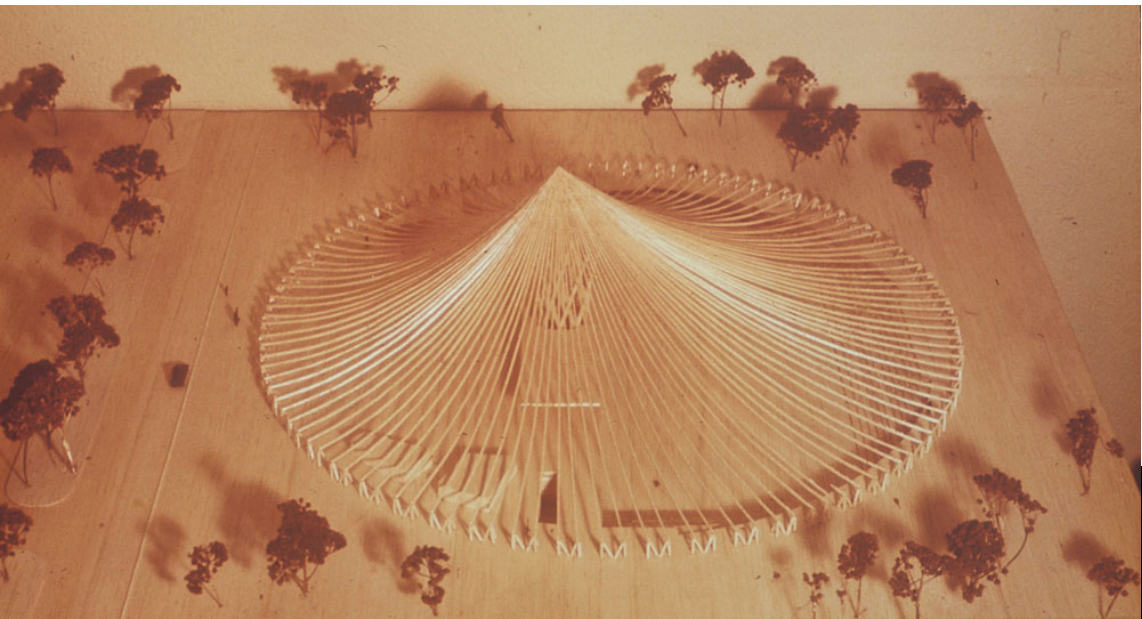


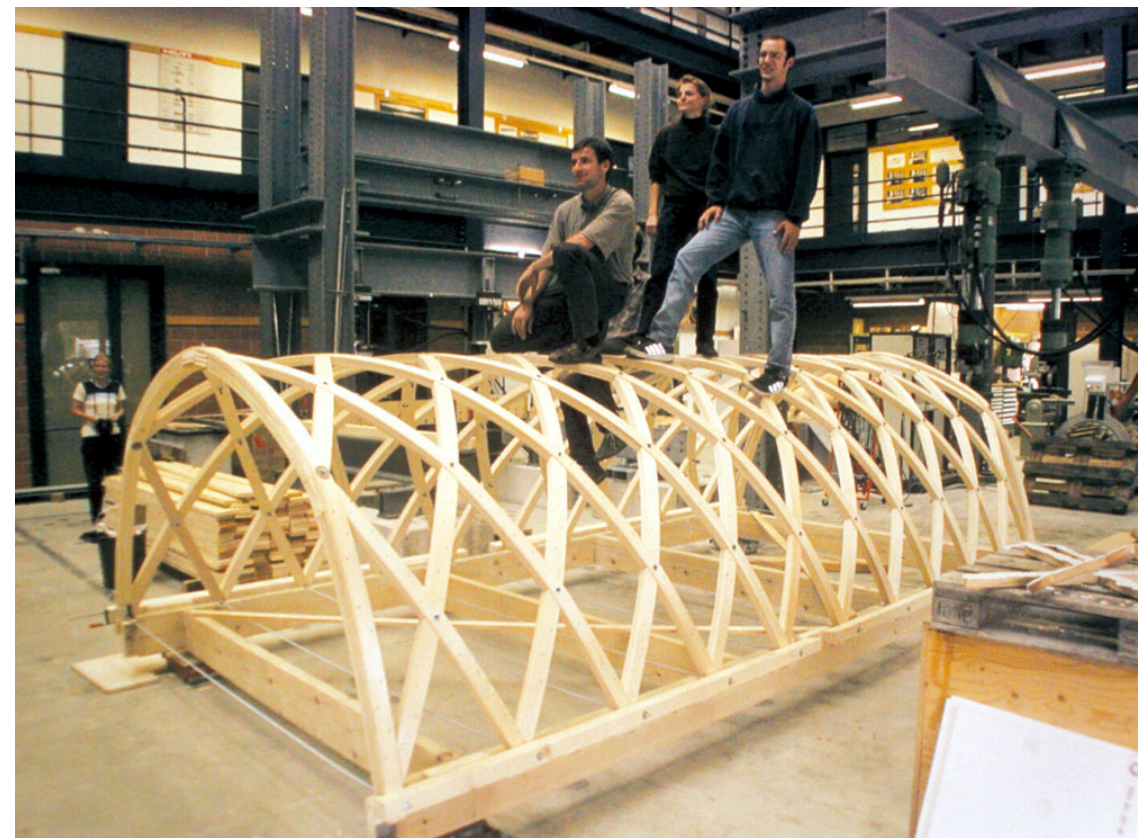
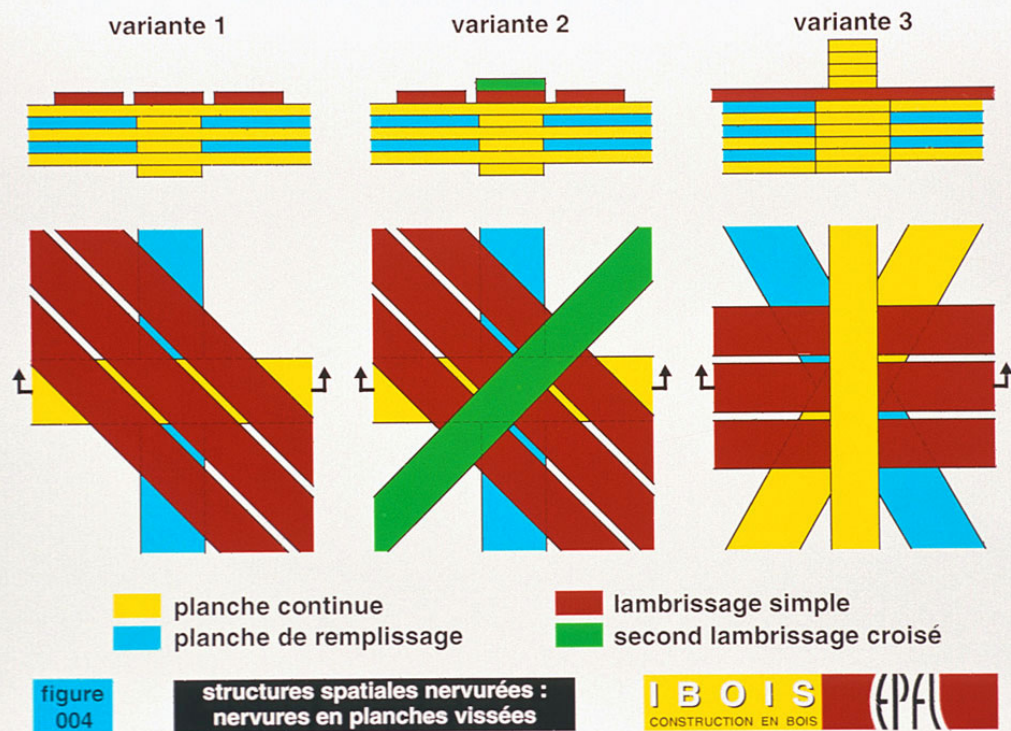










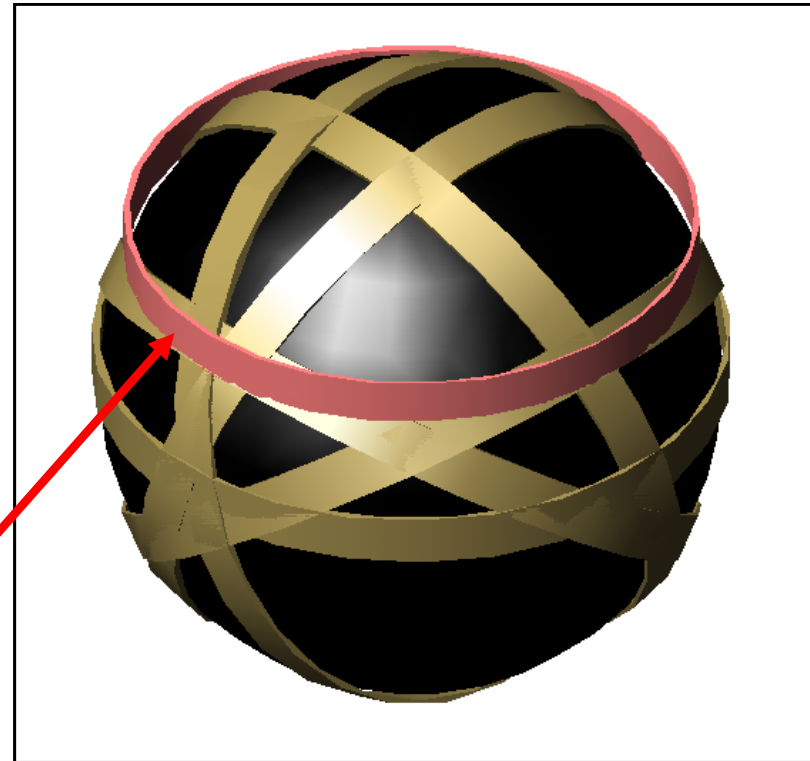


The “la ligne géodésique”

- Planks curved in only one direction

and

- Flush with the surface

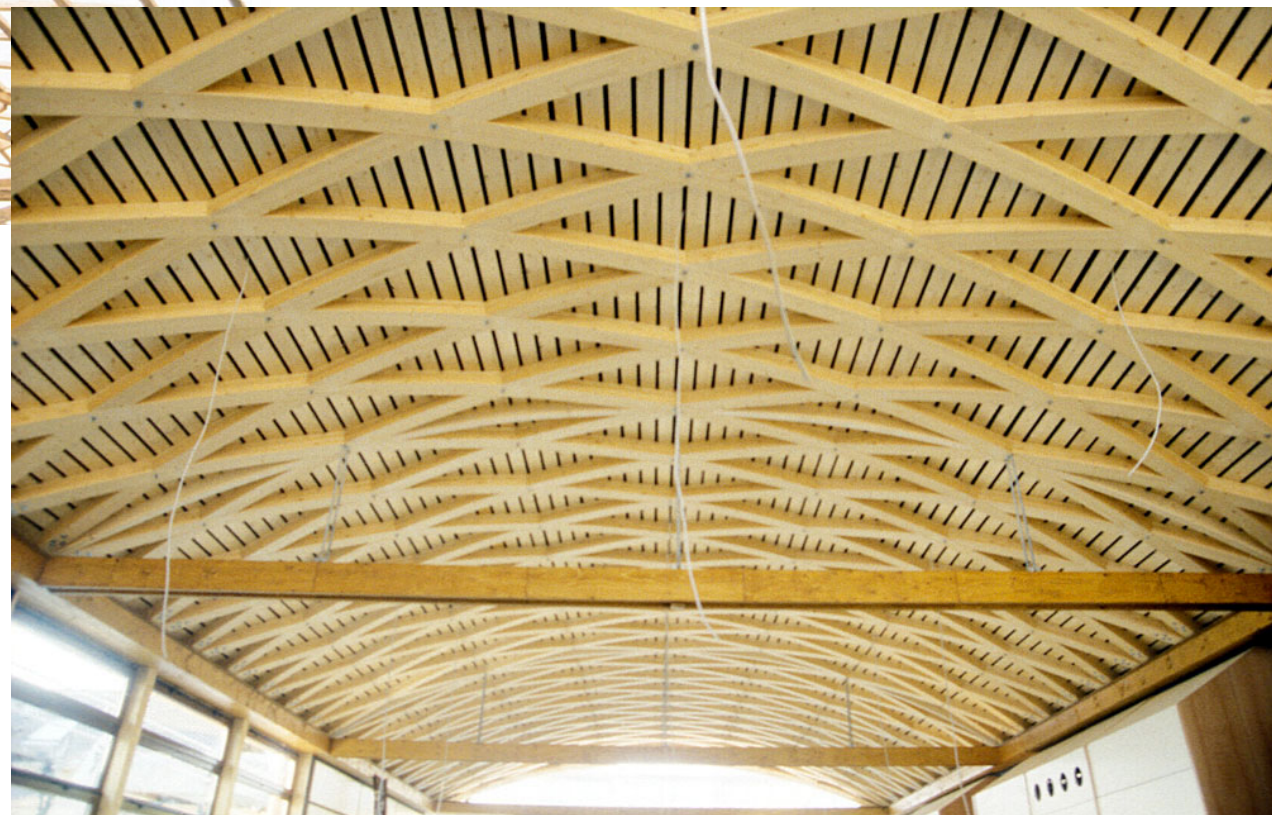


Not a plank line!



barrels





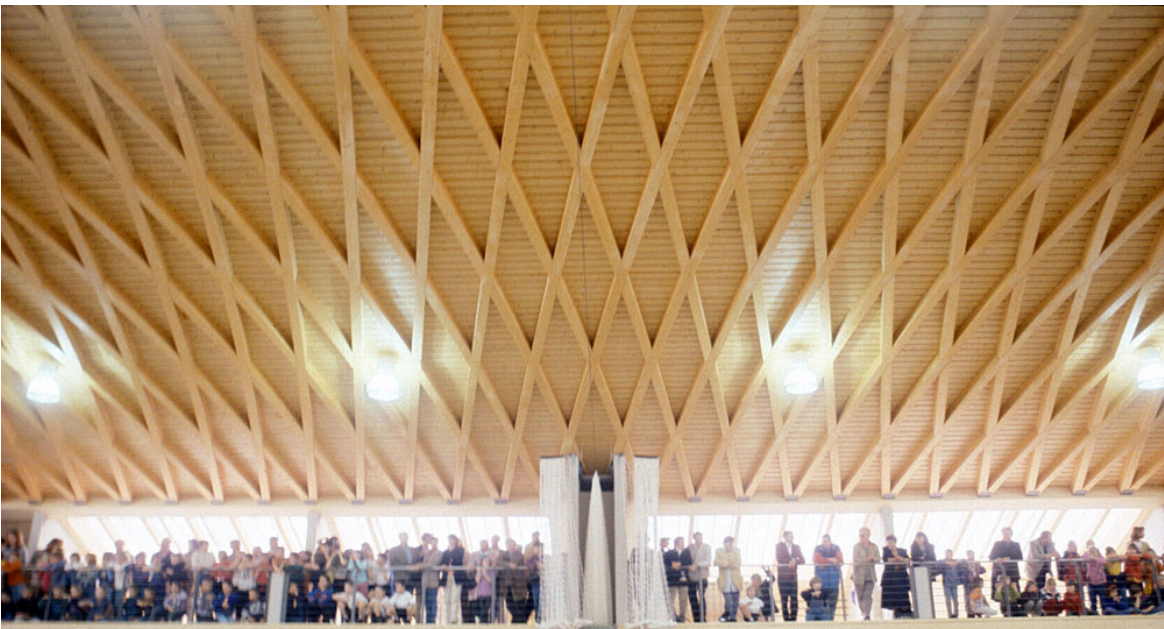








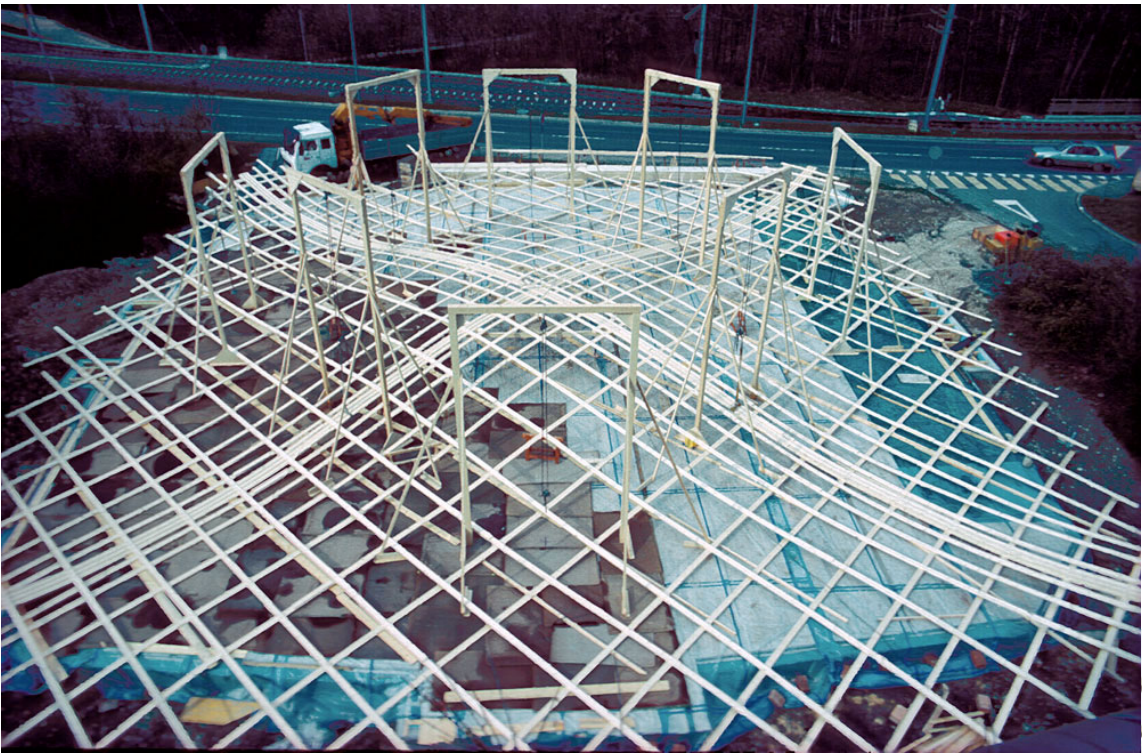


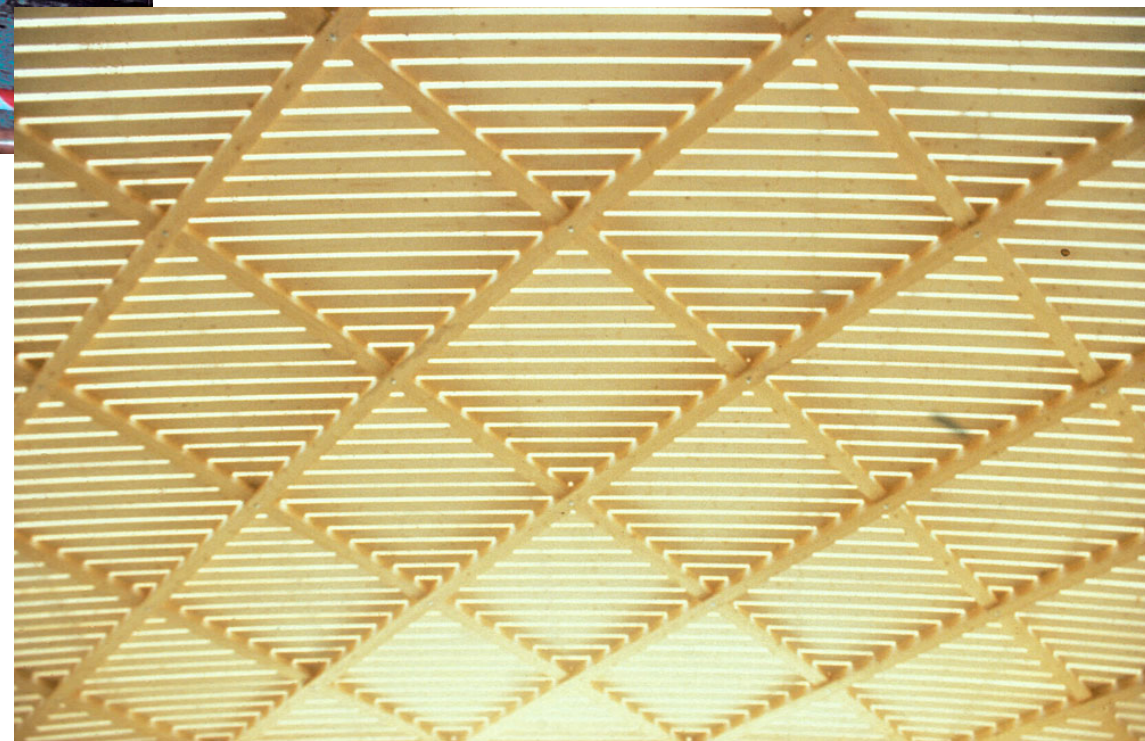
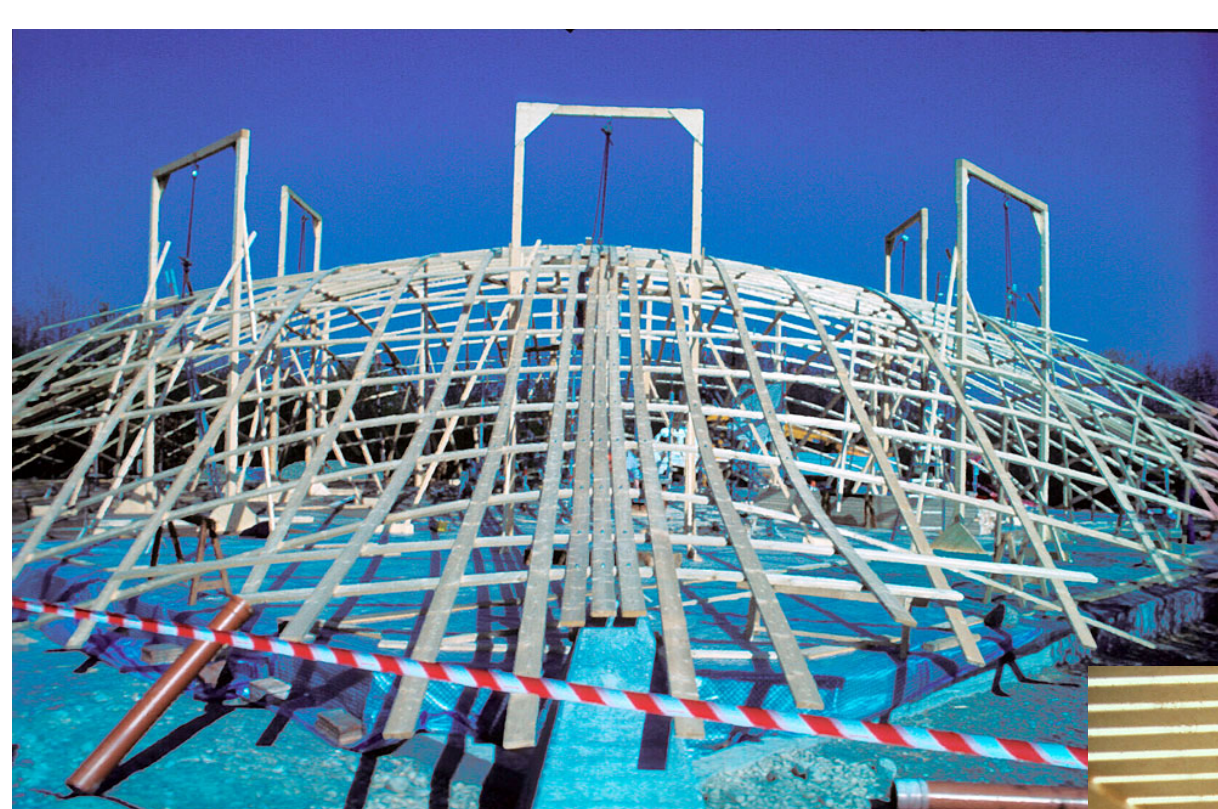






Sphere











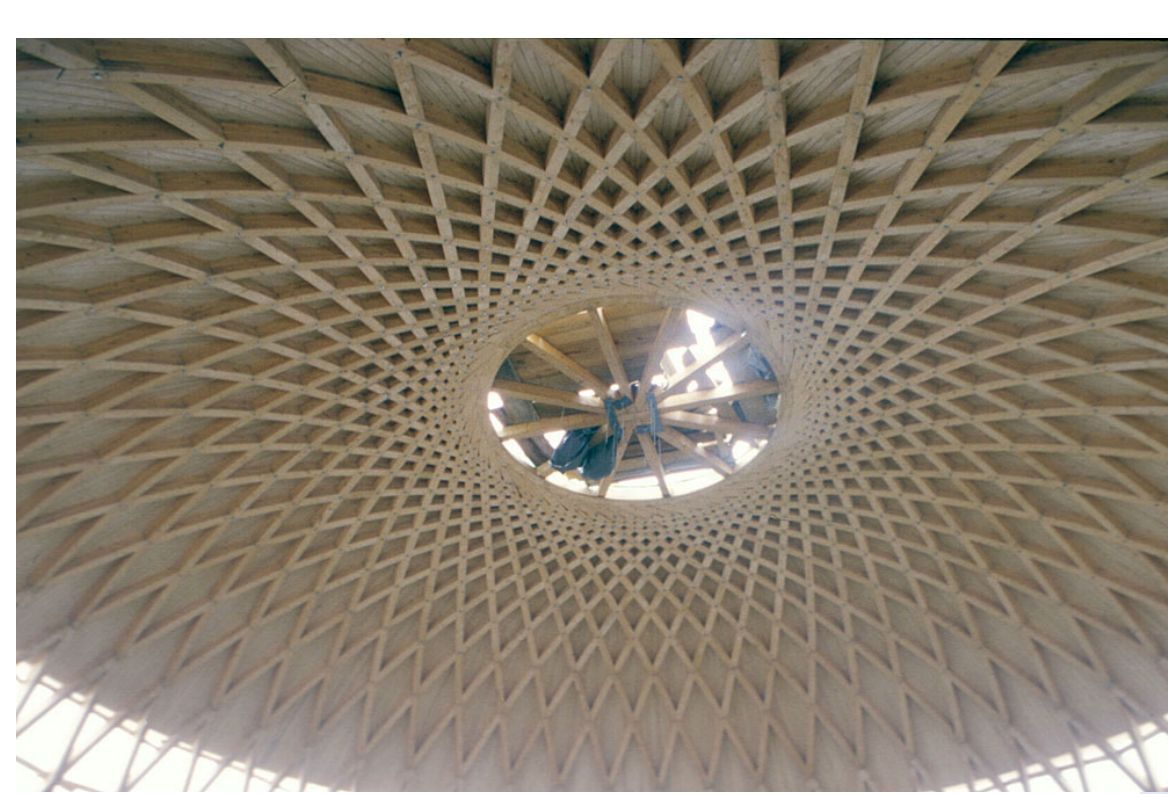










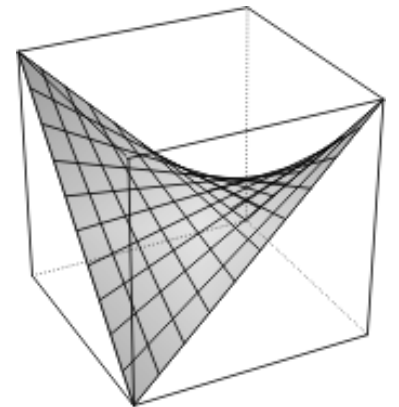
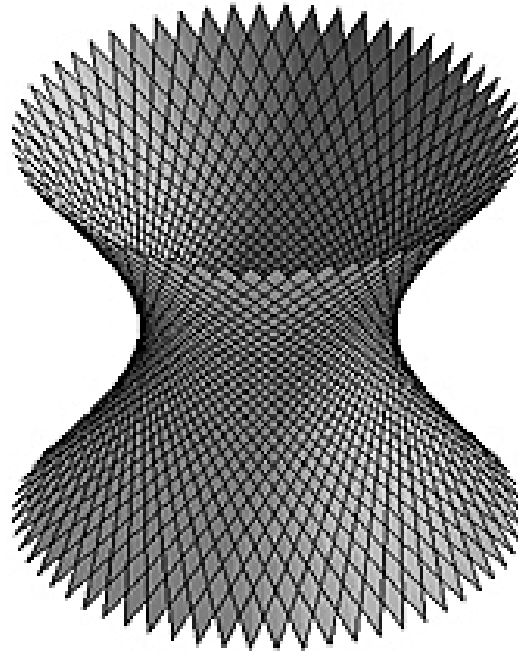
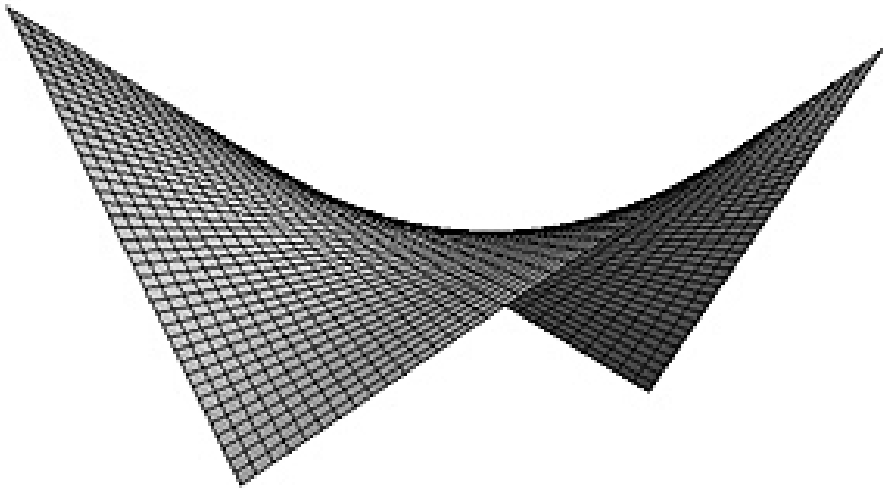




Parboloid

Paraboloid

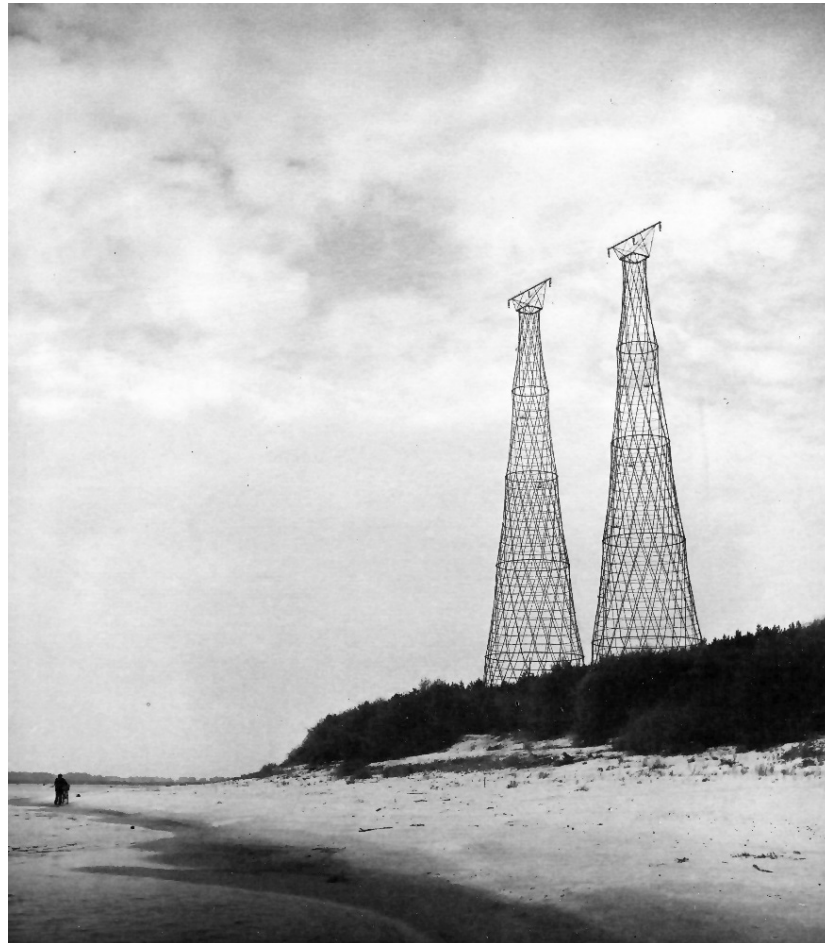
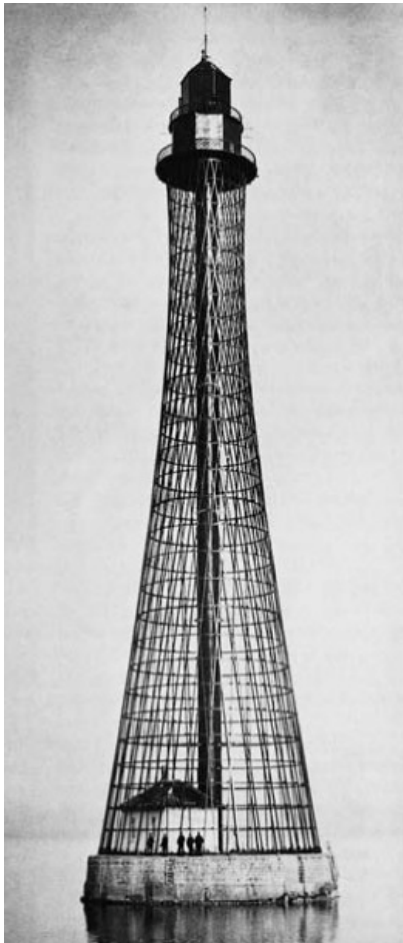
modèle $z = x^2 - y^2$



Wikipedia.org

Vladimir Shukhov (1853-1939)

- Hyperboloid towers









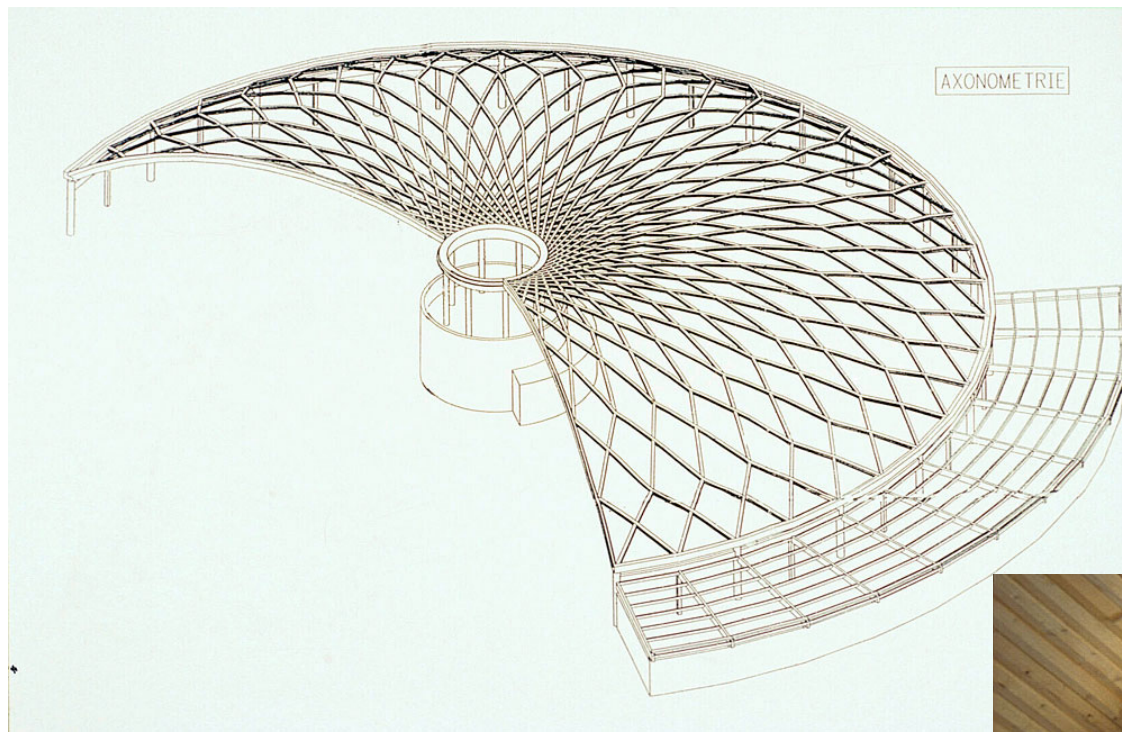










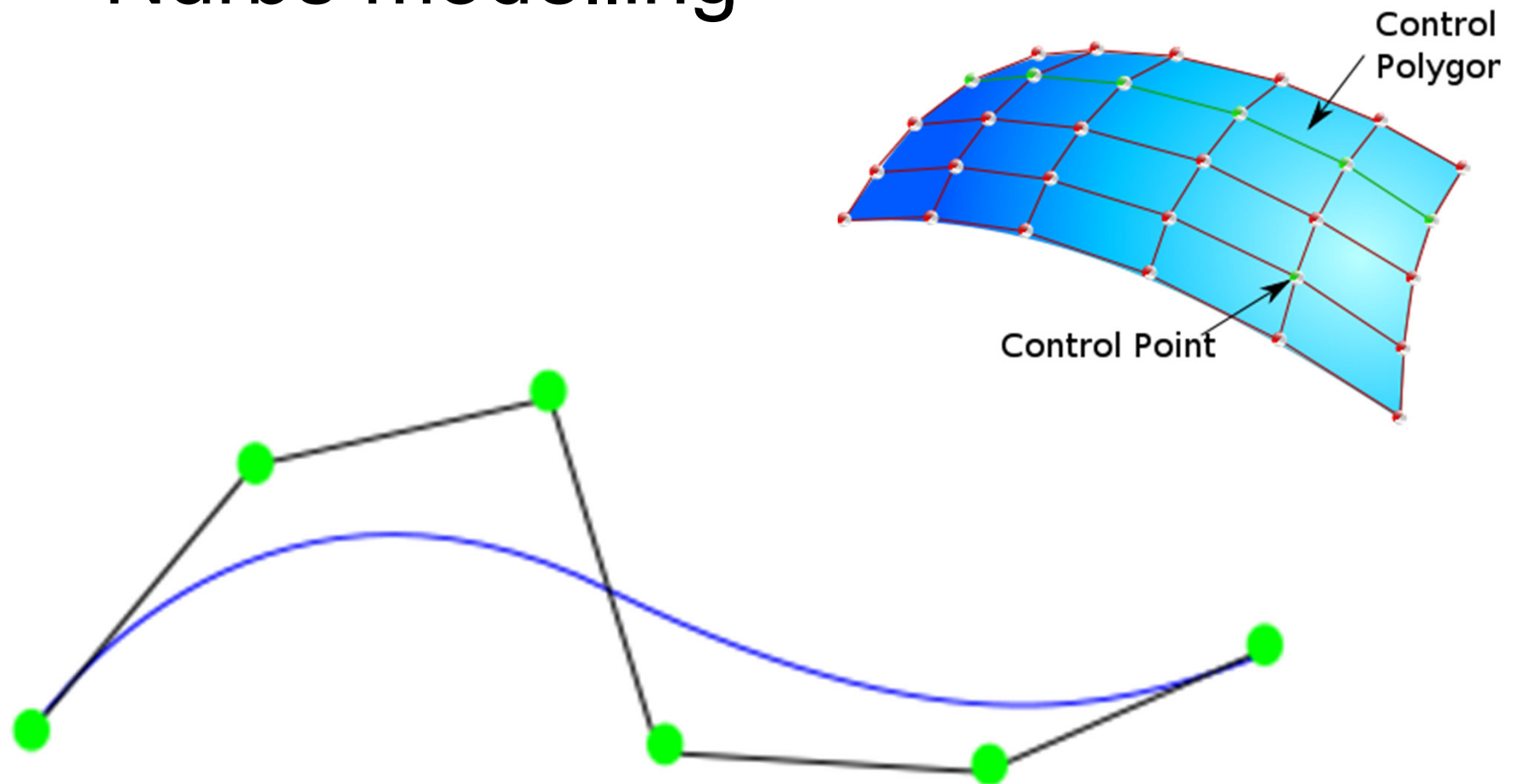




«The wild ones»

rhinoceros

Nurbs modelling



Wikipaida.org

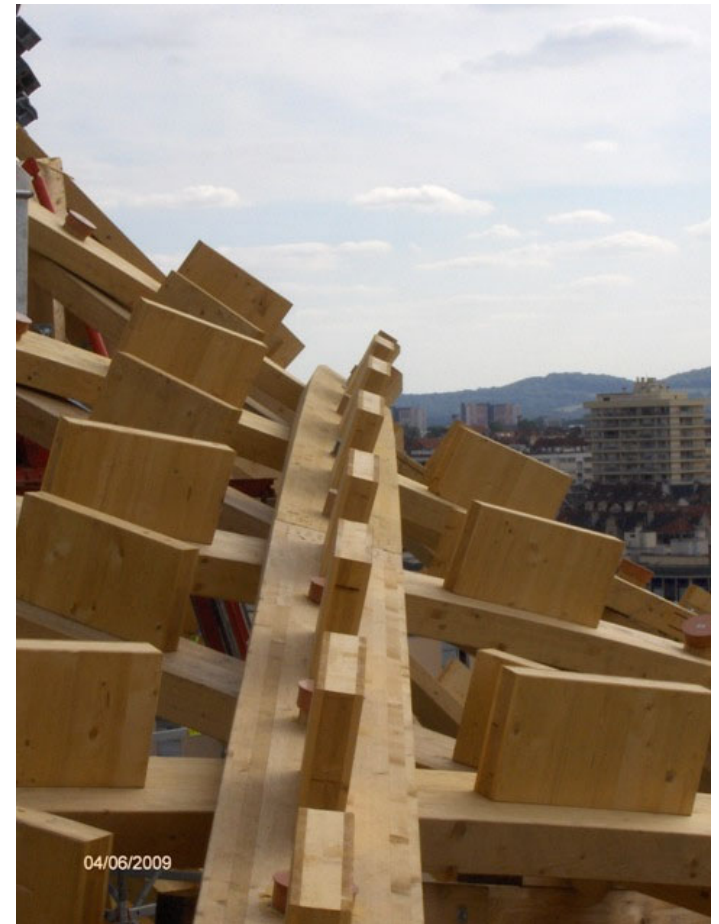
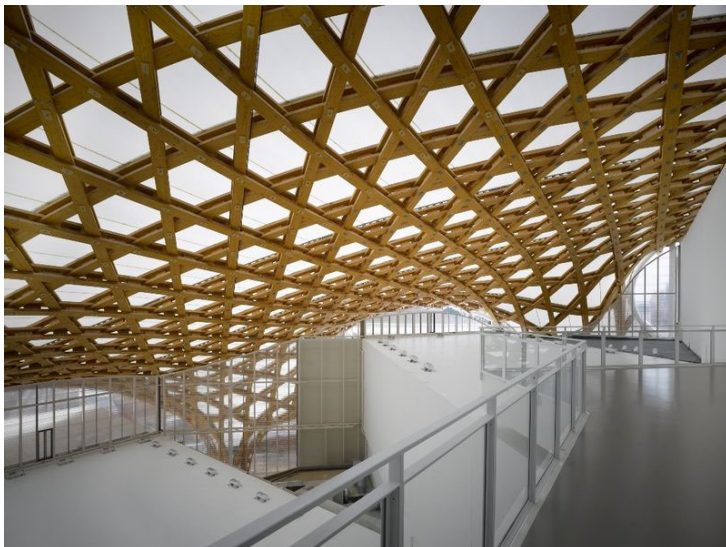


Centre Pompidou de Metz

Photographe: Jacques Mossot
Structurae.

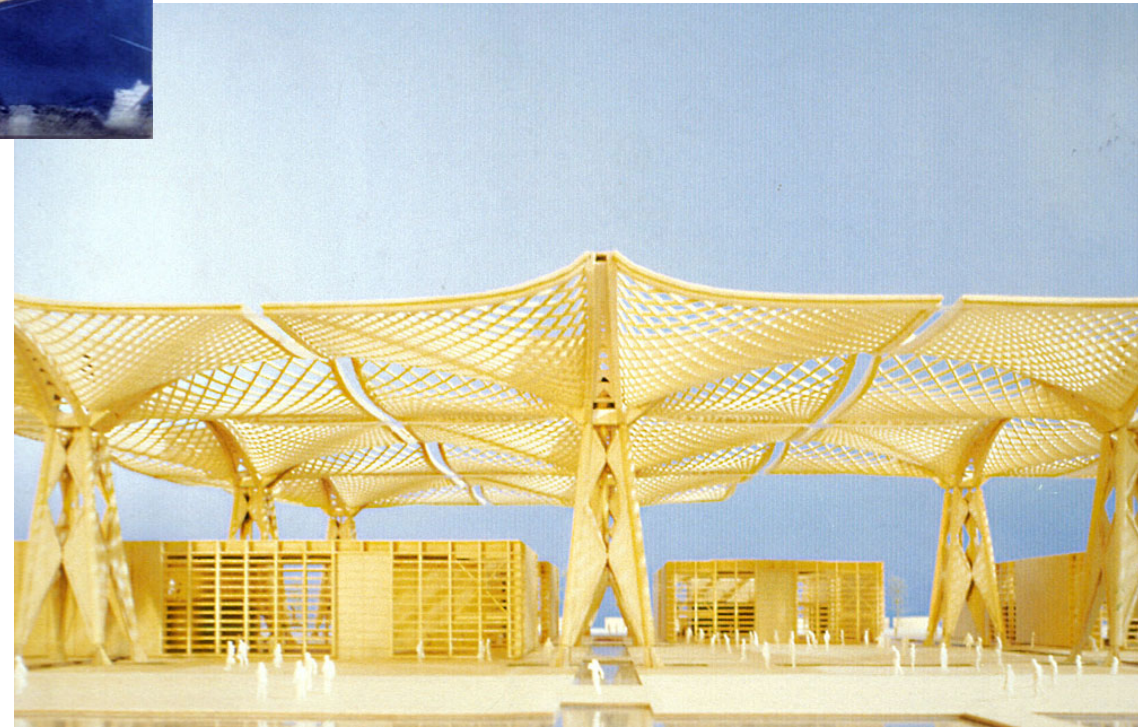


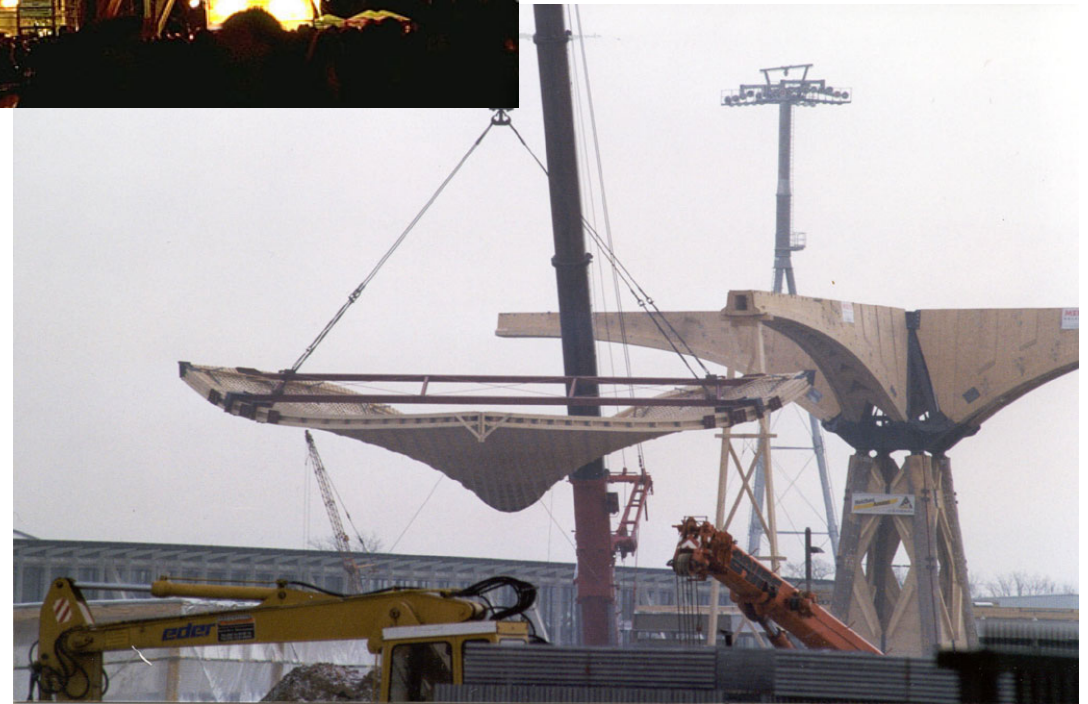
Binderholzbau.de

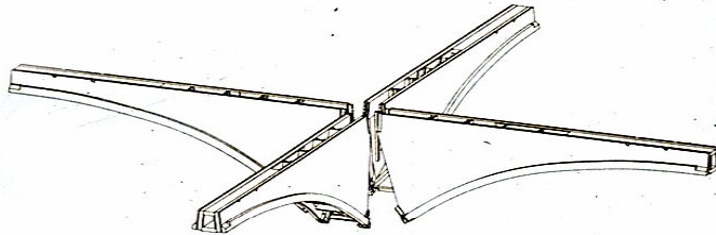
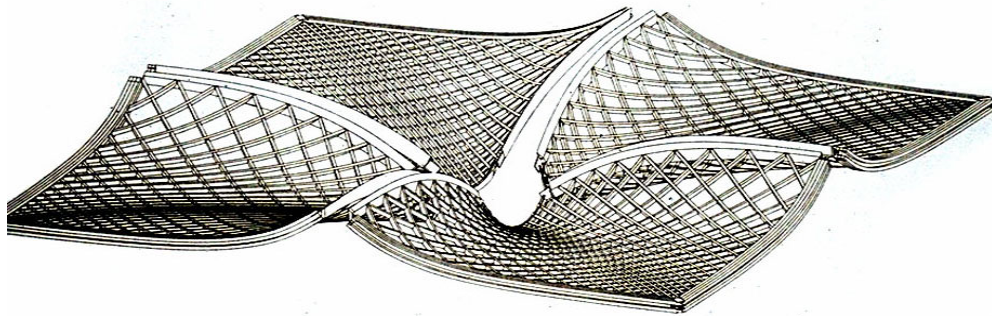




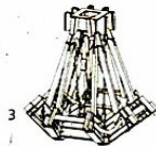
The roof in Hannover



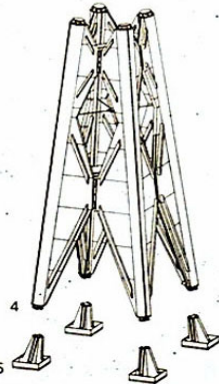




2



3



4

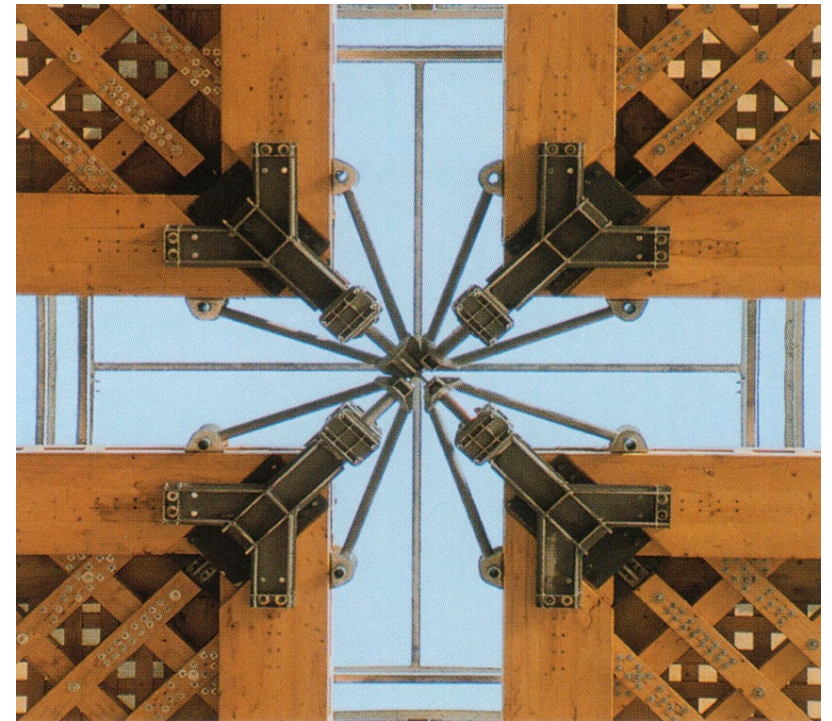
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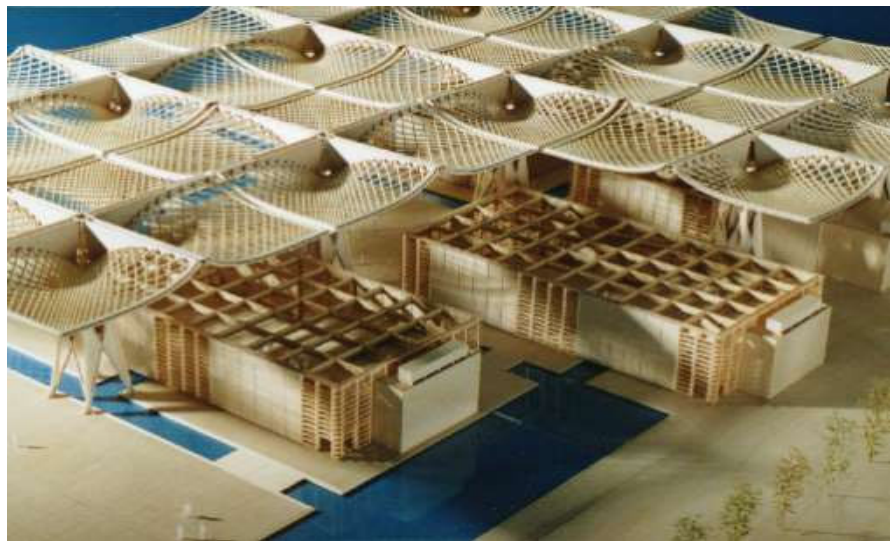
Explosions-Isometrie

- 1 Gitterschalen
- 2 Kragträger
- 3 Stahlpyramide
- 4 Turm mit 4 Vollholzstämmen
- 5 Stahlfüße

Exploded isometric

- 1 Lattice shells
- 2 Cantilevered trusses
- 3 Steel pyramid
- 4 Tower with four solid timber columns
- 5 Steel feet

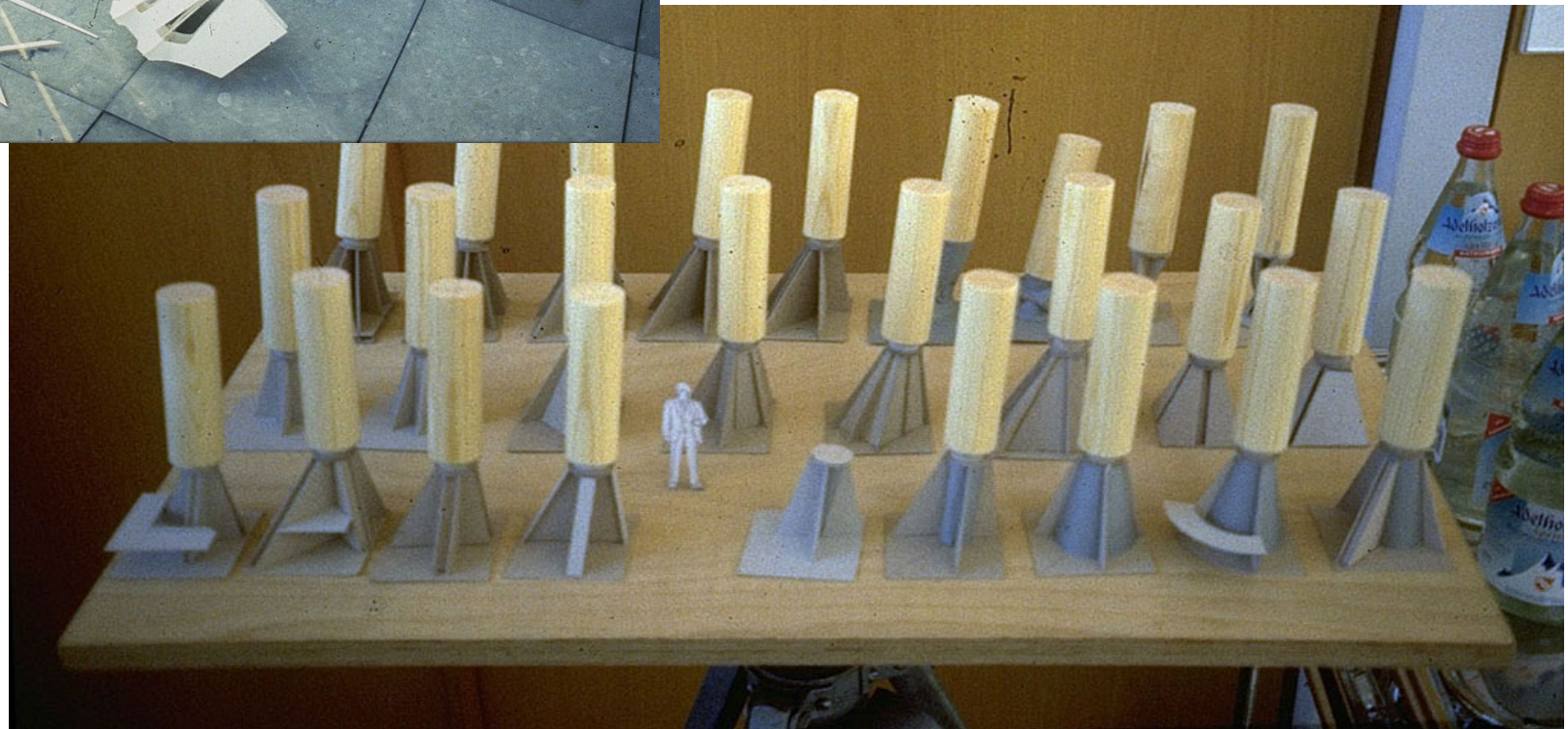




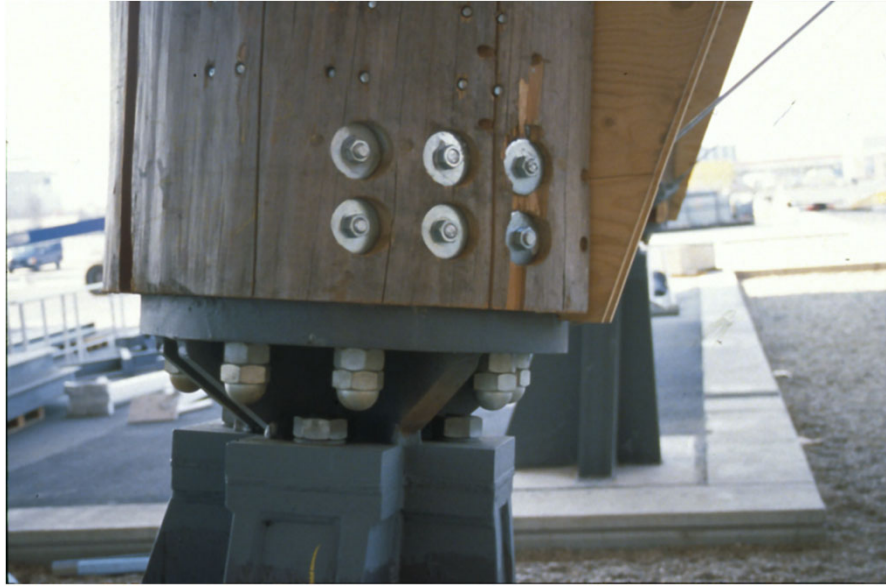




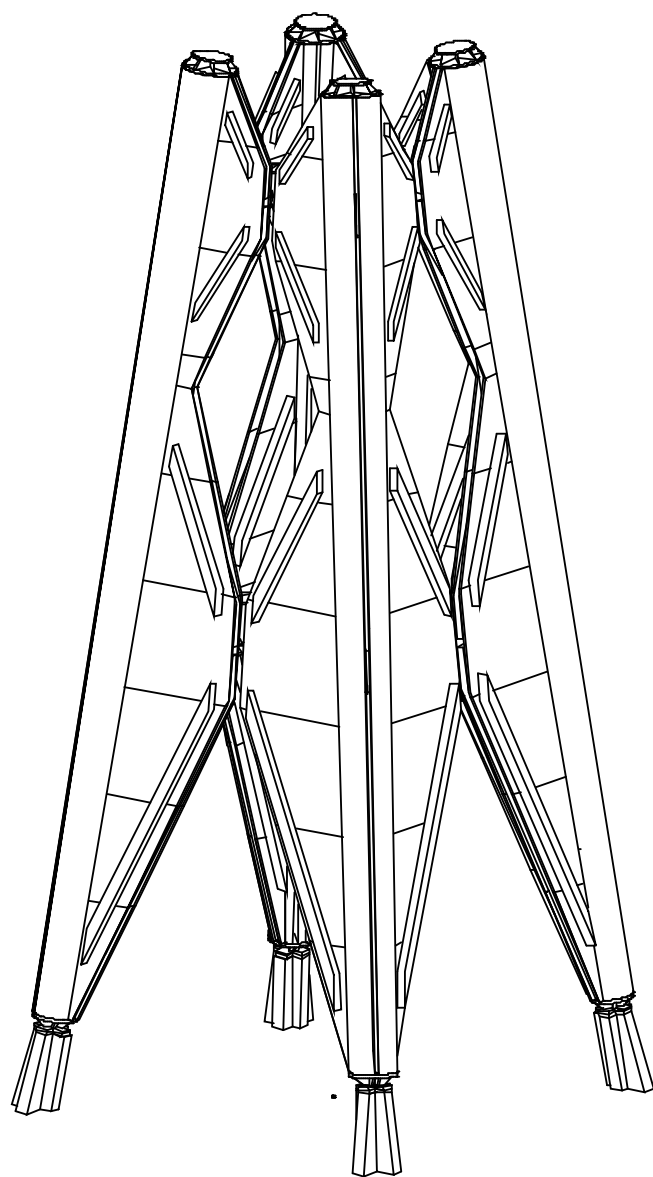




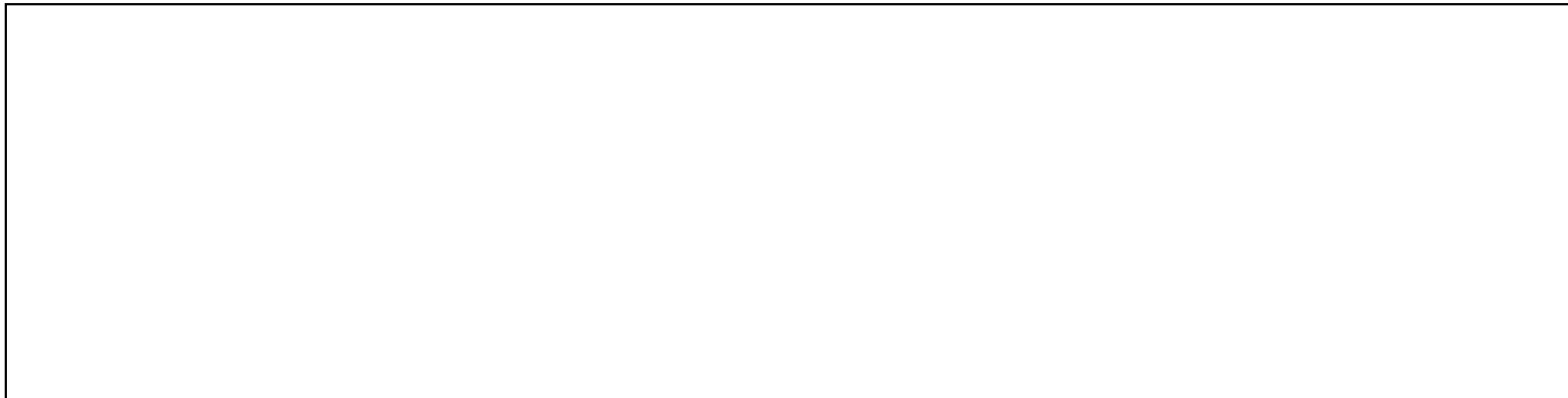


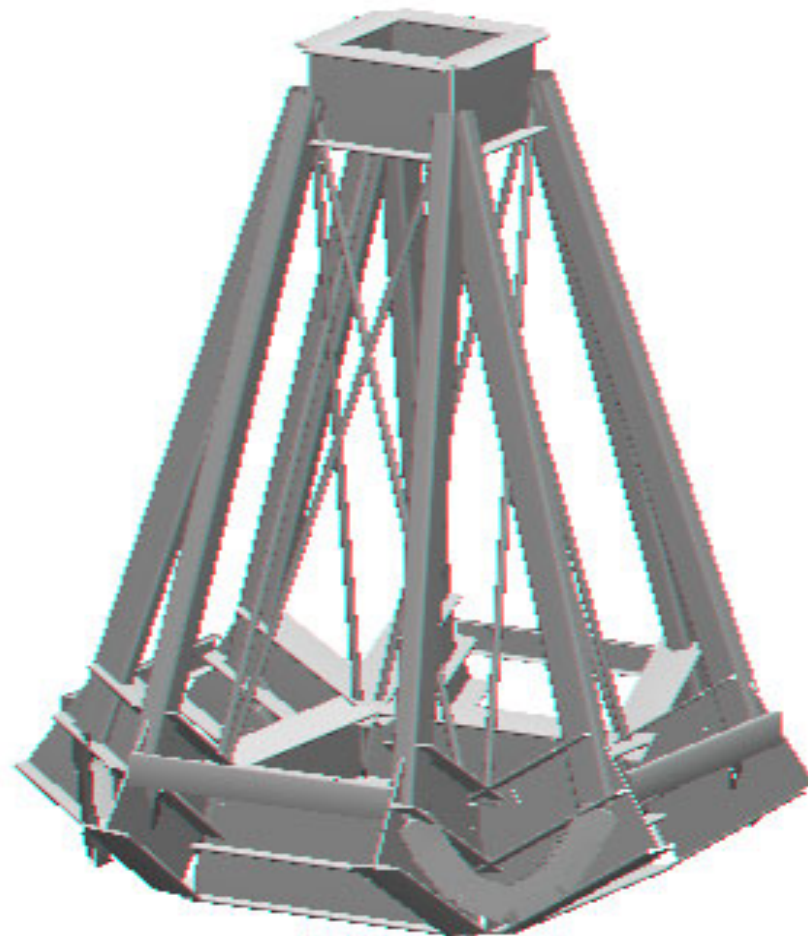
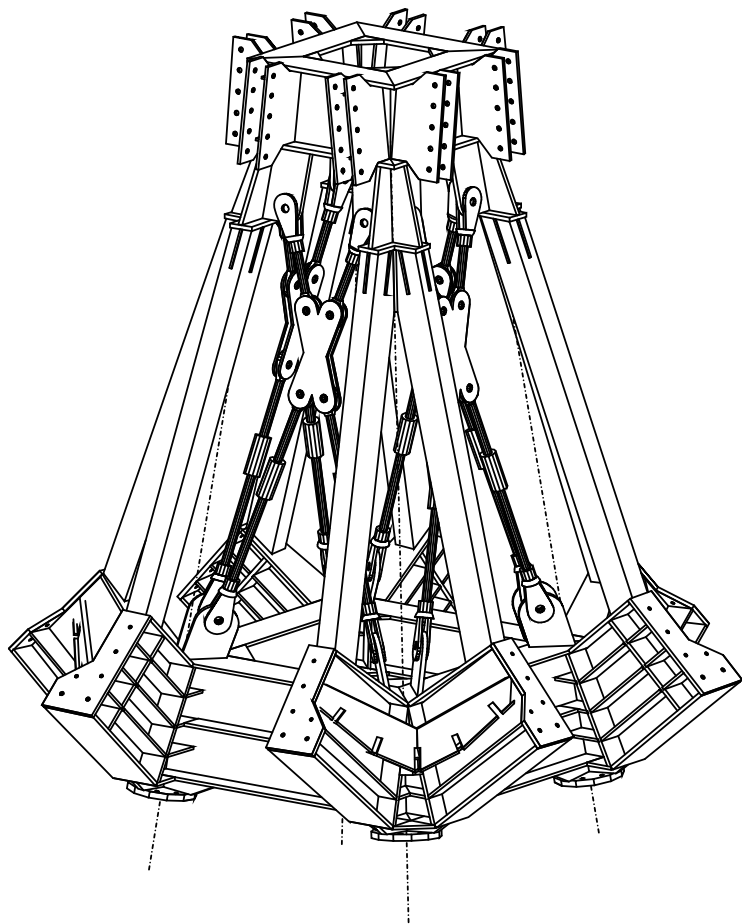


Tower



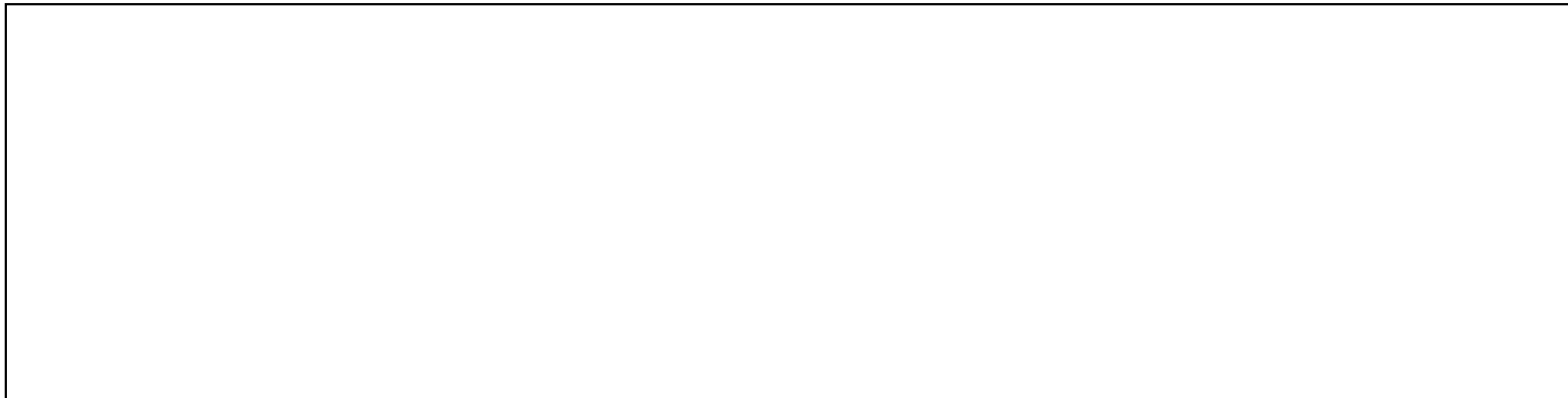
Pyramide







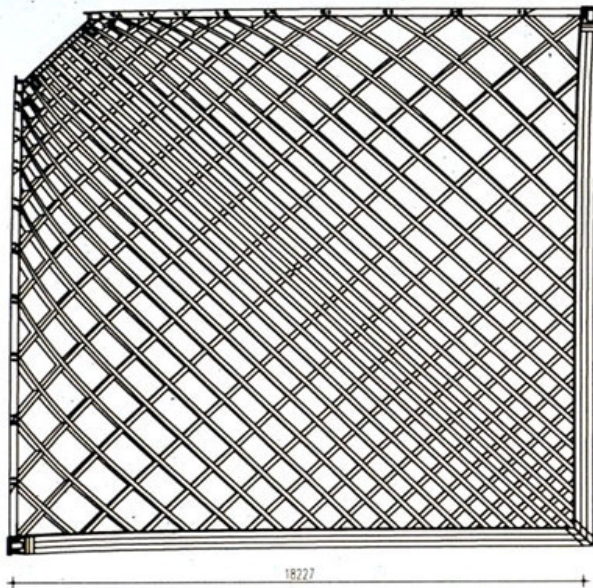
The shell



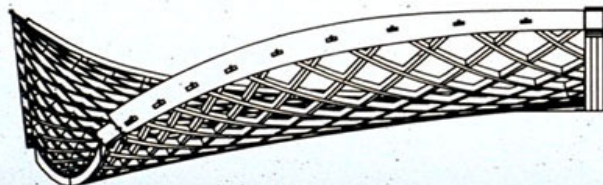


Abmessung der Holzrippenschale M1:100

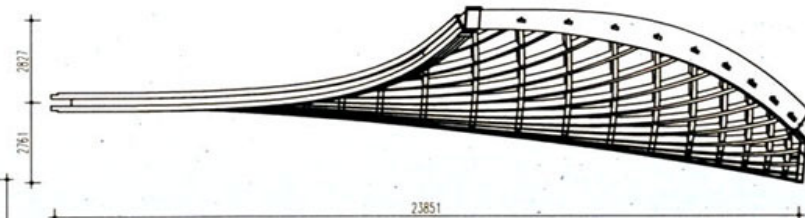
Draufsicht M= 1:100



Ansicht M= 1:100



Ansichten M= 1:100



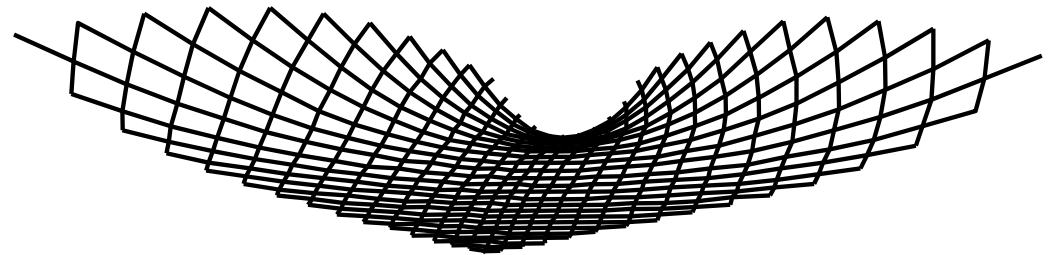
IEZ INTERNATIONALES ENTWICKLUNGSZENTRUM
FÜR HOLZKONSTRUKTIONEN
D-94344 WIESENFELDEN TEL. +49-94 28 72 16 FAX. +49-94 28 73 16

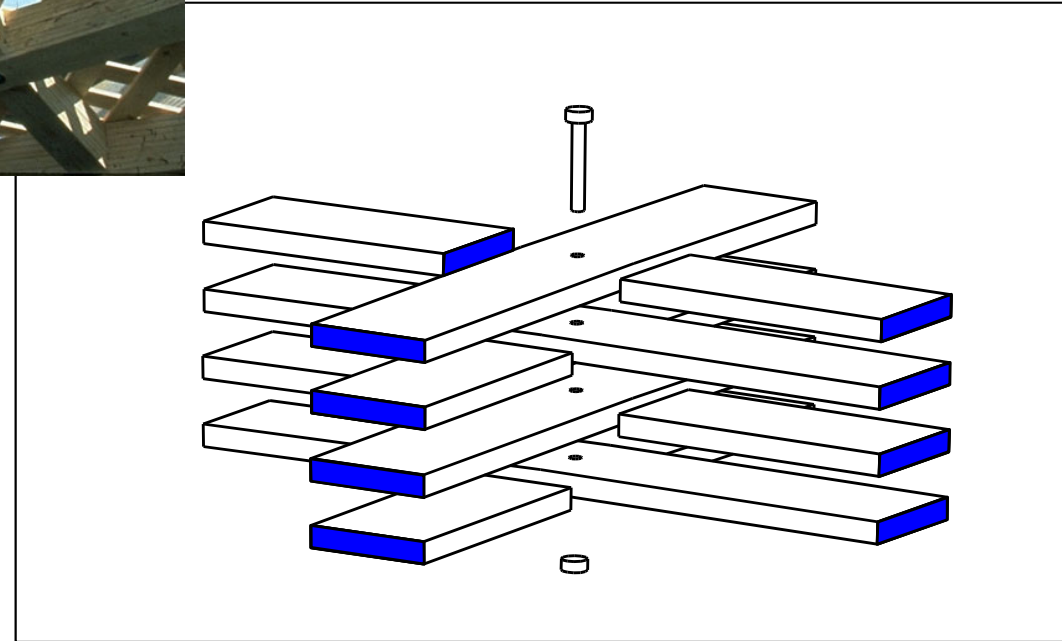
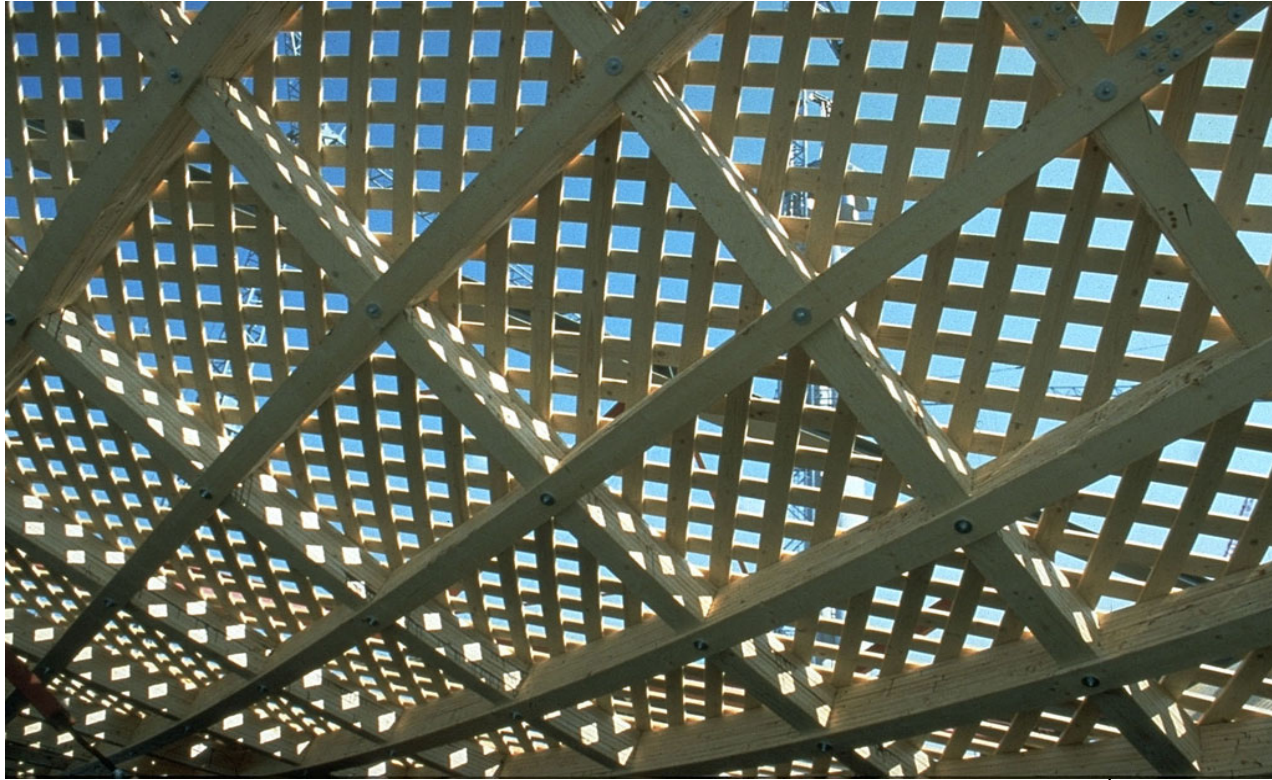
Bauherr: Deutsche Messe AG Hannover
Objekt: Expo-Dach am Hermessee
Planobjekt: Abmessung der Holzrippenschale

Nr. 12

$$\begin{aligned}
 z(x, y) = & \frac{15}{359}(-5\sqrt{2} + 4x)\sqrt{2} - \frac{75}{257762}(-5\sqrt{2} + 4x)^2 + \\
 & + y^2 \frac{\left(-\frac{229}{69} + \frac{109}{50}x - \frac{147}{808}x^2 + \frac{9}{1450}x^3 - \frac{2}{29841}x^4 - \frac{15}{359}(-5\sqrt{2} + 4x)\sqrt{2} + \frac{75}{257762}(-5\sqrt{2} + 4x)^2\right)}{\left(x + \frac{8}{75}\sqrt{2}\left(-\frac{229}{69} + \frac{109}{50}x - \frac{147}{808}x^2 + \frac{9}{1450}x^3 - \frac{2}{29841}x^4\right) - \frac{5}{4}\sqrt{2}\right)^2}
 \end{aligned}$$

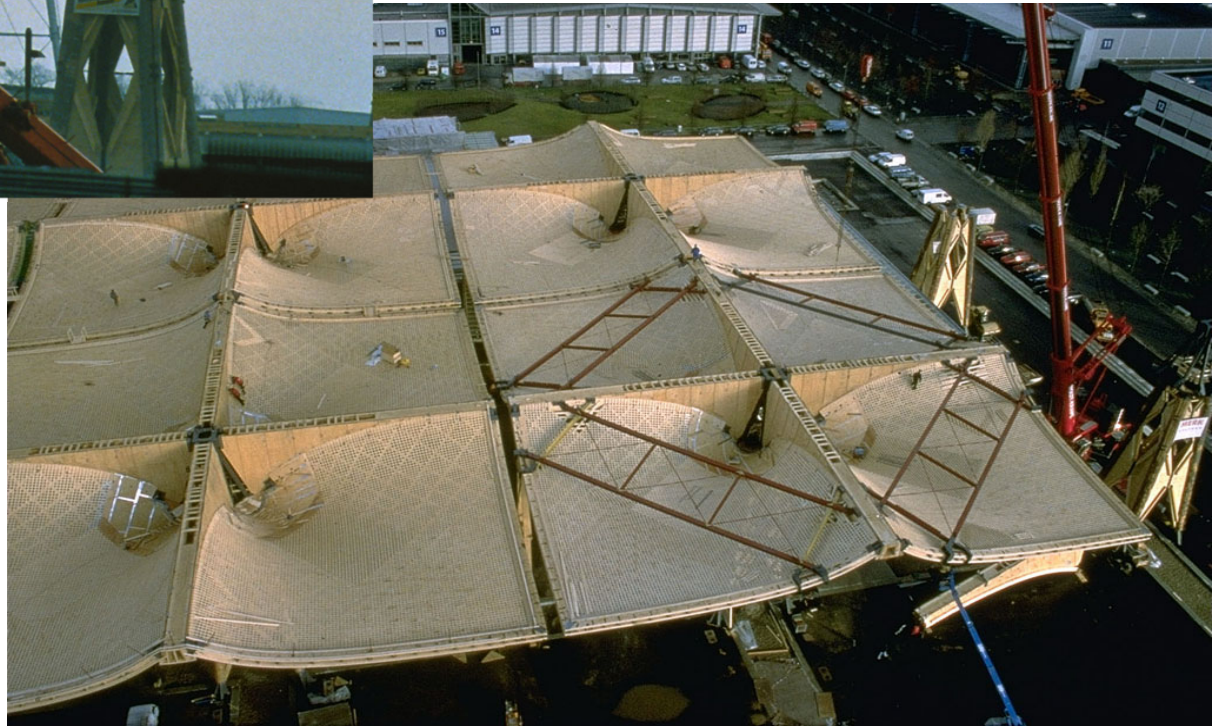
Koordinaten in m
x: in Richtung der Hauptdiagonale
y: in Richtung der Nebendiagonale
z: Höhenkoordinate



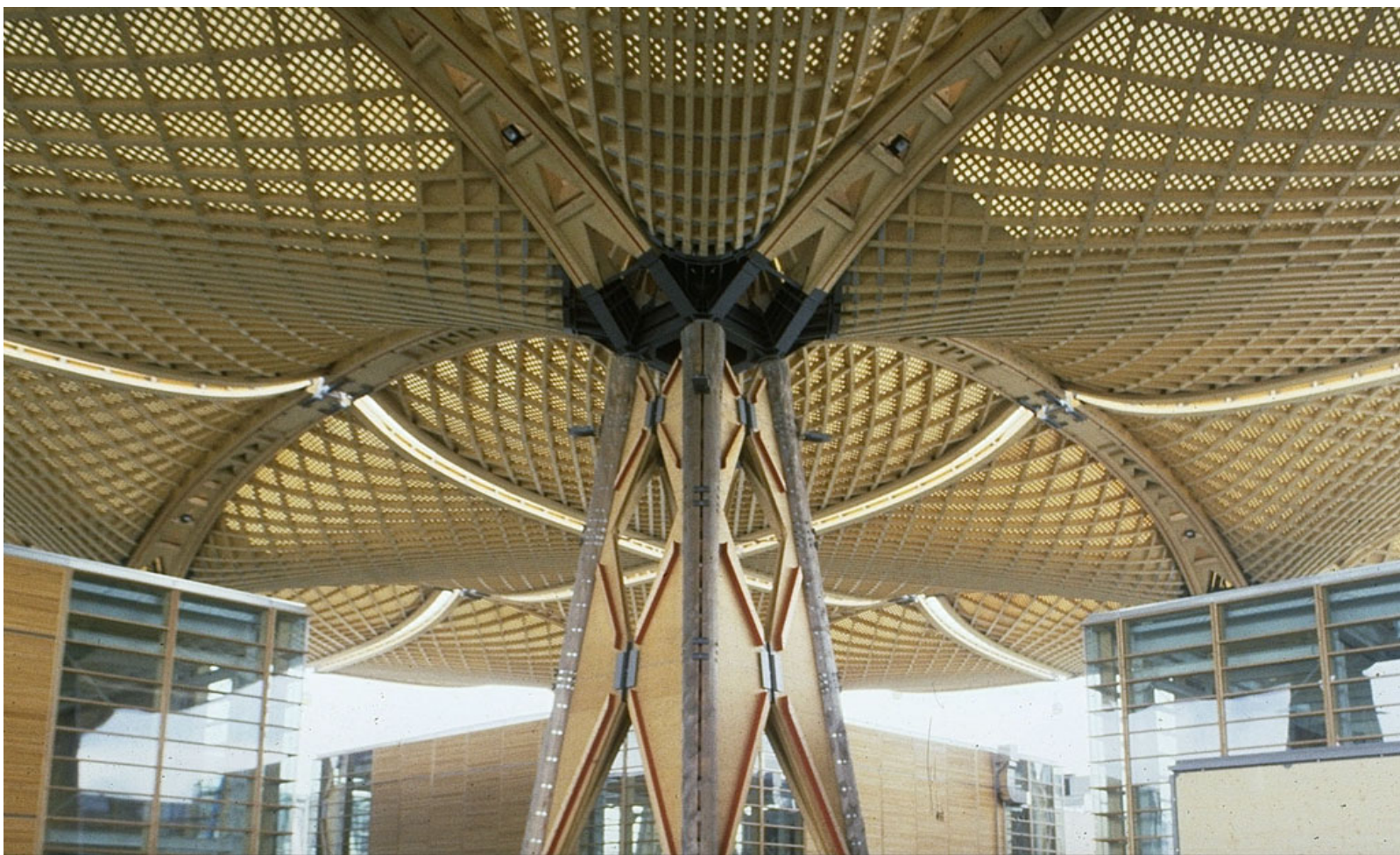


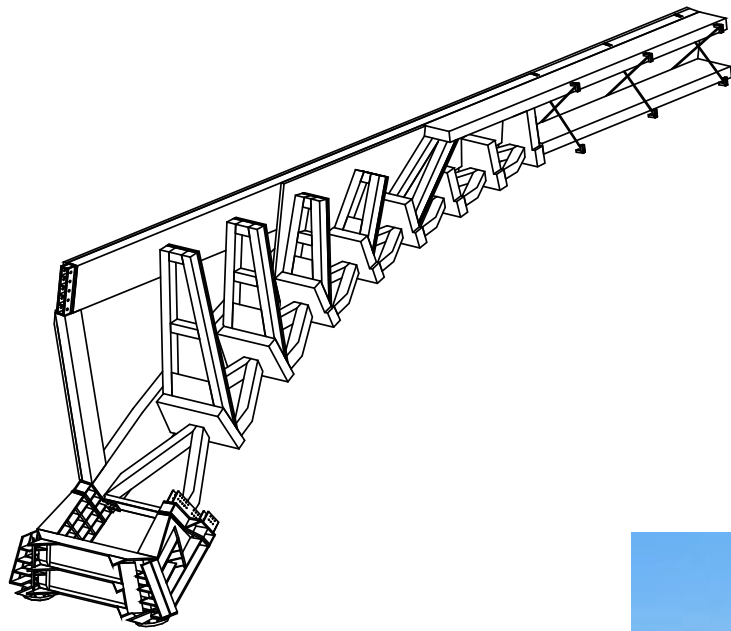


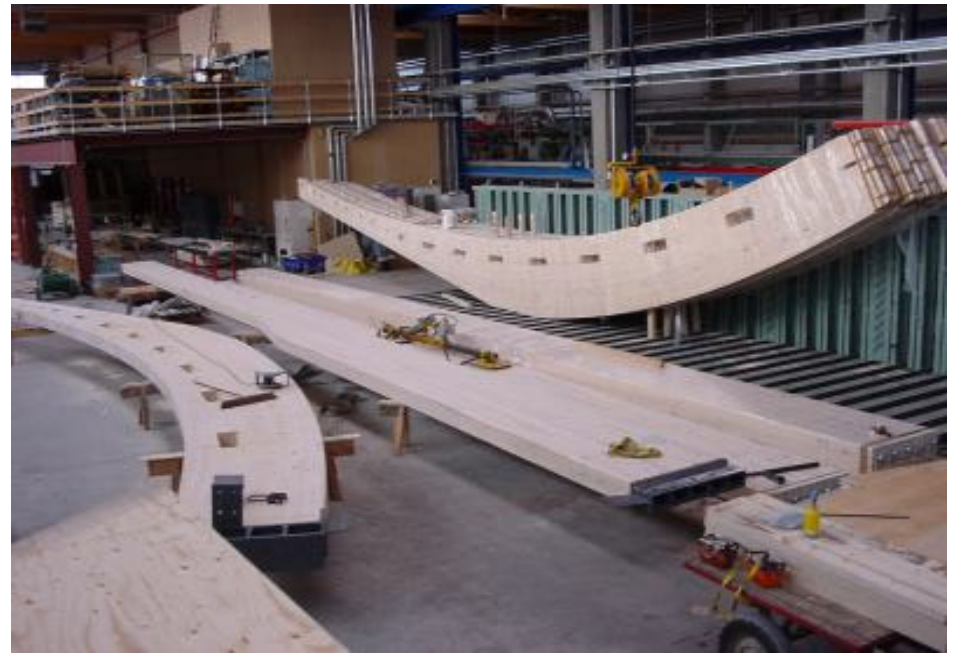




The cantlivers

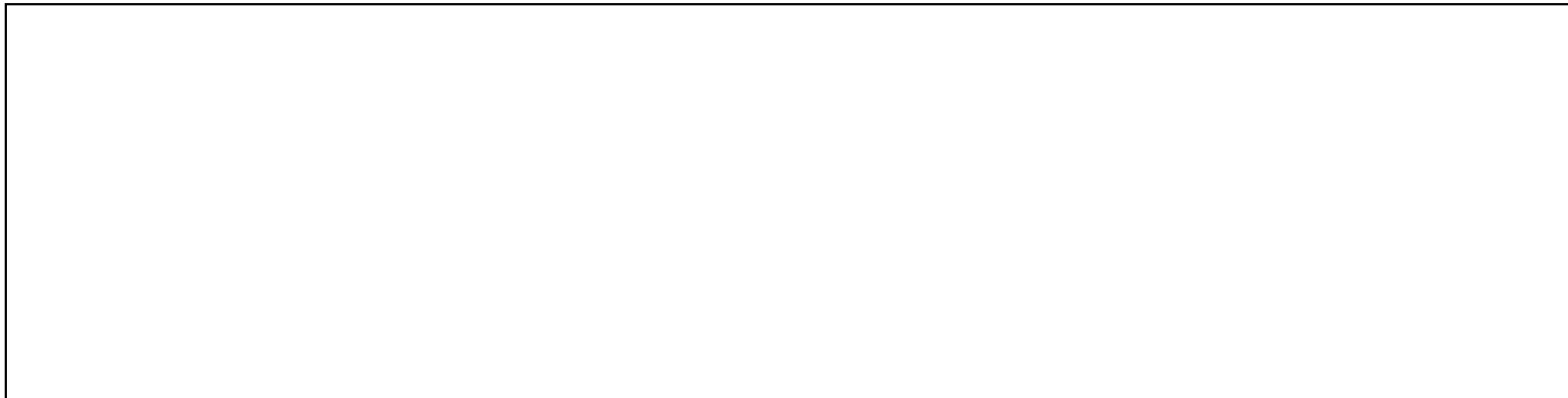


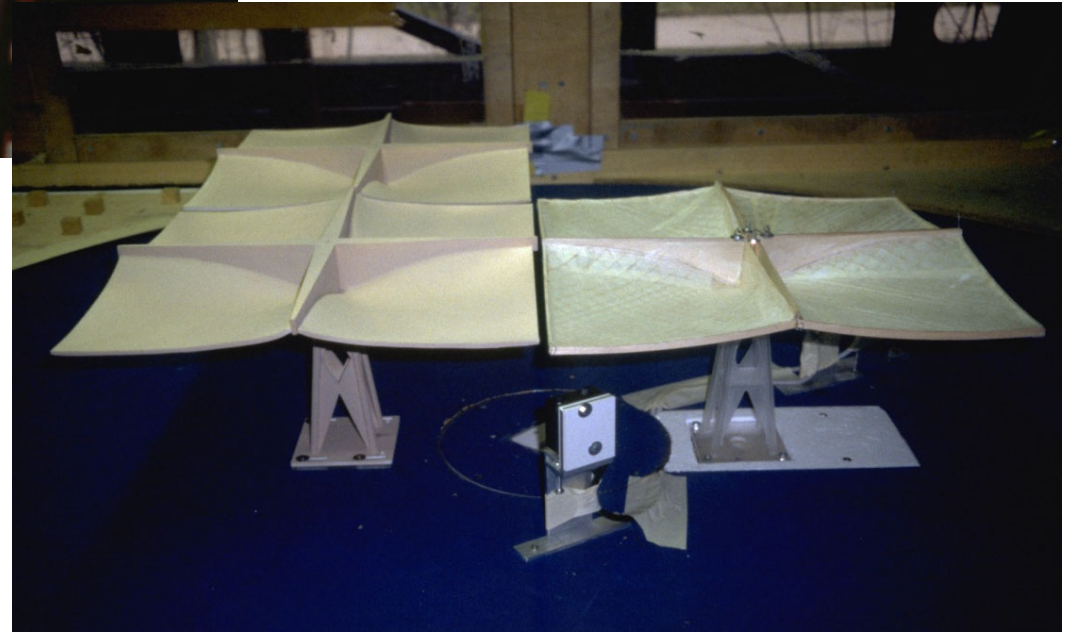
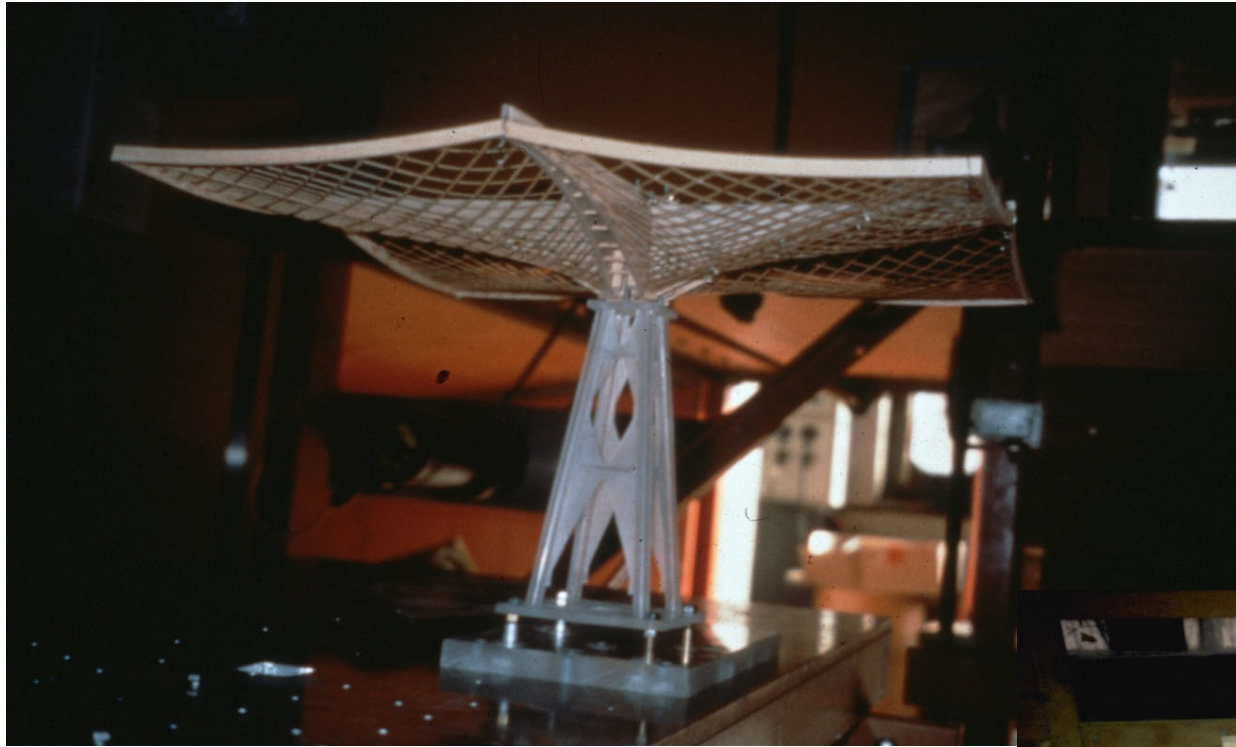






Statik...





Eigenlast

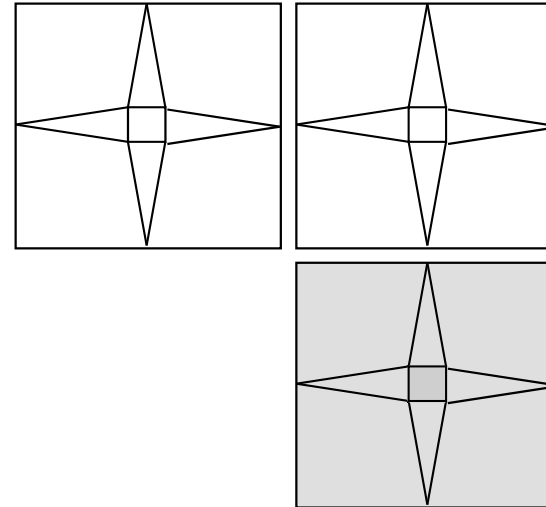
voll
Von der Seite
über Eck

Schnee

voll
von der Seite
über Eck
abgerutscht

Wind

Einzel Schirm von der Seite
Einzel Schirm über Eck
3er Gruppe 0°
3er Gruppe -45°
3er Gruppe 135°
3er Gruppe mit Gebäude 0°
3er Gruppe mit Gebäude -45°
3er Gruppe mit Gebäude 135°
4er Gruppe 0°
4er Gruppe 45°



Über Eck
 -135°

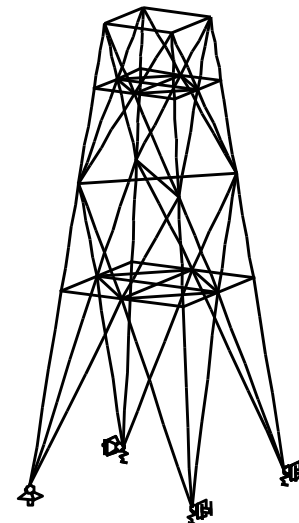
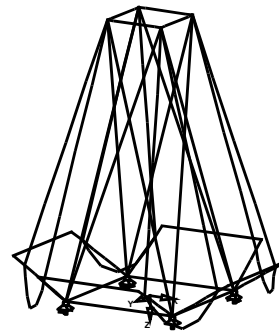
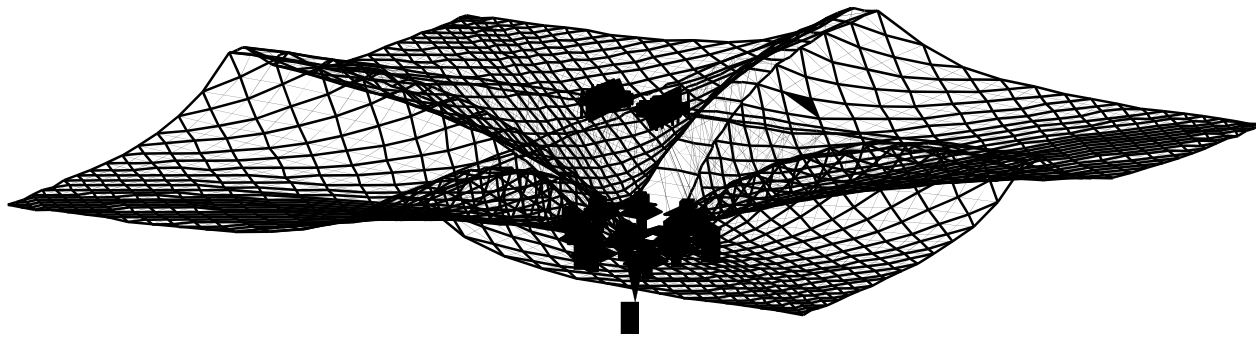


Von der Seite
 0°

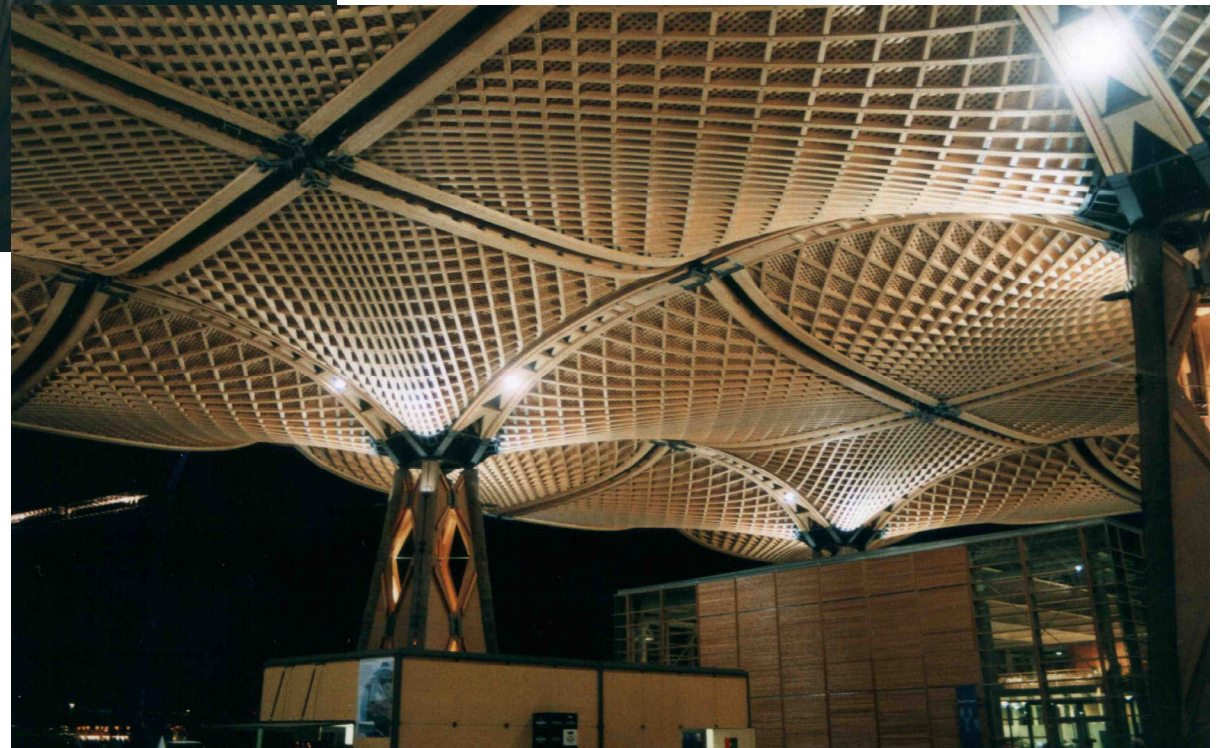
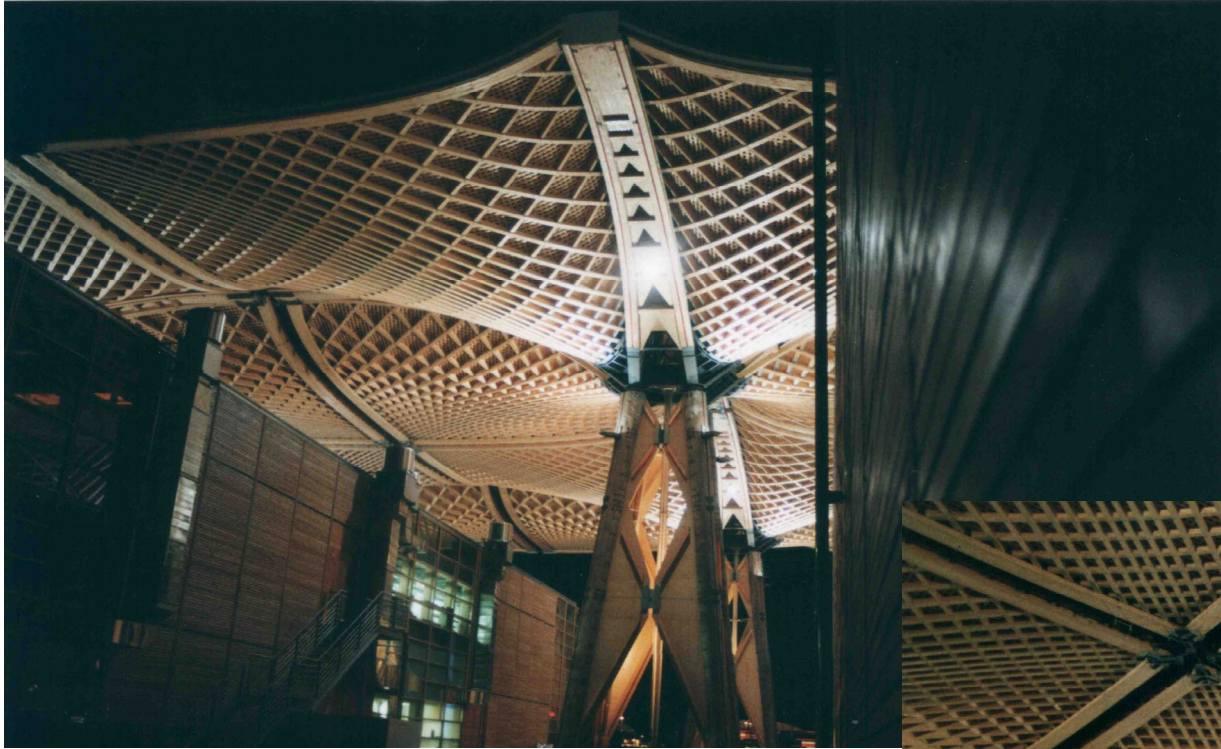


Über Eck
 -45°





Merk-Holzbau GmbH & Co	86551 Aichach	Panter Holzbau	97947 Grünsfeld
Holzbau Amann GmbH	79809 Weilheim/Bannholz	Remmer Holzwerkstätten GmbH	30163 Hannover
BVD-Verbindungs- mittel Vertrieb GmbH	63897 Miltenberg	Wiedmann Ingenieur-Holzleimbau	79618 Rheinfelden
Ingo u. Lutz Langheim Holzbau GmbH	37541 Kreiensen	WTH GmbH	49377 Langförden
Willi Alms Holzbau GmbH	29303 Bergen	Huber u. Sohn GmbH & Co KG	83549 Eiselfing-Bachmehring
Altenloh, Brinck & Co	68240 Ennepetal	Jacob HMR, Metallwaren	94487 Osterhofen
Barl Maschinenbau GmbH	86672 Thierhaupten	Horst Kettler Zimmerei	37586 Dassel
Zimmerei Heinrich Becher	31552 Apelern	Klöpperholz GmbH	85283 Wolnzach
Betzmeir Transport GmbH	86568 Hollenbach	Kühnlenz Holzbau	07318 Kleingeschwenda
Brockhaus Alfred	49413 Dinklage	H. Wilhelm Lege Zimmermeister	31249 Bierbergen
Bullinger Holzwerke GmbH & Co KG	16818 Werder	Ulrich Lübbert	24558 Henstedt-Rhen
Christian Burgbacher GmbH & Co	78647 Trossingen	Zimmerei Maderthoner	25578 Dägeling
Zimmerei Chemokon	50389 Wesseling	Hans-H. Matthias	27446 Selsingen
Chors Alfred, Zimmerei	28816 Stuhr-Fahrenhorst	Gerhard Panning	29640 Schneverdingen
Cordes Holzbau GmbH & Co KG	27356 Rotenburg	Zimmerei & Holzbau Jörg Pfeiffer	07356 Burglemnitz
W. & J. Derix GmbH & Co	41372 Niederkrüchten	Zimmerei H. Röhrs Holzbau	29303 Bergen
Norbert Enneking Montagebau	10965 Berlin	Herman-Josef Rottinghaus	49451 Holdorf
Finnforest	SF-8101 Lohja (Finnland)	Egon Rottinghaus GmbH	49393 Lohne
Horst Fricke GmbH	27374 Visselhövede-Wittorf	Sauer W. Zimmerei & Holzbau	37351 Dingelstädt
Albert Gennerich/Manfred Geisler GmbH	37079 Göttingen	Holzbau Schaper GmbH	38110 Braunschweig
Glinka-Holzbau	28844 Weyhe-Kirchweyhe	Holzbau M. Schäuble	79862 Höchenschwand
Michael Groß	79774 Albbruck-Unteralpfen	Schmitz Holzbau	88690 Uhldingen
Held Schlosserei GmbH & Co	78166 Donaueschingen	Schnieder-Bau GmbH	49152 Bad Essen
Holzbau Montage GmbH	79682 Todtmoos	Themann Holzbau GmbH	49451 Holdorf
Hordermann Holzbau	07366 Lichtenbrunn	Volk GmbH	72818 Trochtelfingen
BKSP Projektpartner GmbH	30173 Hannover	Landesforstverwaltung Baden-Württemberg	70182 Stuttgart
cadwork Informatik GmbH	31134 Hildesheim	Skyspan Europe GmbH	83253 Rimsting/Chiemsee
Caparol GmbH & Co Vertriebs KG	64369 Ober-Ramstadt	VDMA-Fachverband Holzbearbeitungsmaschinen	60528 Frankfurt/Main









Elefanten Haus - Zurich

Angaben zum Objekt

Bauherrschaft:

Zoo Zürich AG, Zürich

Gemeinschaftsprojekt:

Markus Schietsch

Architekten GmbH, Zürich

Lorenz Eugster Landschafts-
architektur und

Städtebau GmbH, Zürich

Tragwerksplanung (Beton, Holz)
und Fassade, Bauleitung
gesamte Hülle:

Walt+Galmarini AG, Zürich

Gesamtleitung:

BGS & Partner Architekten AG,
Rapperswil

Holzbau (in ARGE):

Implenia Bau AG, Zürich

Brunner Erben AG, Zürich

(heute Strabag AG, Zürich)



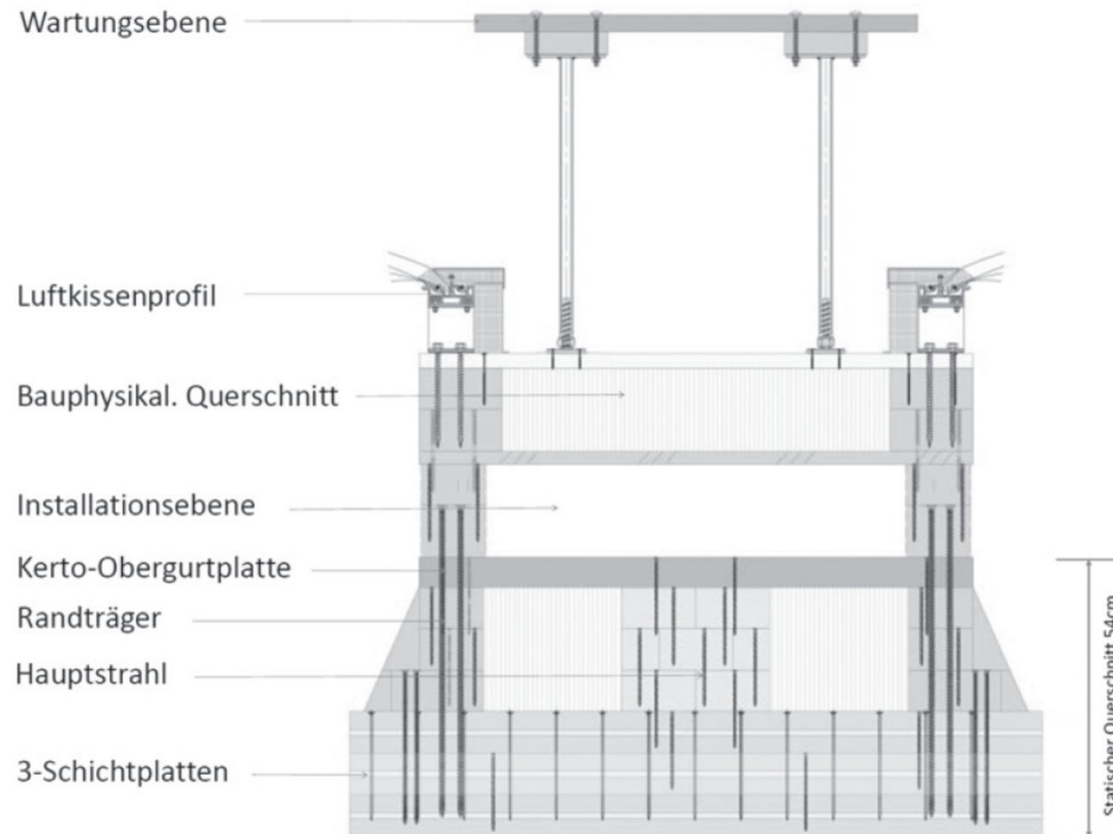


Abbildung 8 Regelquerschnitt

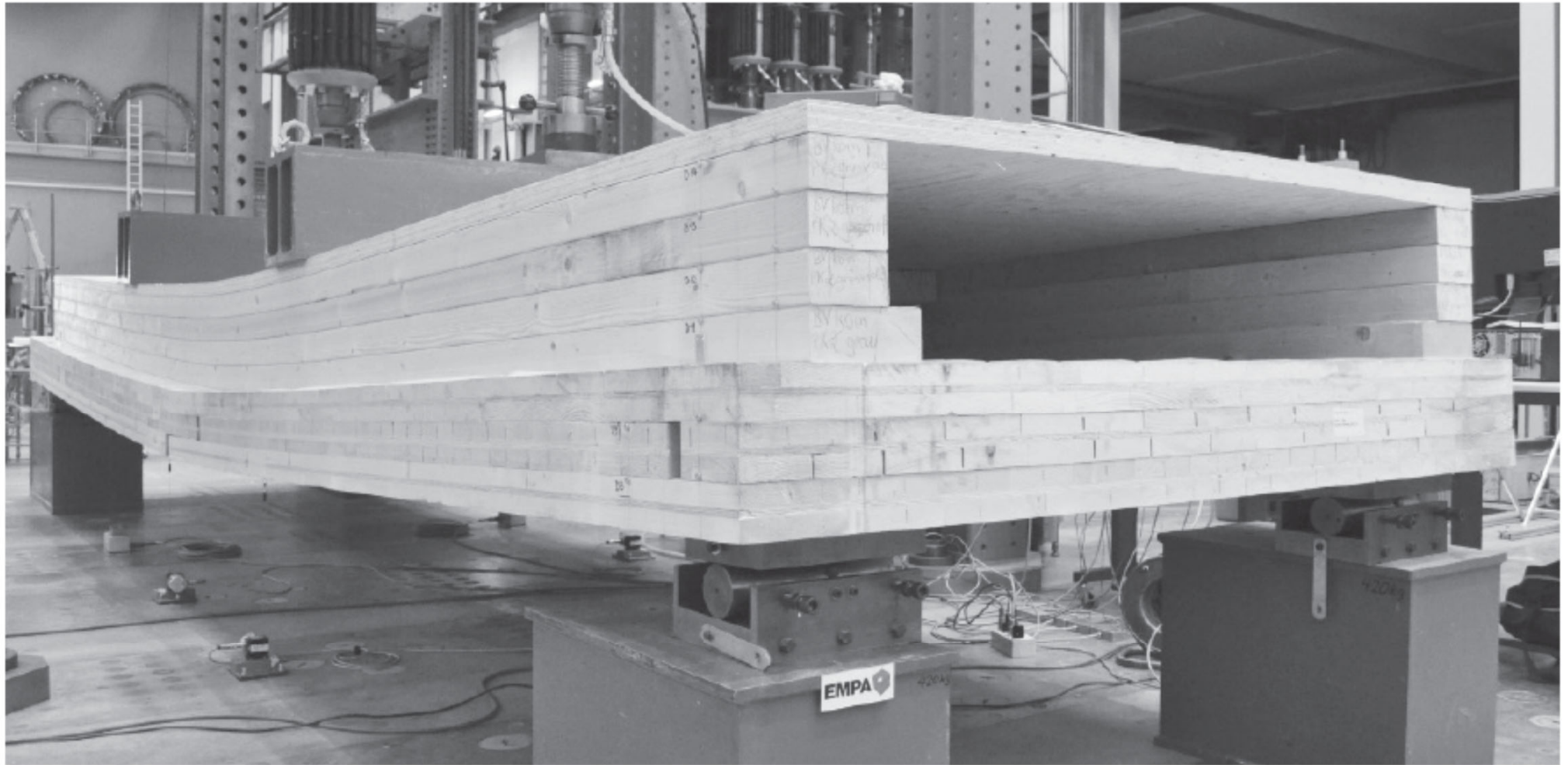
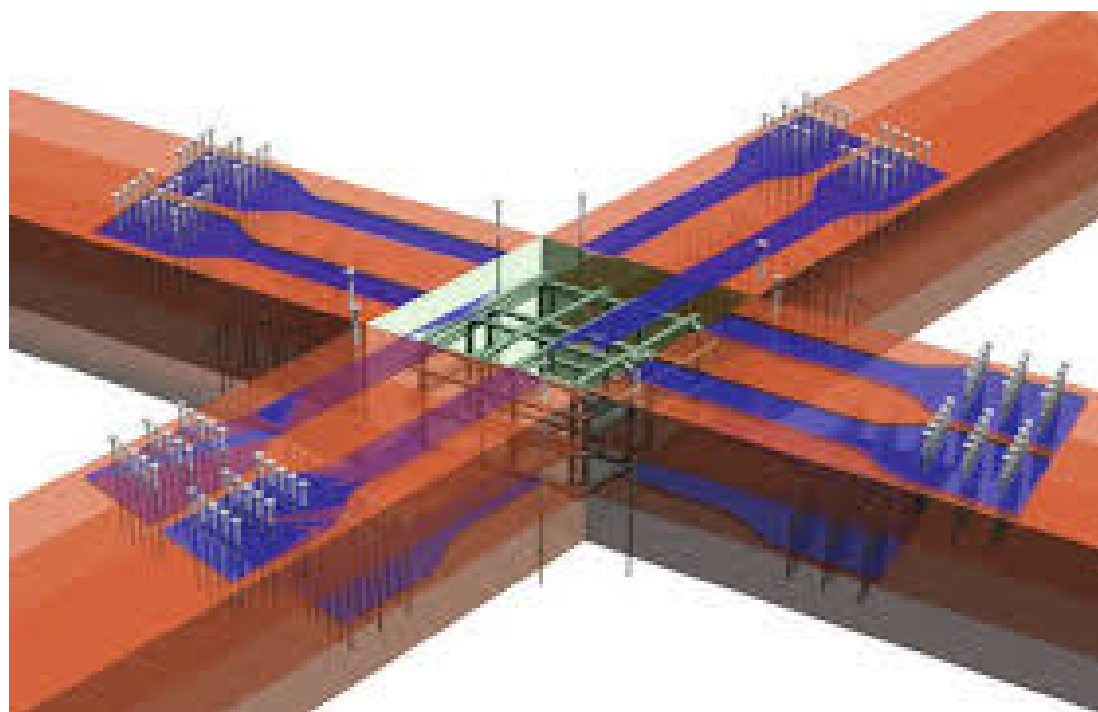


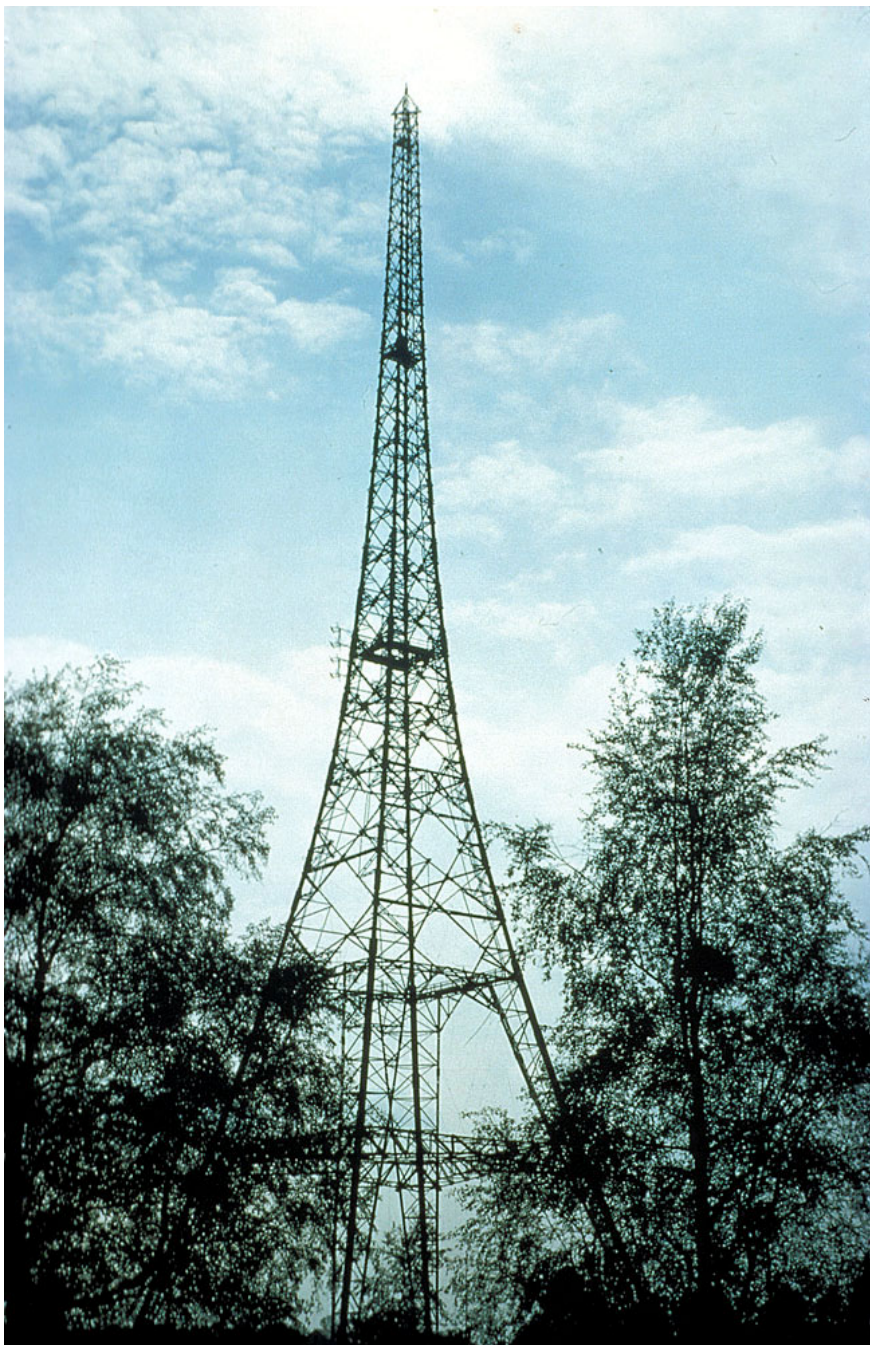
Abbildung 9 Vier-Punkt-Biegeversuch eines repräsentativen Aufbaus





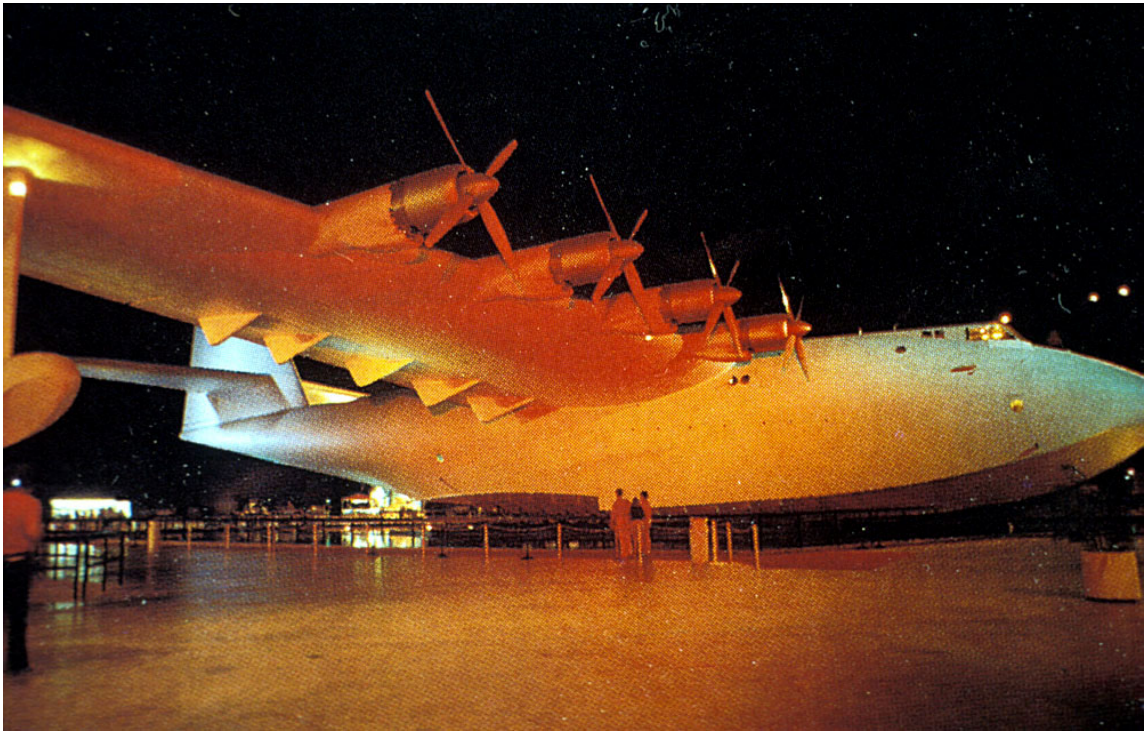












**Nicht weil die Dinge schwierig sind, trauen wir uns nicht,
sondern weil wir uns nicht trauen, sind die sie schwierig**

**Ce n'est pas parce que les choses sont difficiles
que nous n'osons pas, c'est parce que nous n'osons pas
qu'elles sont difficiles**

**It is not because the things is difficult that we do not dare,
it is because we do note dare that they are difficult**

Senèque