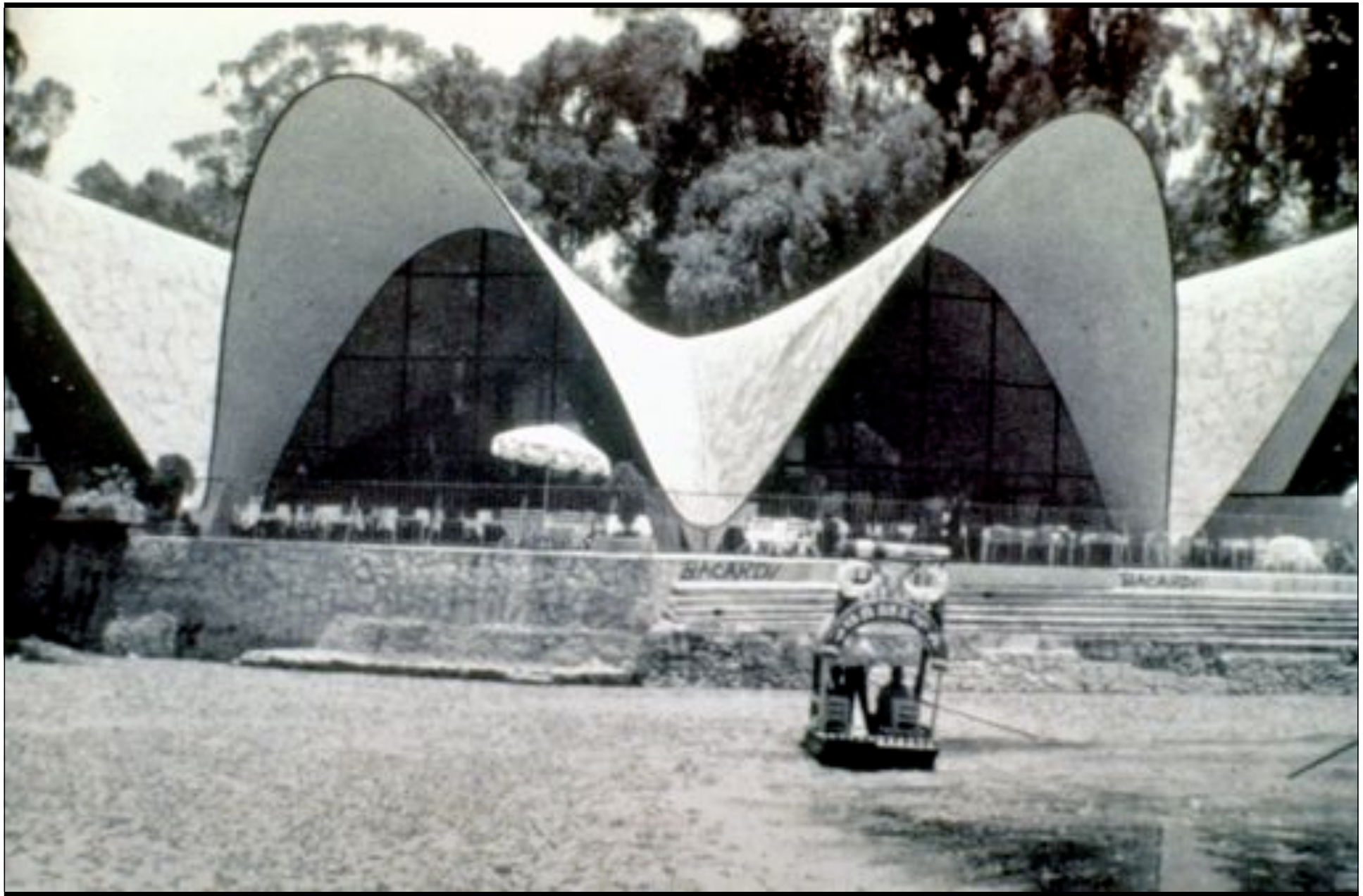
Roof Vaults and National Styles

Early 20th Century

The German approach: analysis and geometry
The Italian approach: ribs, coffers, and buttresses
The "Spanish" approach: double curvature and thinness
Concrete shells and stiffness
Economy of labor vs. efficiency of materials
Complexity of analysis vs. complexity of form


BACARDI
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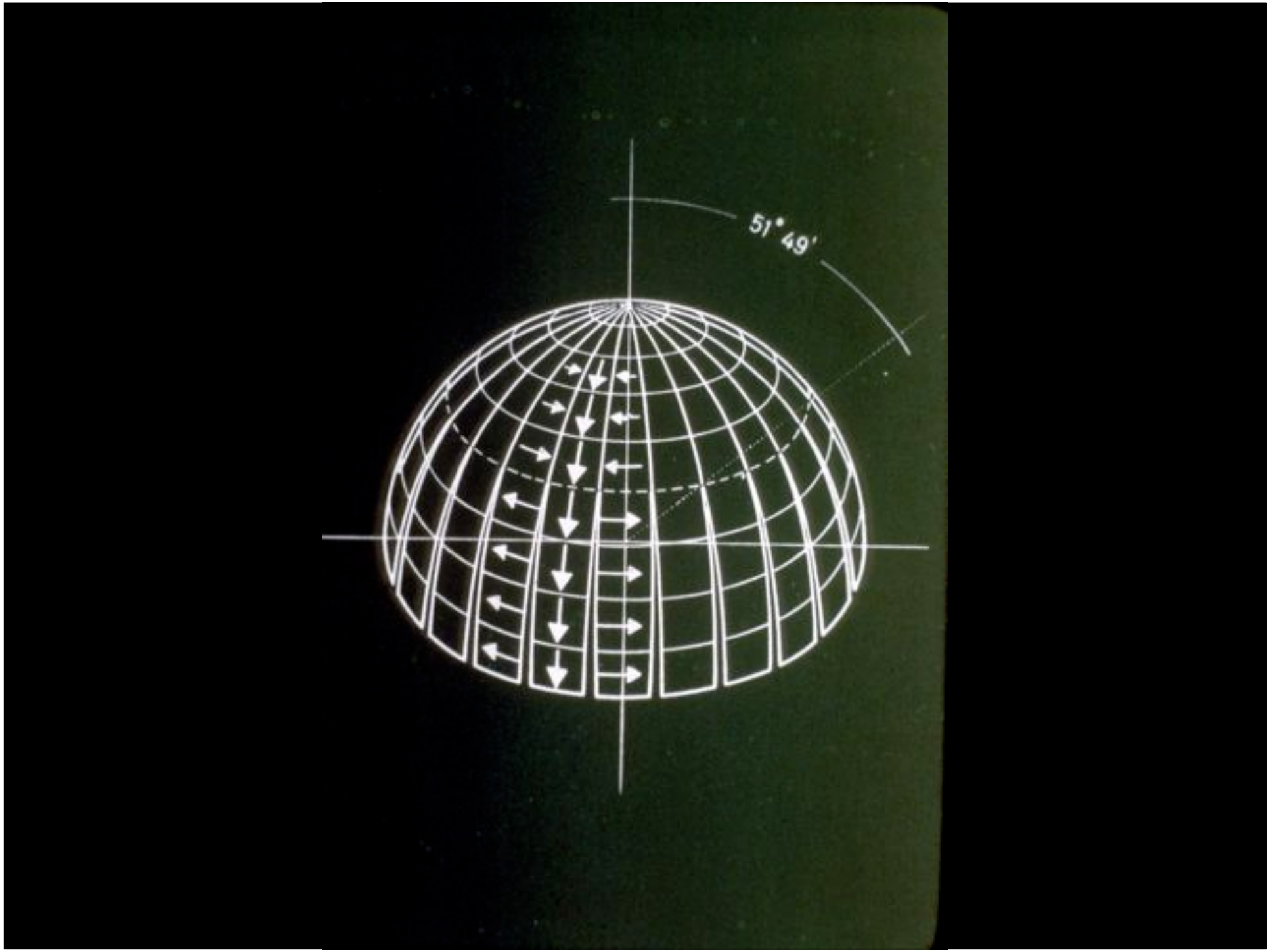
German Tradition

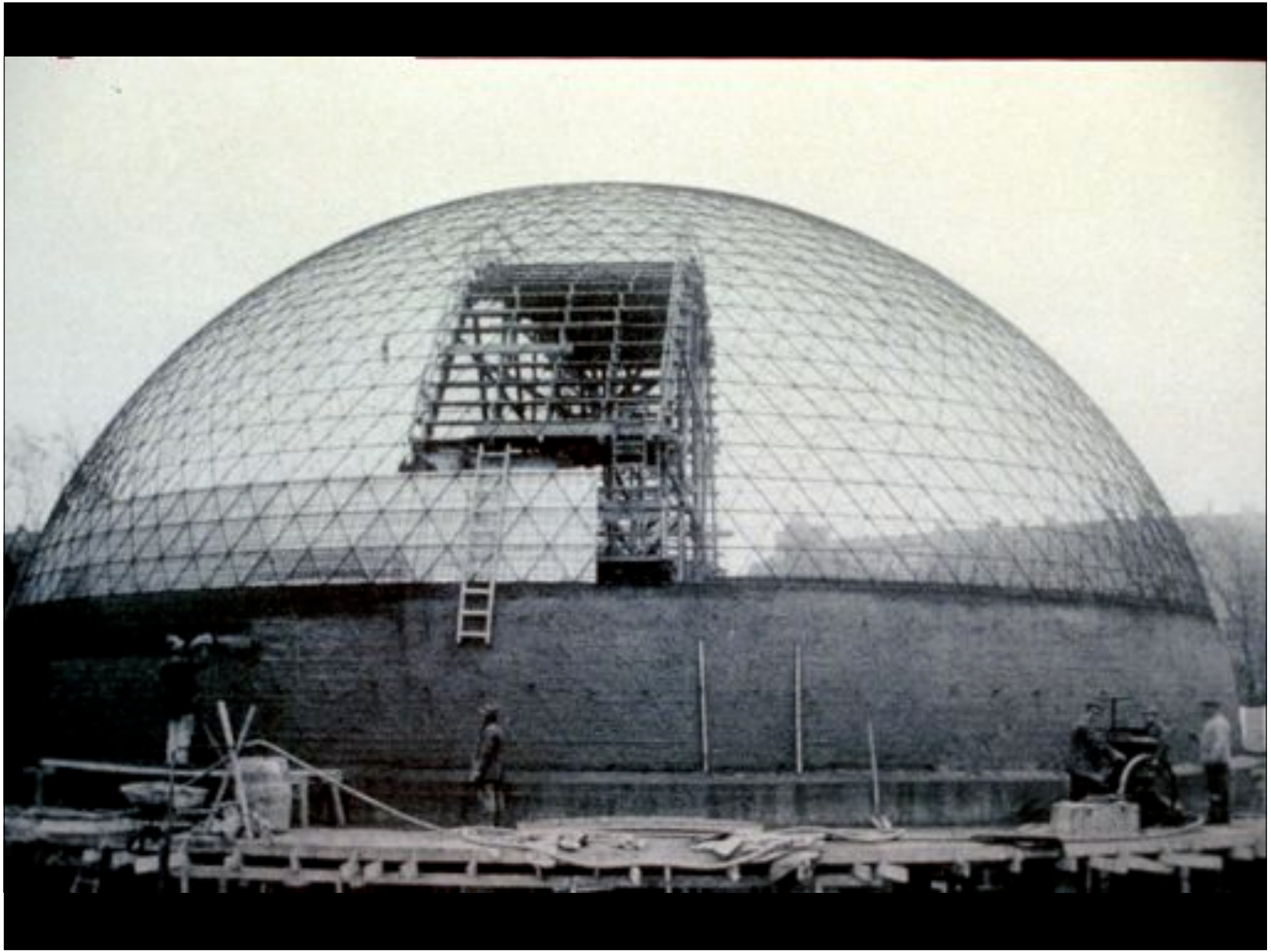
Firm of Dycherhoff and Widmann

F. Dischinger (1887-1953)

U. Finsterwalder (1897-1988)

A. Tedesko (1903-1994)


51° 49'



Longest Spanning Domes in the World

Date	Place	Span (m)	Rise (m)	Weight (metric ton)
1590	Rome	42	21	10,000
1913	~~Breslau~~ Wroclaw Poland	67	16	6,340
1929	Leipzig	76	17.5	**2,160**

Centennial Hall Wroclaw Poland

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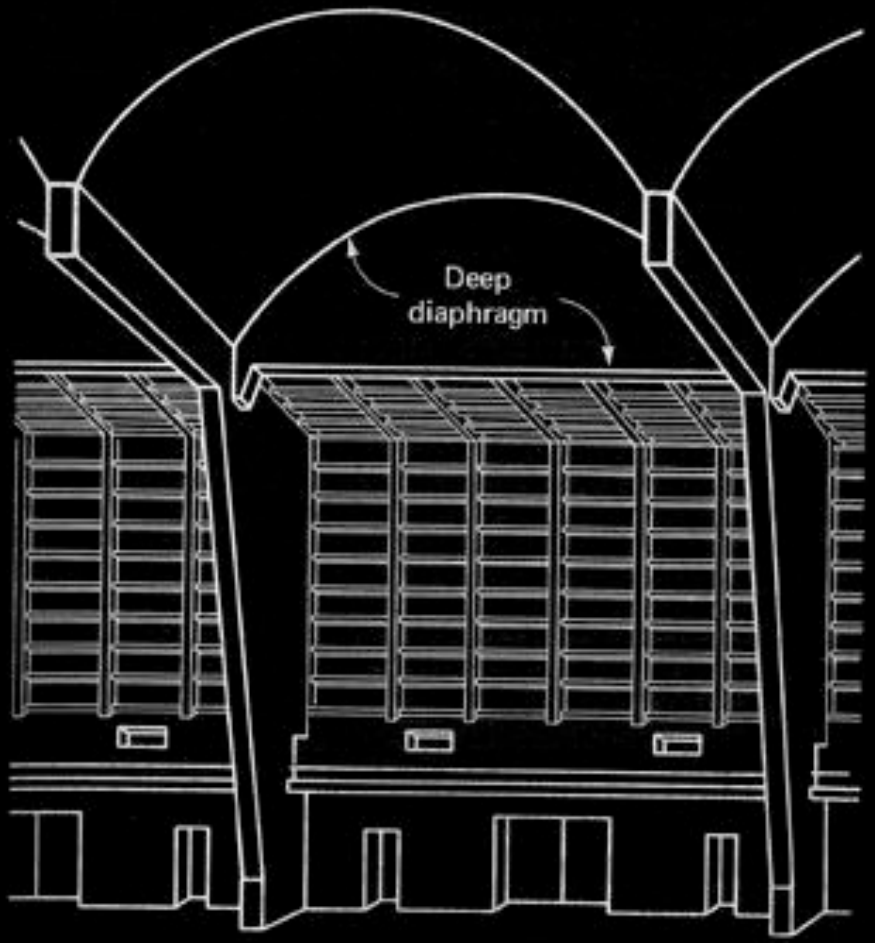

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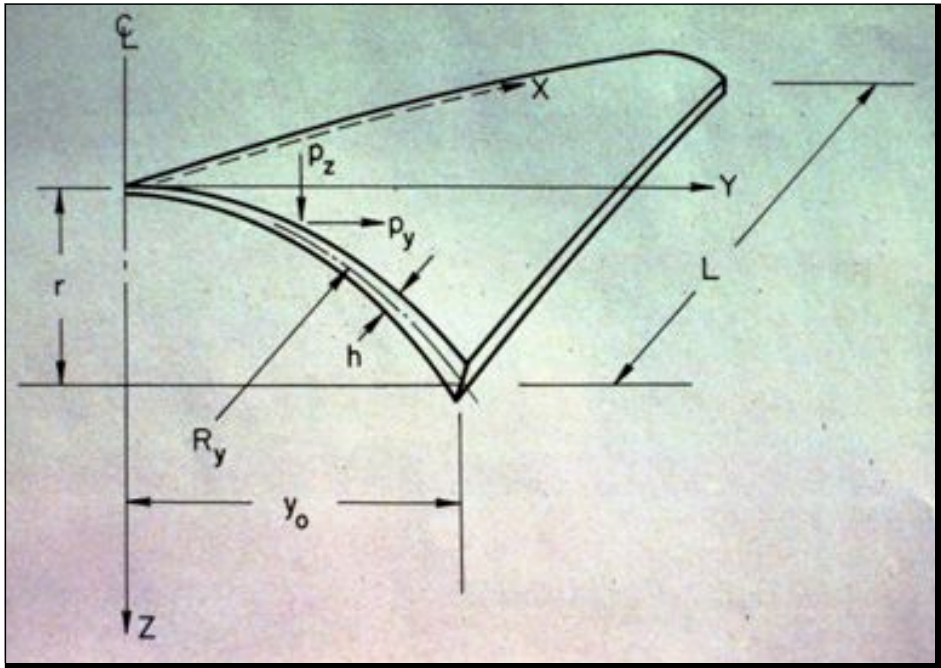
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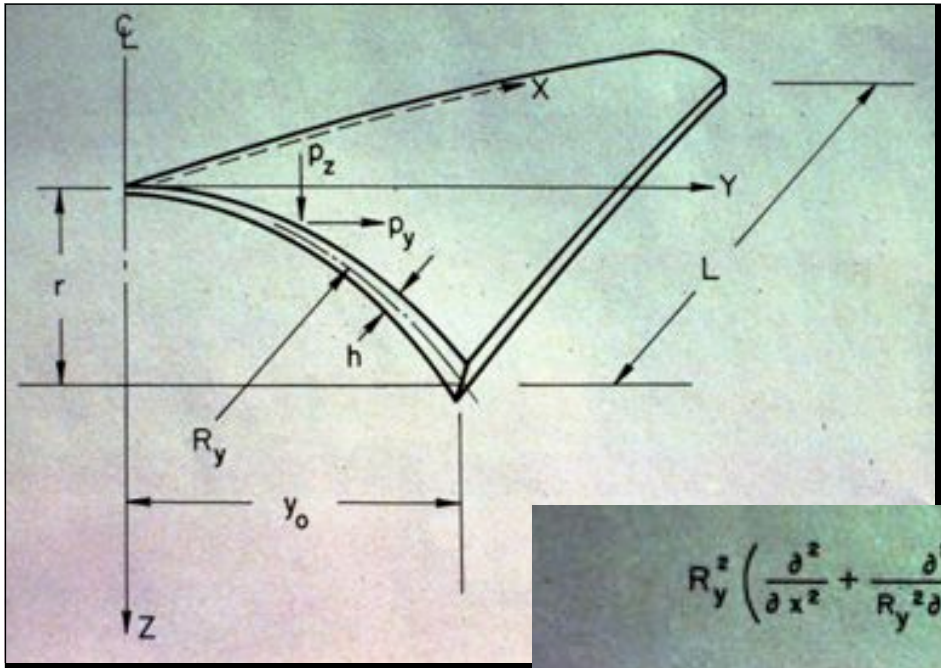


$$R_y^2\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{R_y^2\partial\phi^2}\right)^4 w+\frac{12}{h^2}\frac{\partial^4 w}{\partial x^4}=f(p_x,p_\phi,p_z)$$

$$\frac{du}{dy}=-a_y\frac{\pi}{L}v+a_y\frac{2}{Eh}N_{xy}$$

$$\frac{dv}{dy}=a_y\frac{W}{R_y}+a_y\frac{N_y}{Eh}$$

$$\frac{dw}{dy}=a_y\theta$$

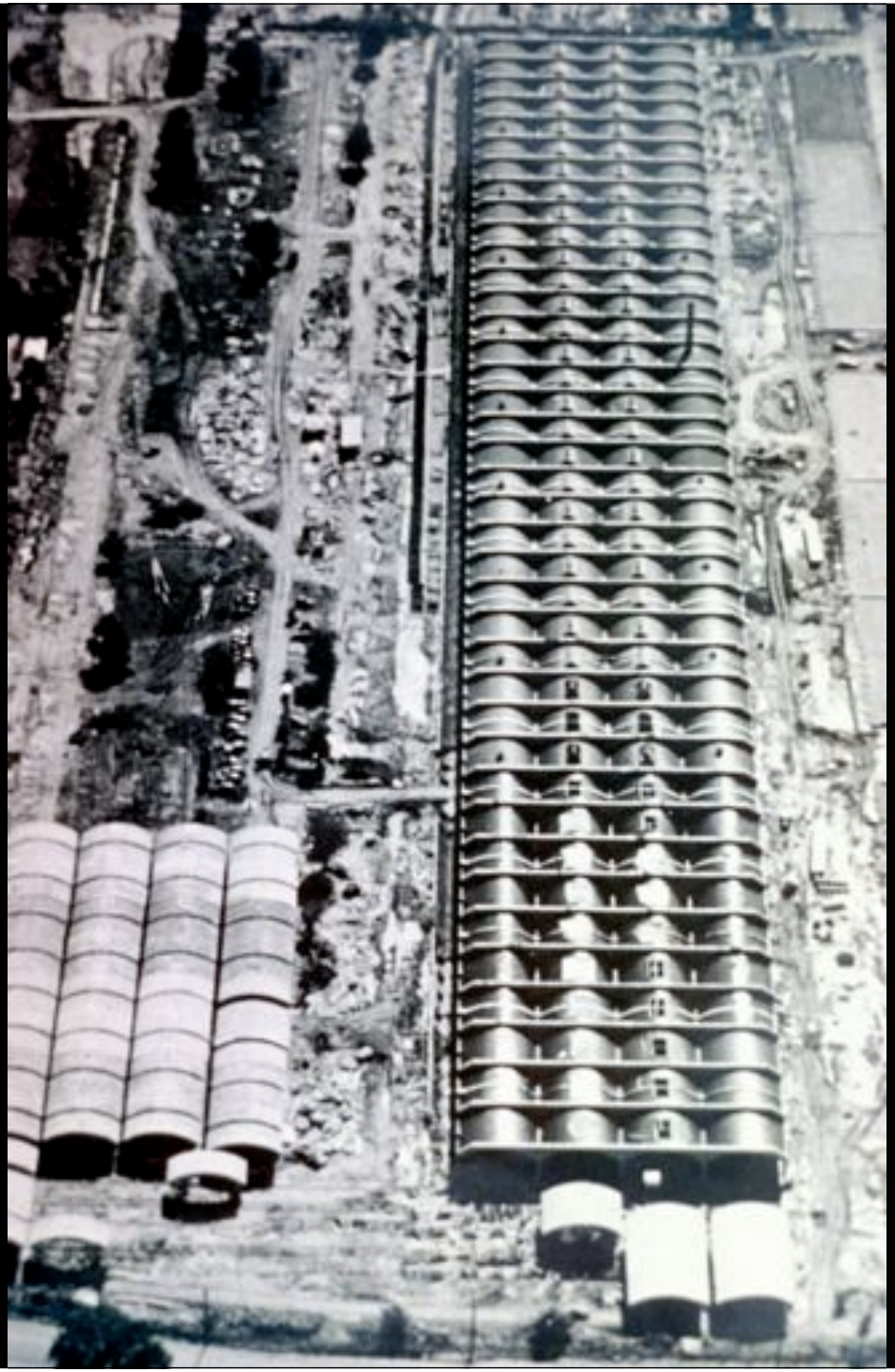
$$\frac{d\theta}{dy}=-a_y\frac{12}{Eh^3}M_y$$

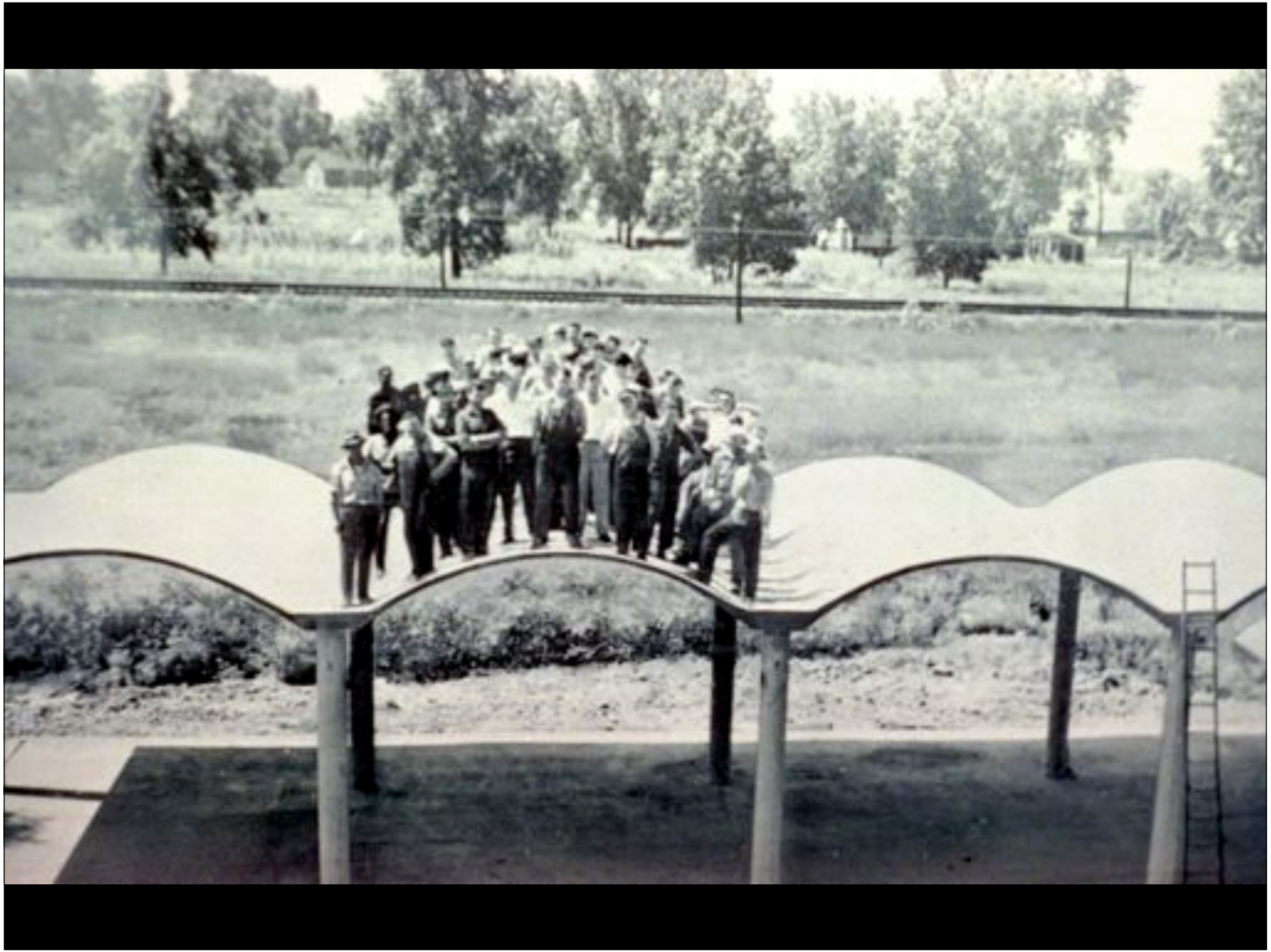
$$\frac{dM_y}{dy}=-a_y\frac{\pi^2}{L^2}\frac{Eh^3}{6}\theta+a_yS_y$$

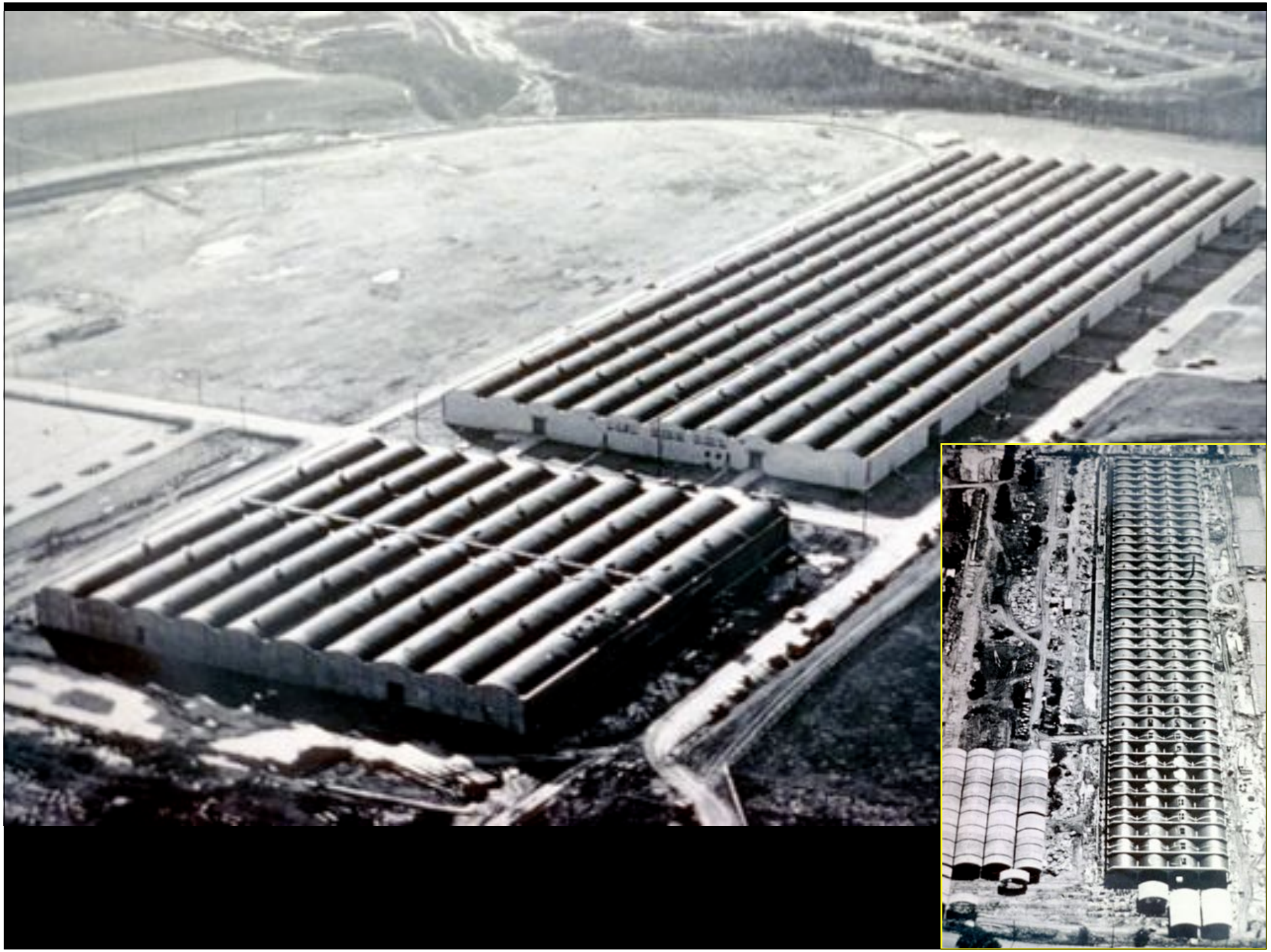
$$\frac{dN_y}{dy}=a_y\frac{\pi}{L}N_{xy}+a_yp_y$$

$$\frac{dN_{xy}}{dy}=a_y\frac{\pi^2}{L^2}Eh\,u+a_yp_x$$

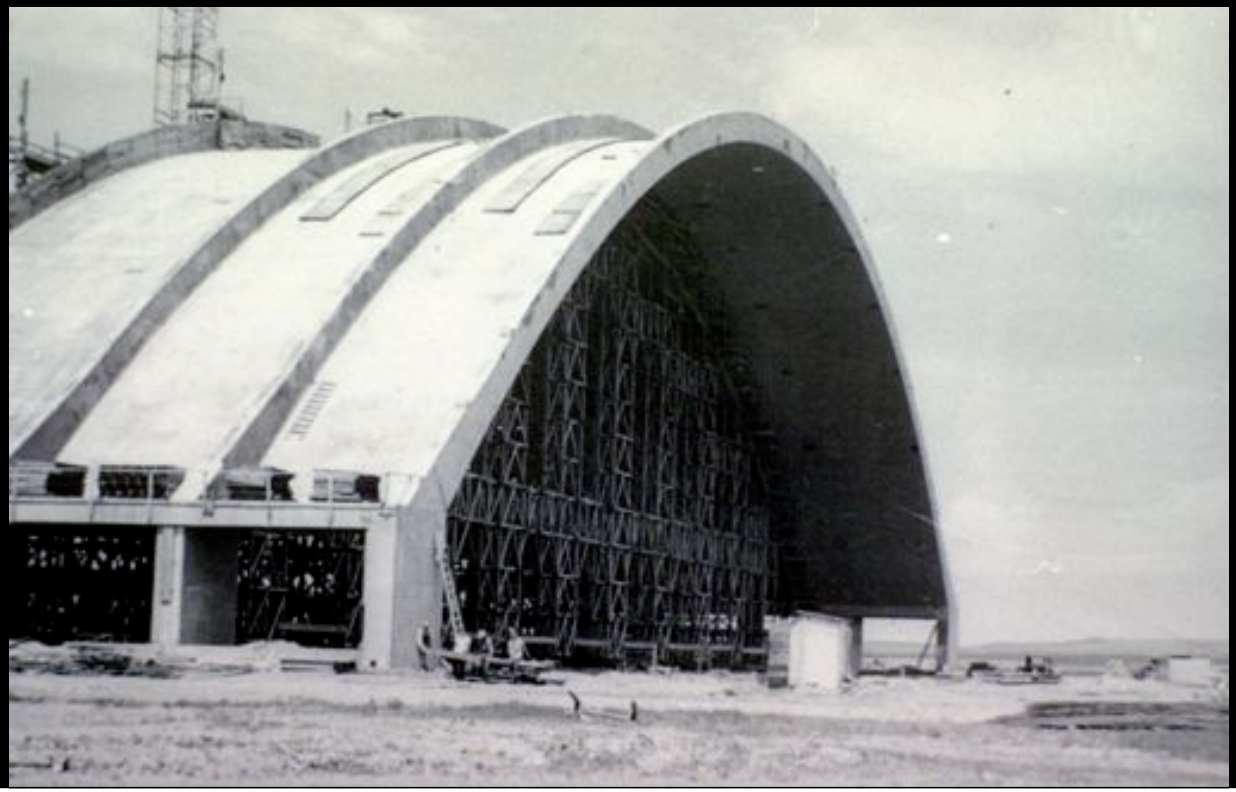
$$\frac{dS_y}{dy}=-a_y\frac{N_y}{R_y}+a_yp_z$$







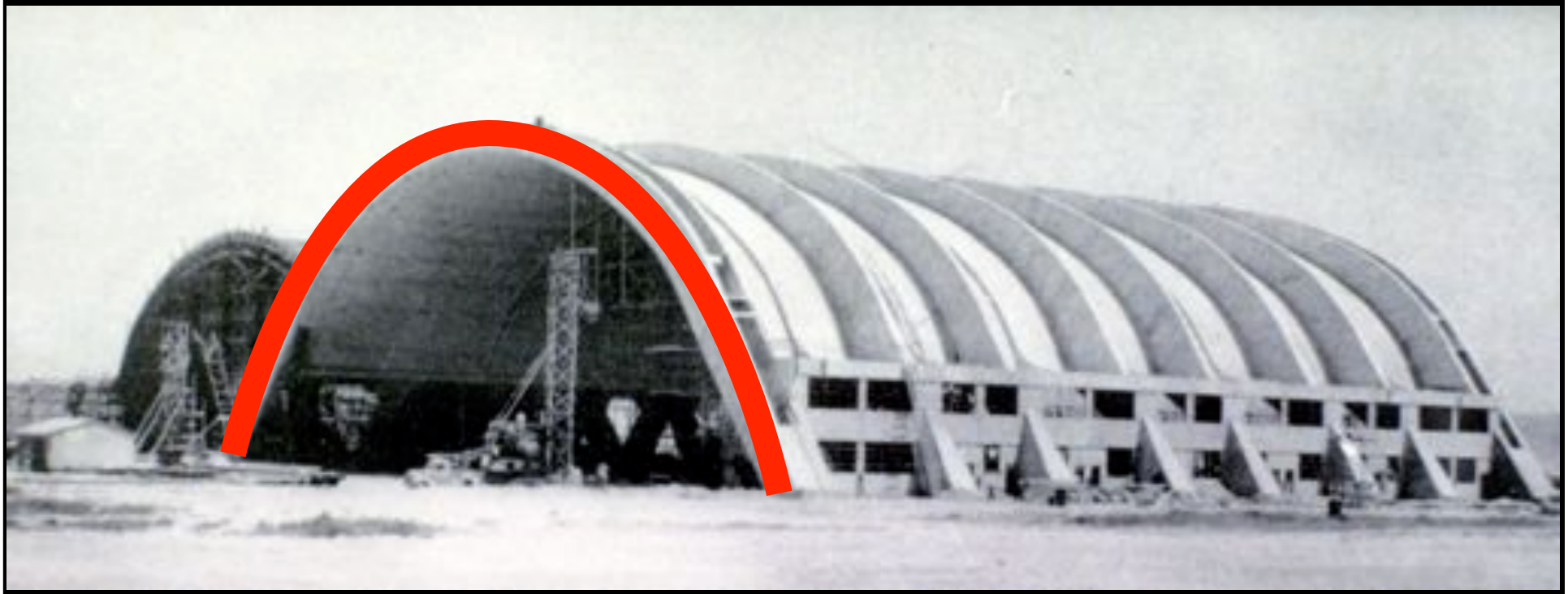
1941



Ribbed barrels by

Anton Tedesko

1948



1D ribs = Stiffness

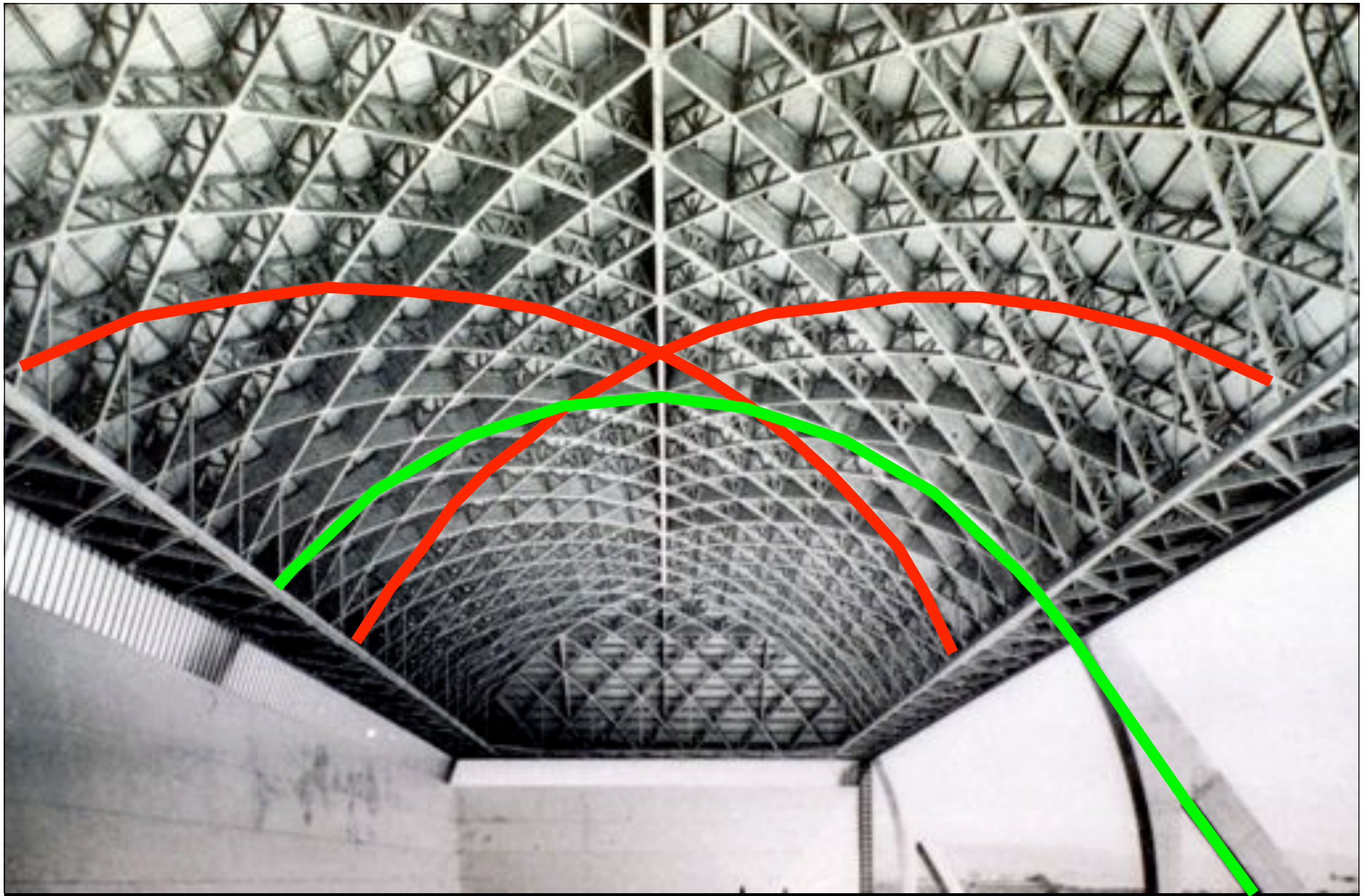
Describe the method used by the German school for finding forms for roof structures.

Why would such an approach be justified for structural engineering?

Why might it be limiting for structural art?

Italian Tradition

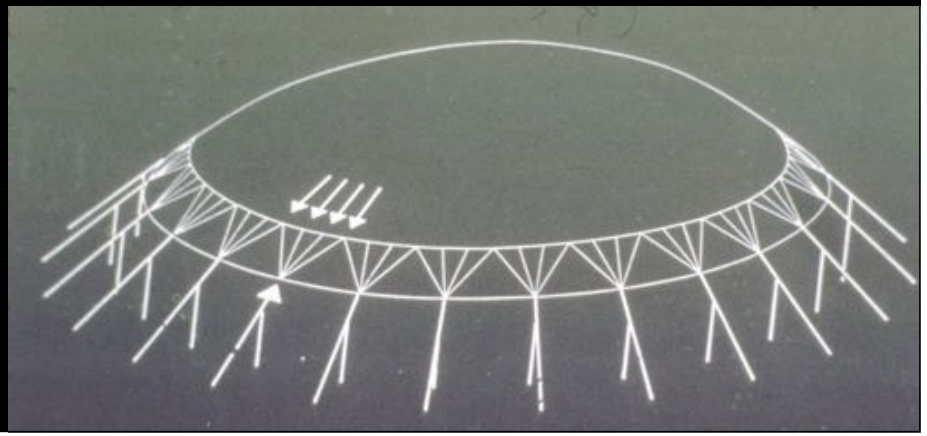
P.L. Nervi (1891-1979)

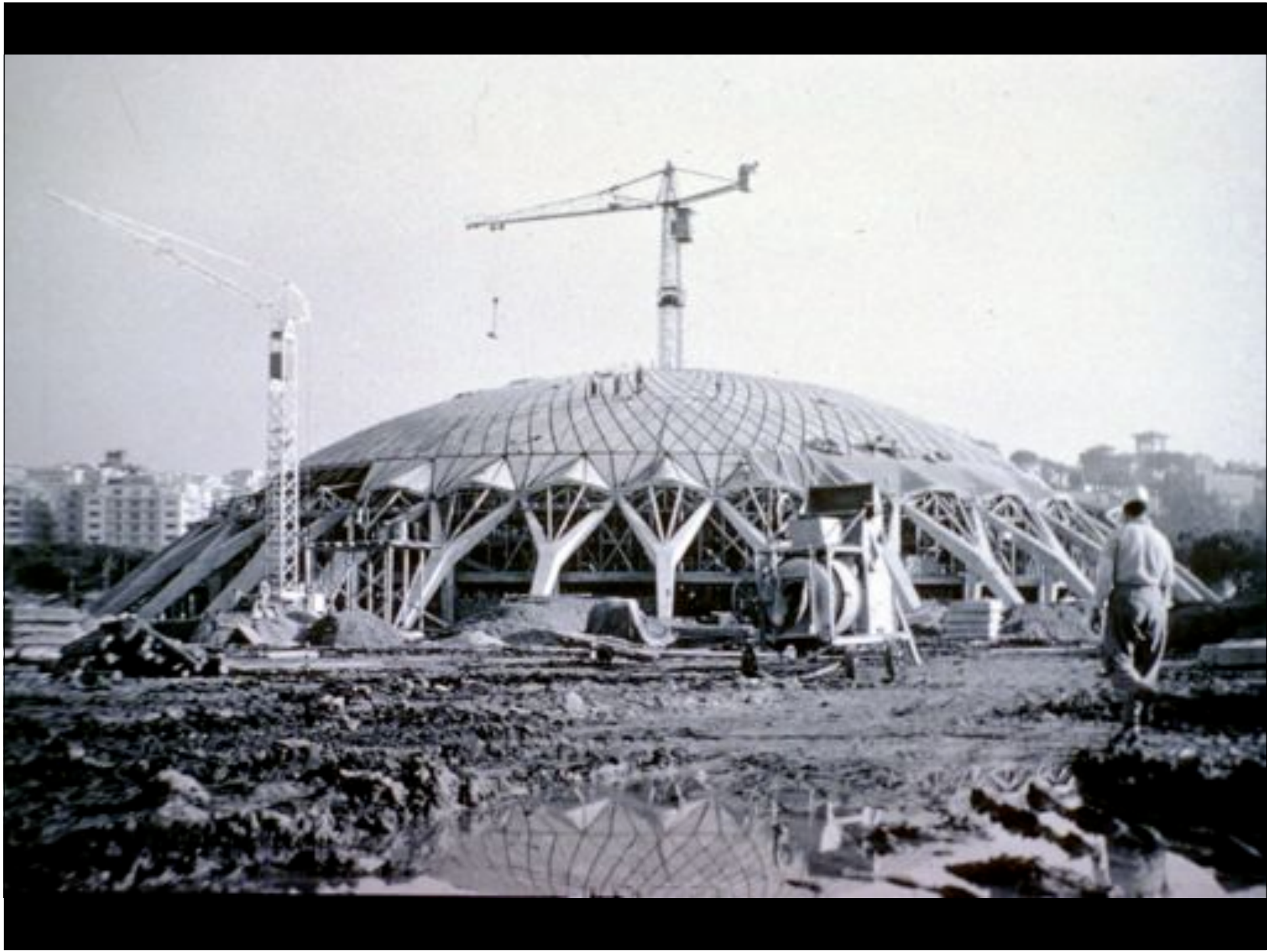

2D ribs = Stiffness
1D rib = Strength

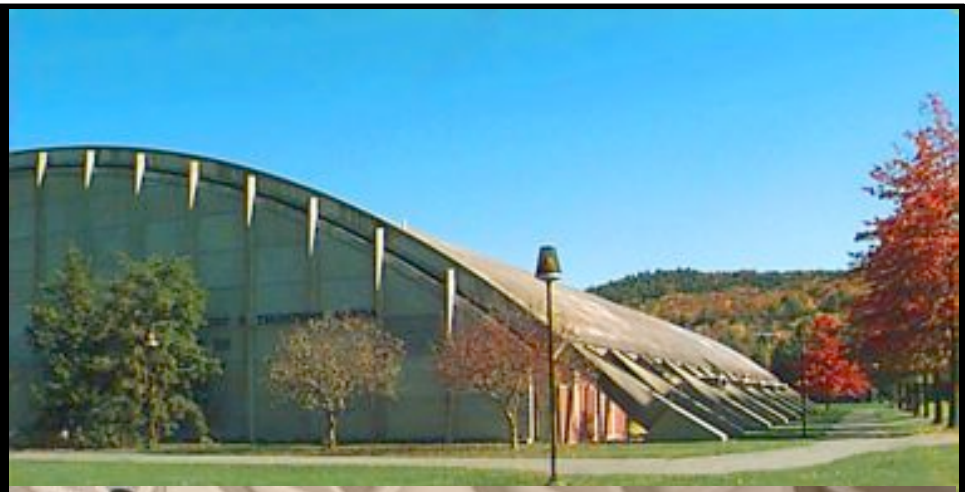
Nervi

Tedesko

Little Sports Palace
1957

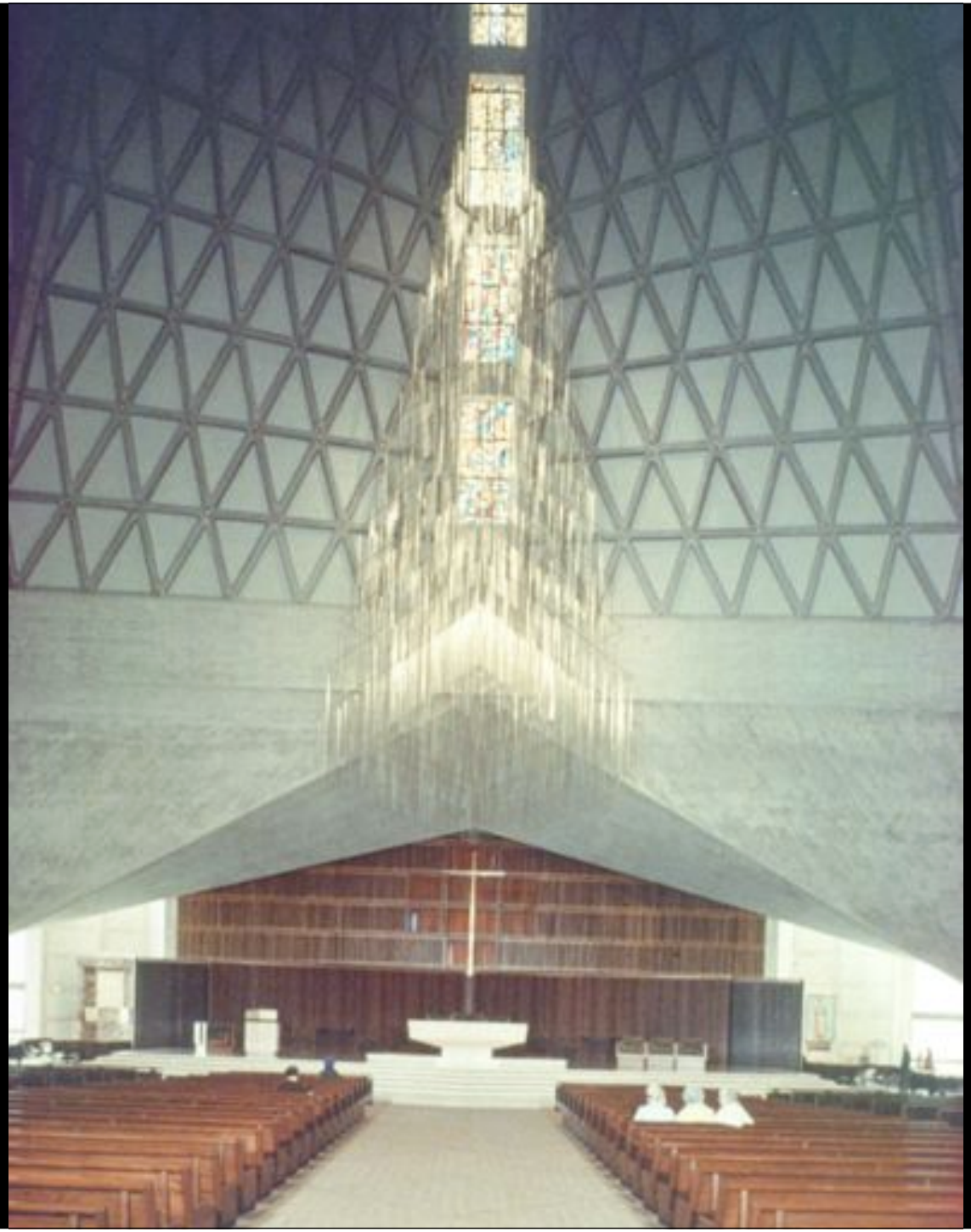




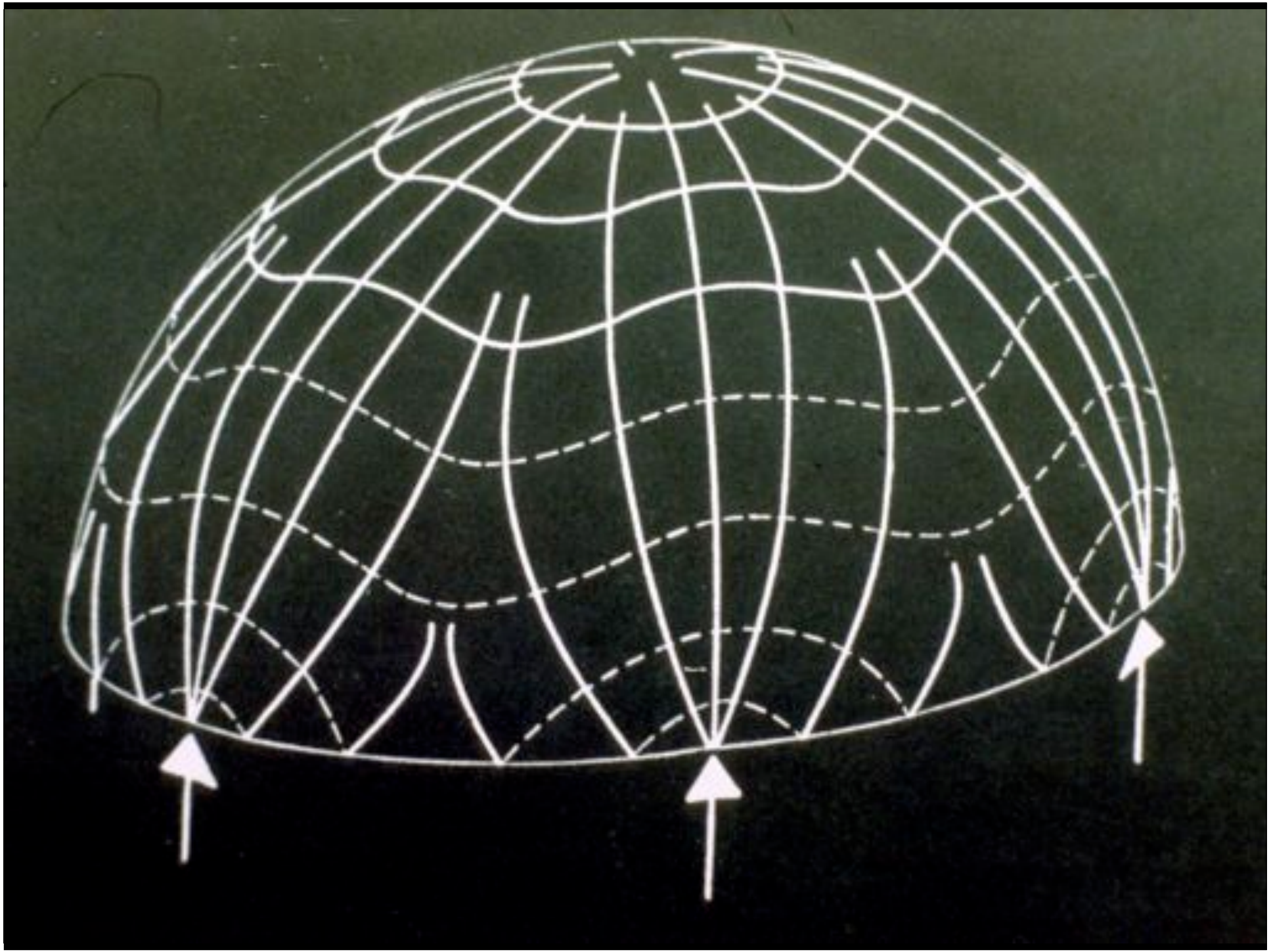


Describe the differences in the ribbing in these two Nervi structures.
What are the differences in the way domes and barrels carry loads?

failures in translation



structure, not structural art



What makes Nervi's solution so much more elegant?
What are the scientific reasons, if any, for his aesthetic choices?

Spanish Tradition

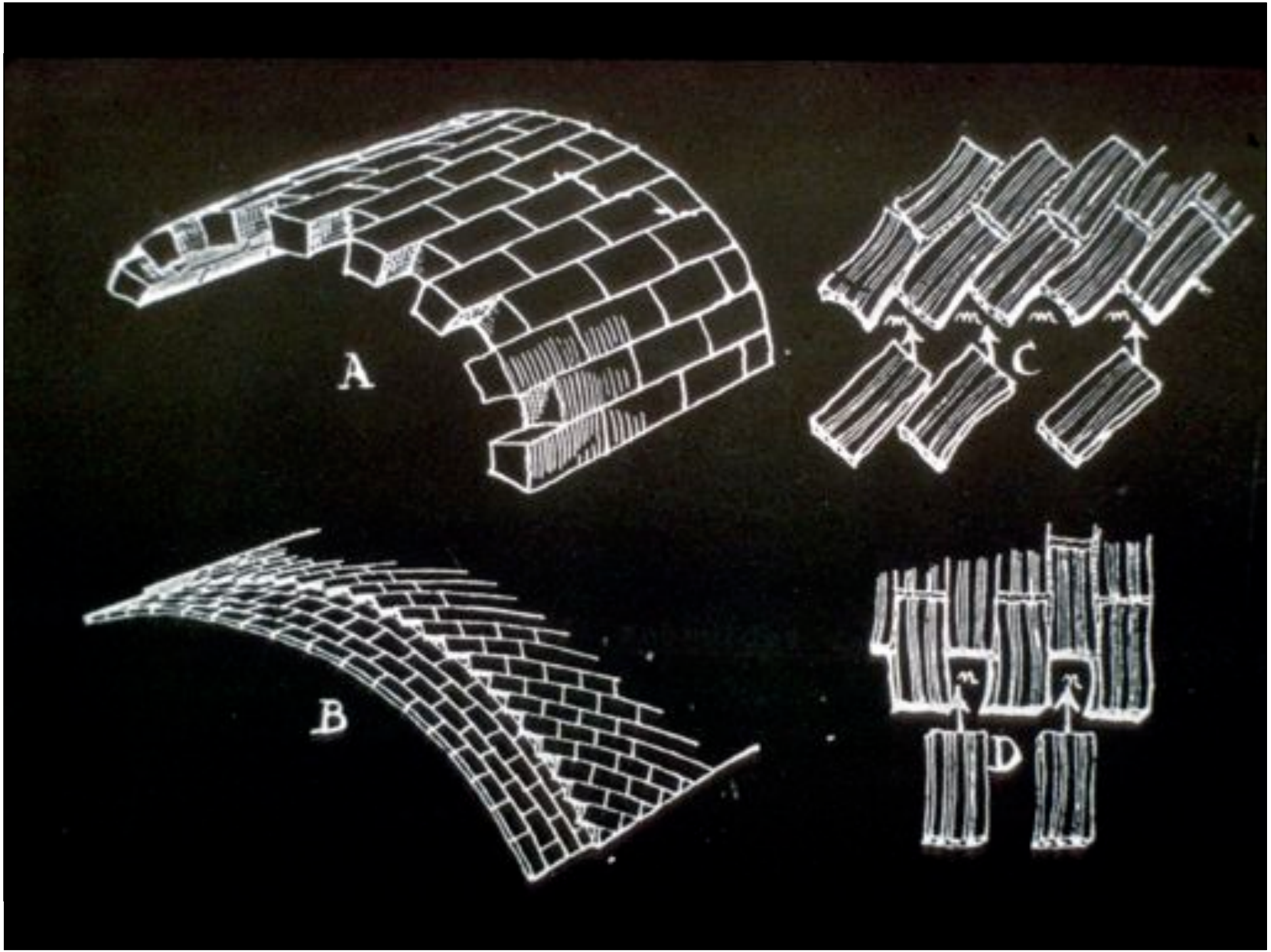
Catalan influence

A. Gaudi (1852-1926)

E. Torroja (1899-1961)

F. Candela (1910-1997)

E. Dieste (1917-2000)


A
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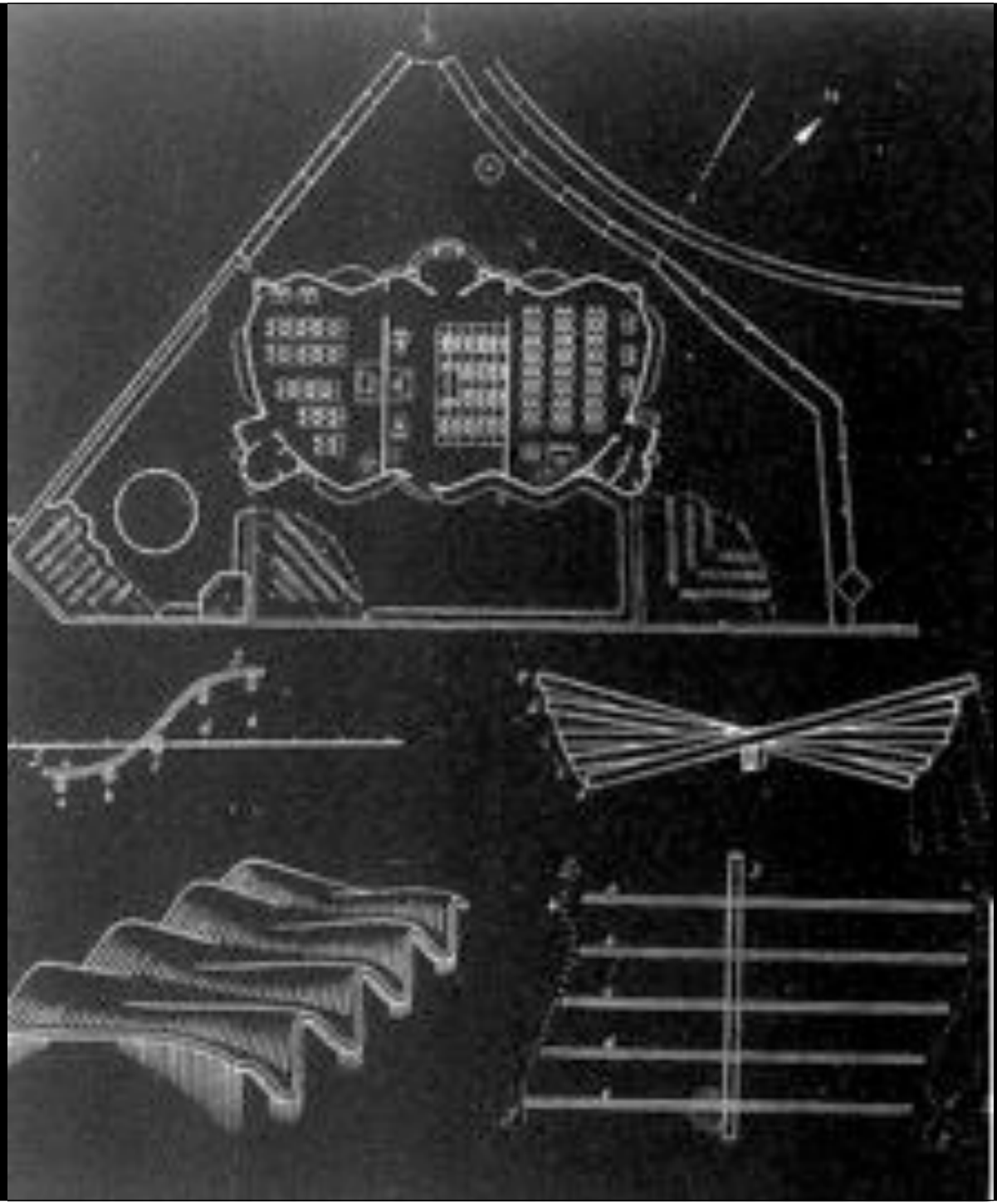
D

Sagrada Familia School



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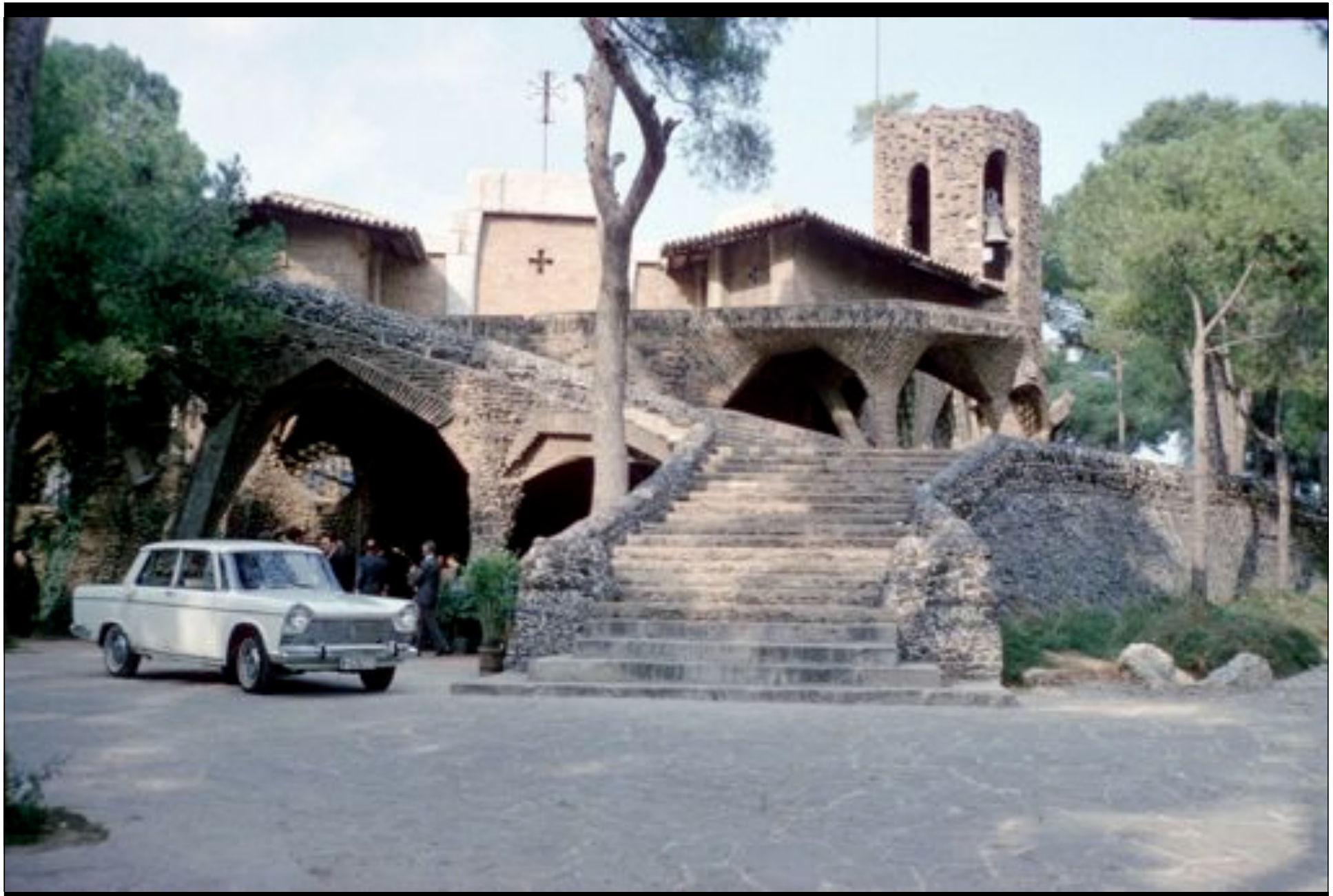
Church of the Sagrada Familia
Gaudi, 1882 - present

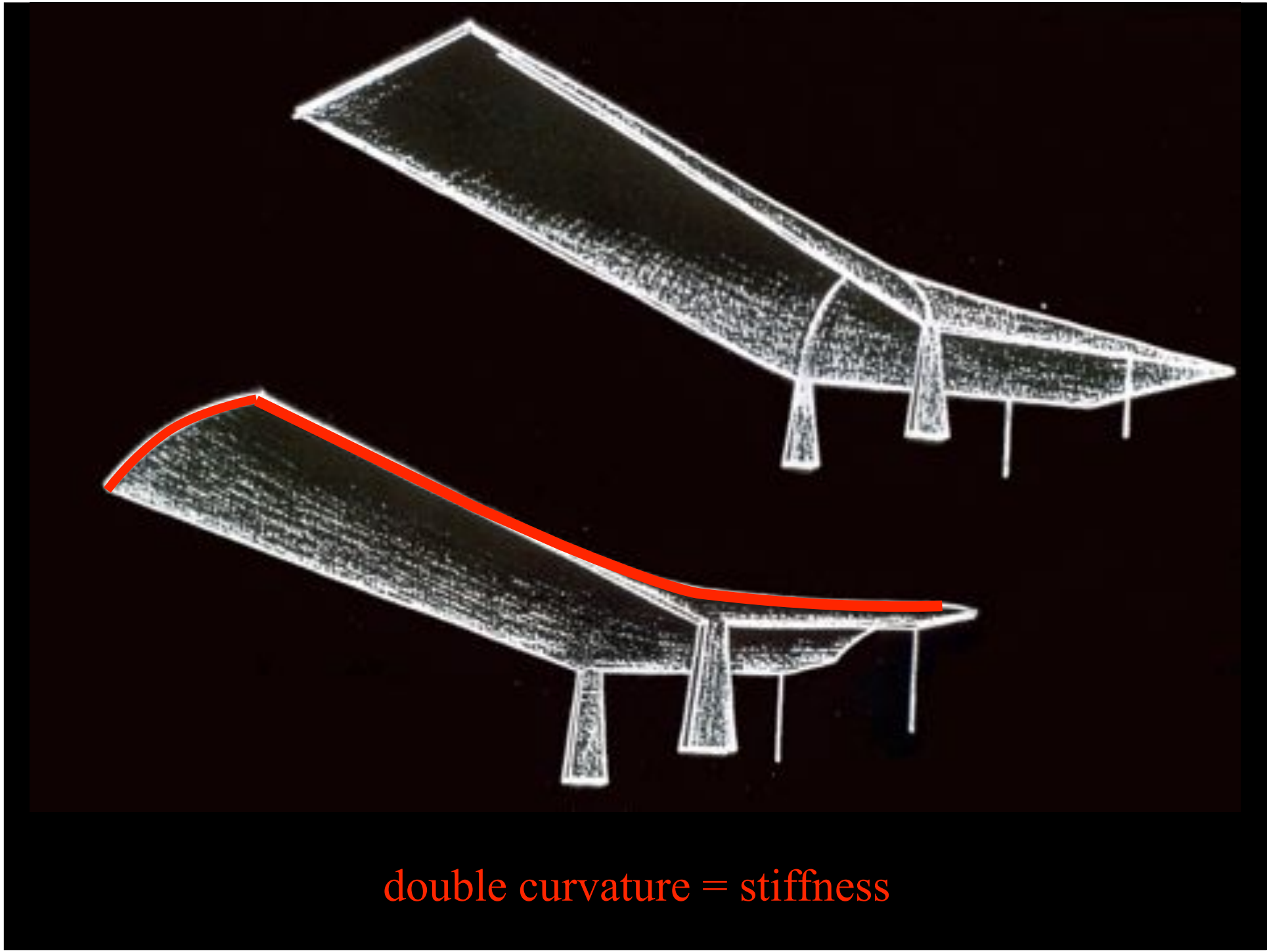


Church of the Colonia Guell

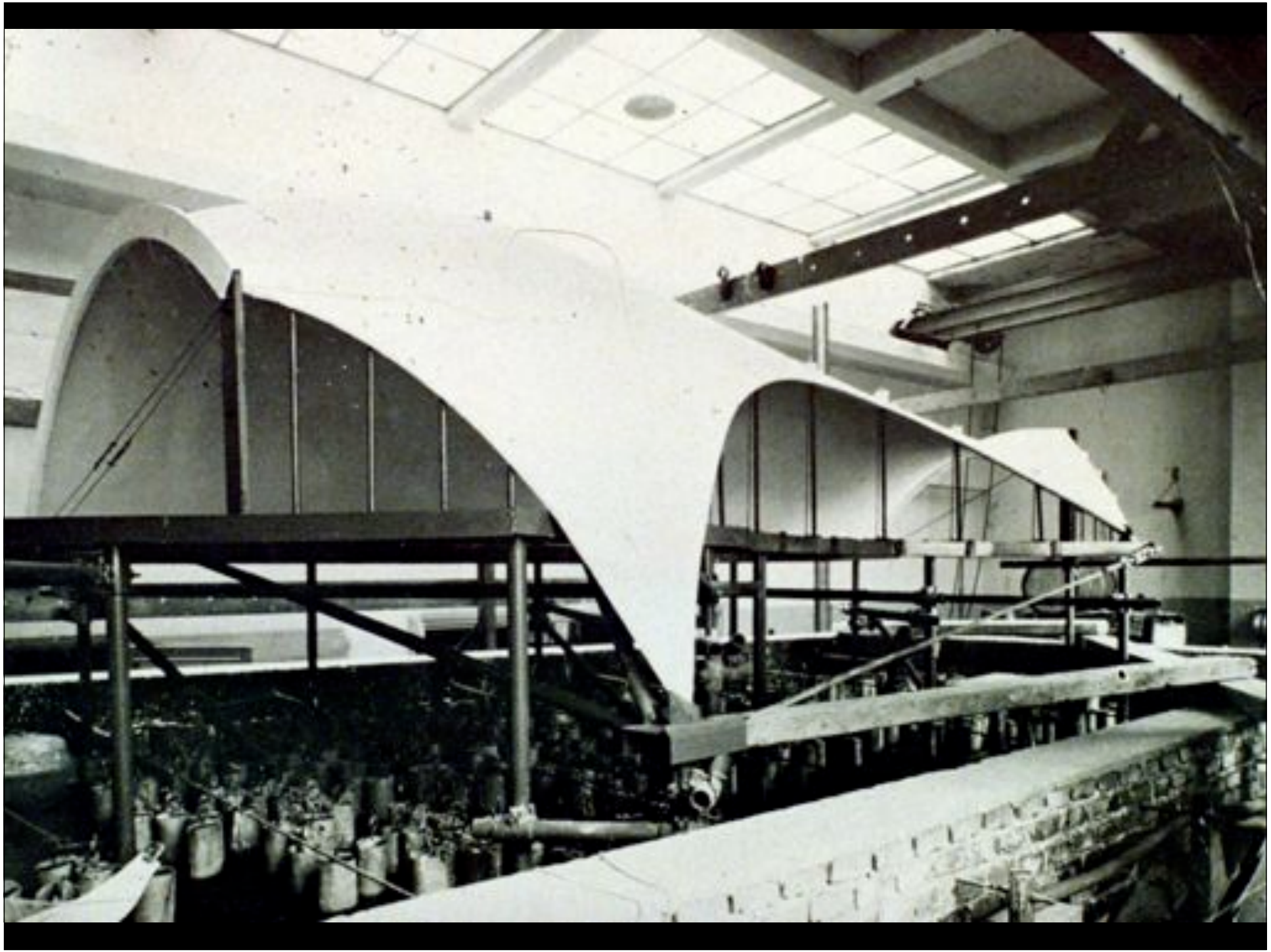
Zarzuella Hippodrome (1935), Eduardo Torroja

Torroja

Nervi

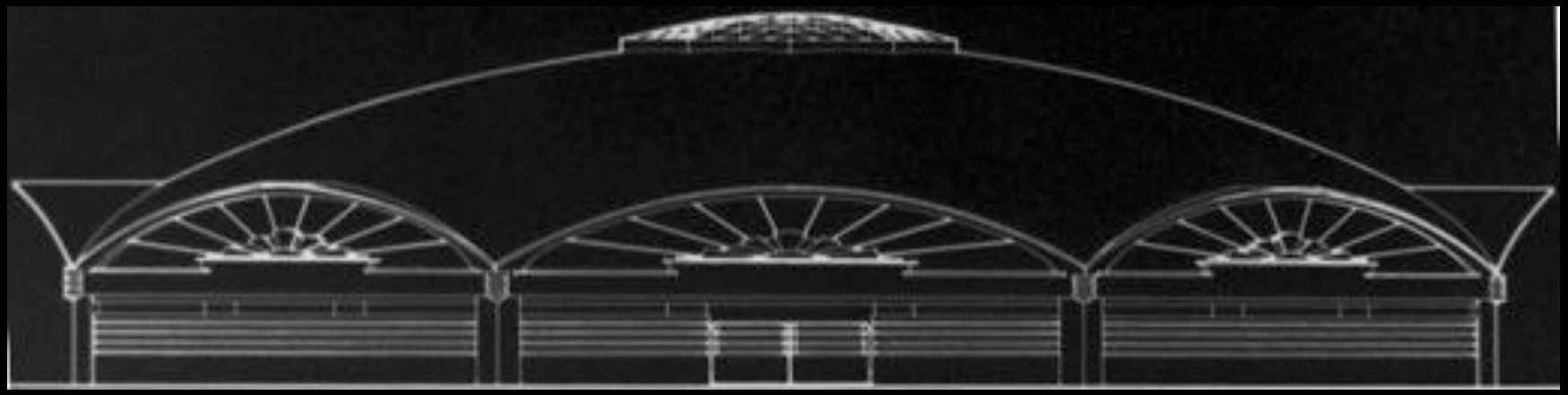


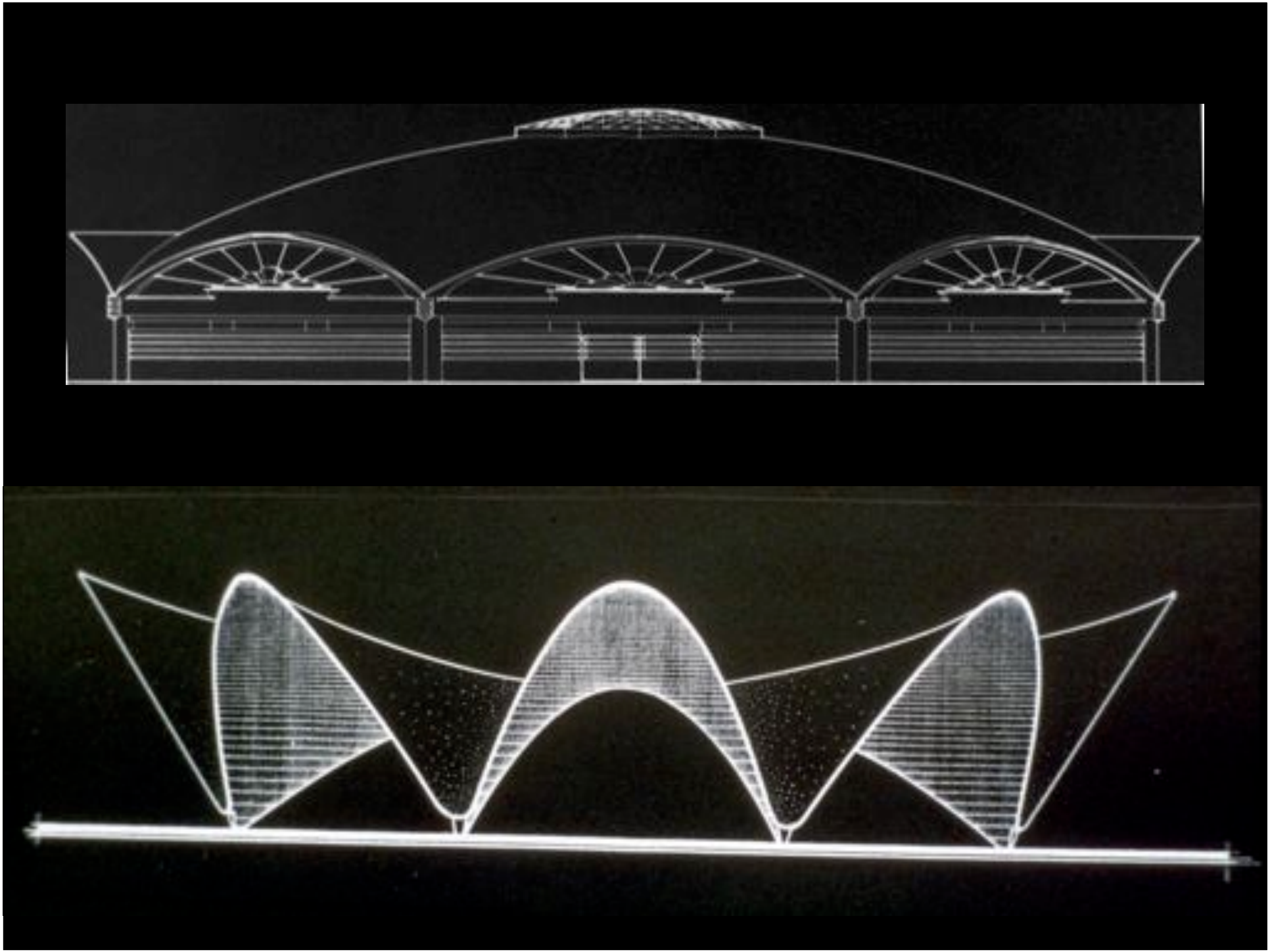
double curvature = stiffness

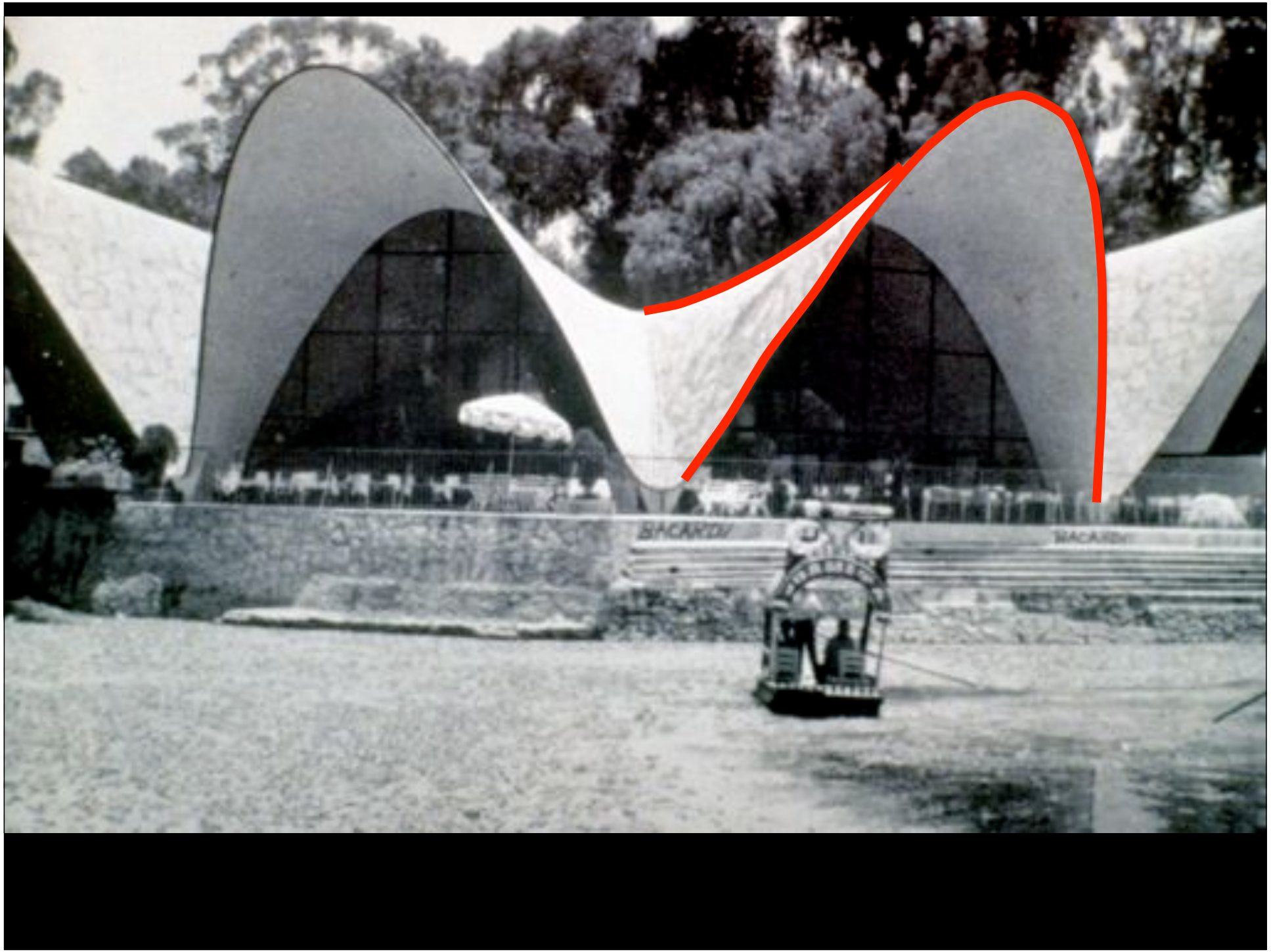


Algeciras market hall

Locate the double curvature in this shell
Comment on the aesthetics



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Xochimilco restaurant

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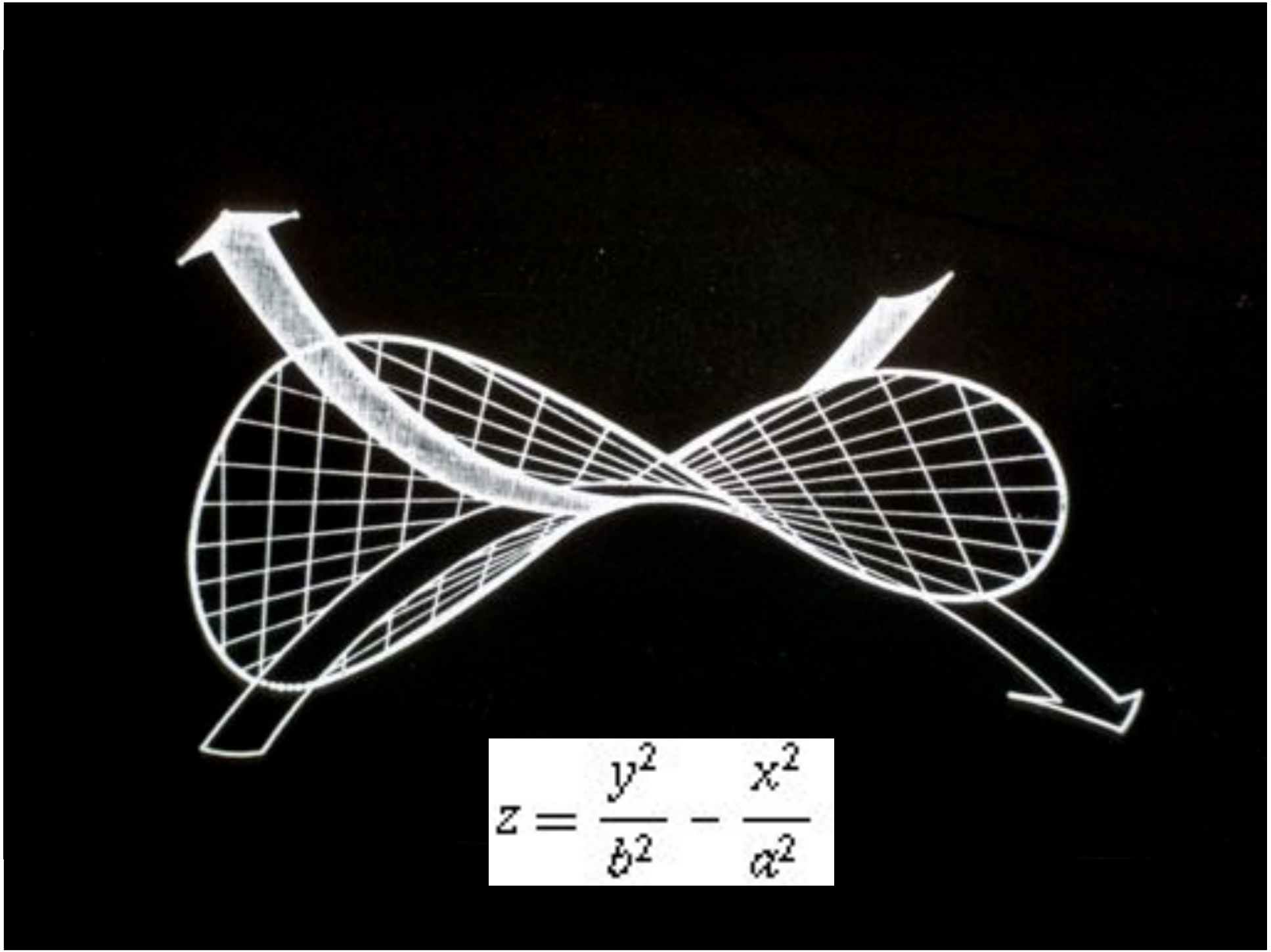
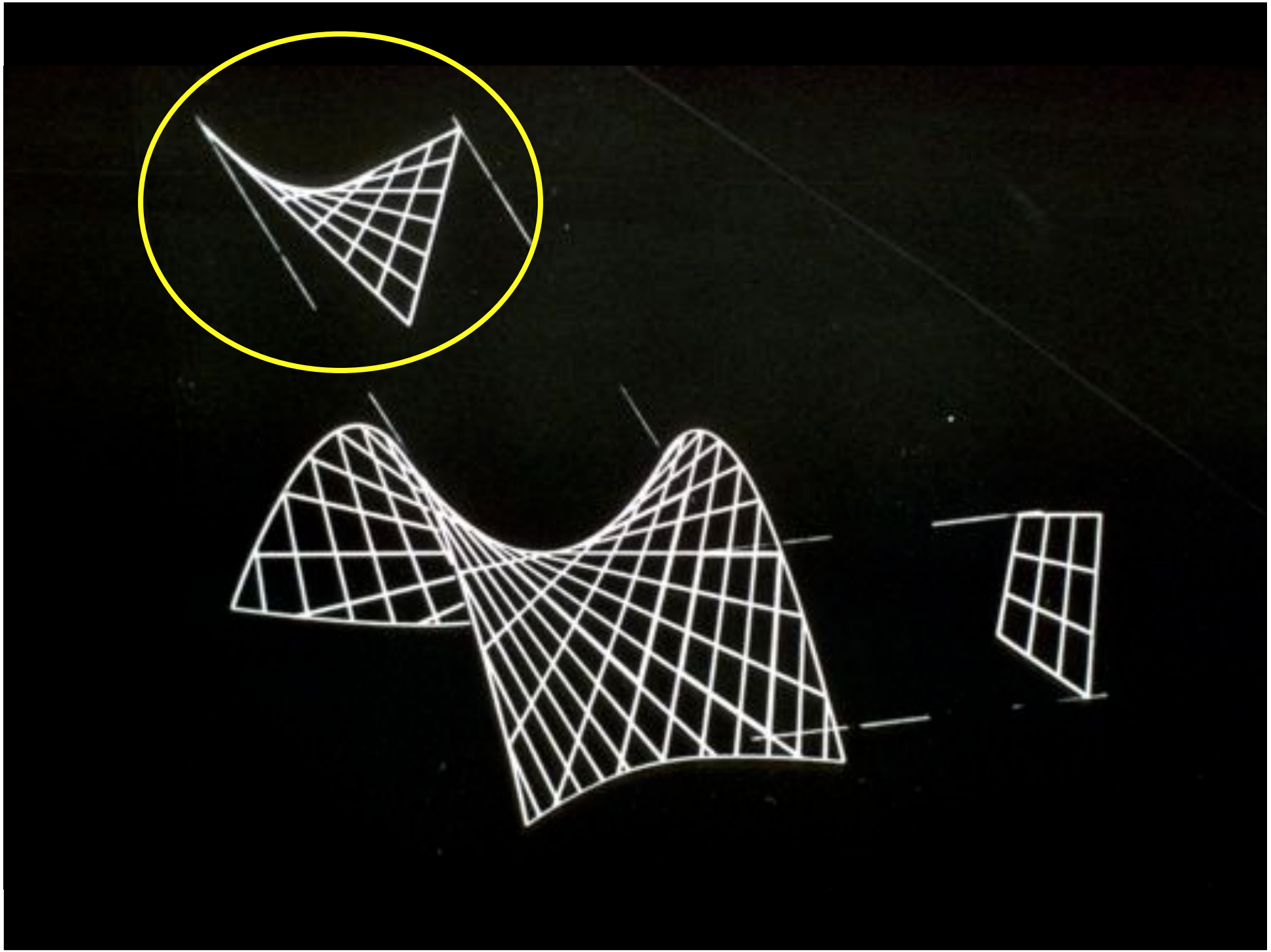
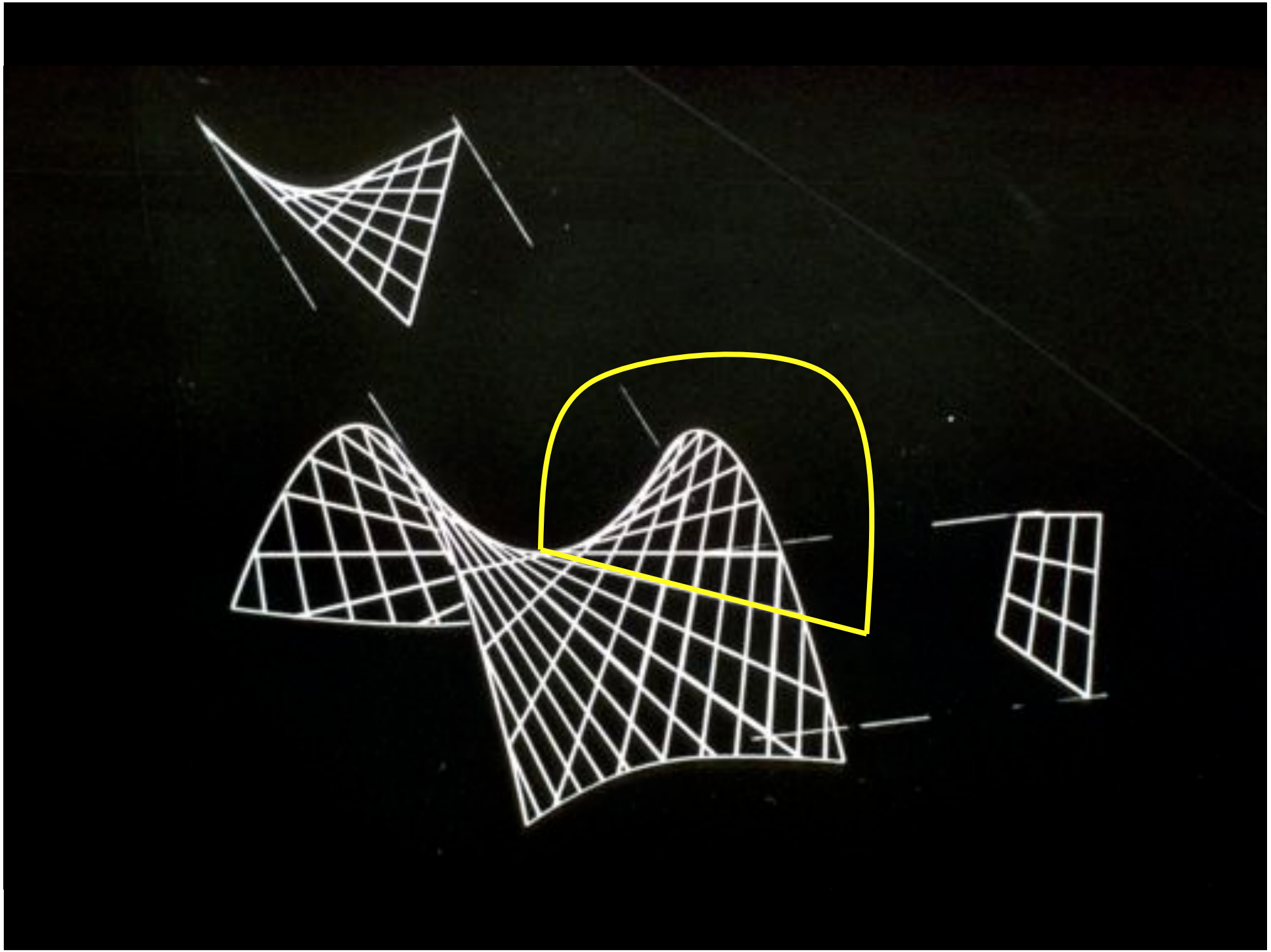
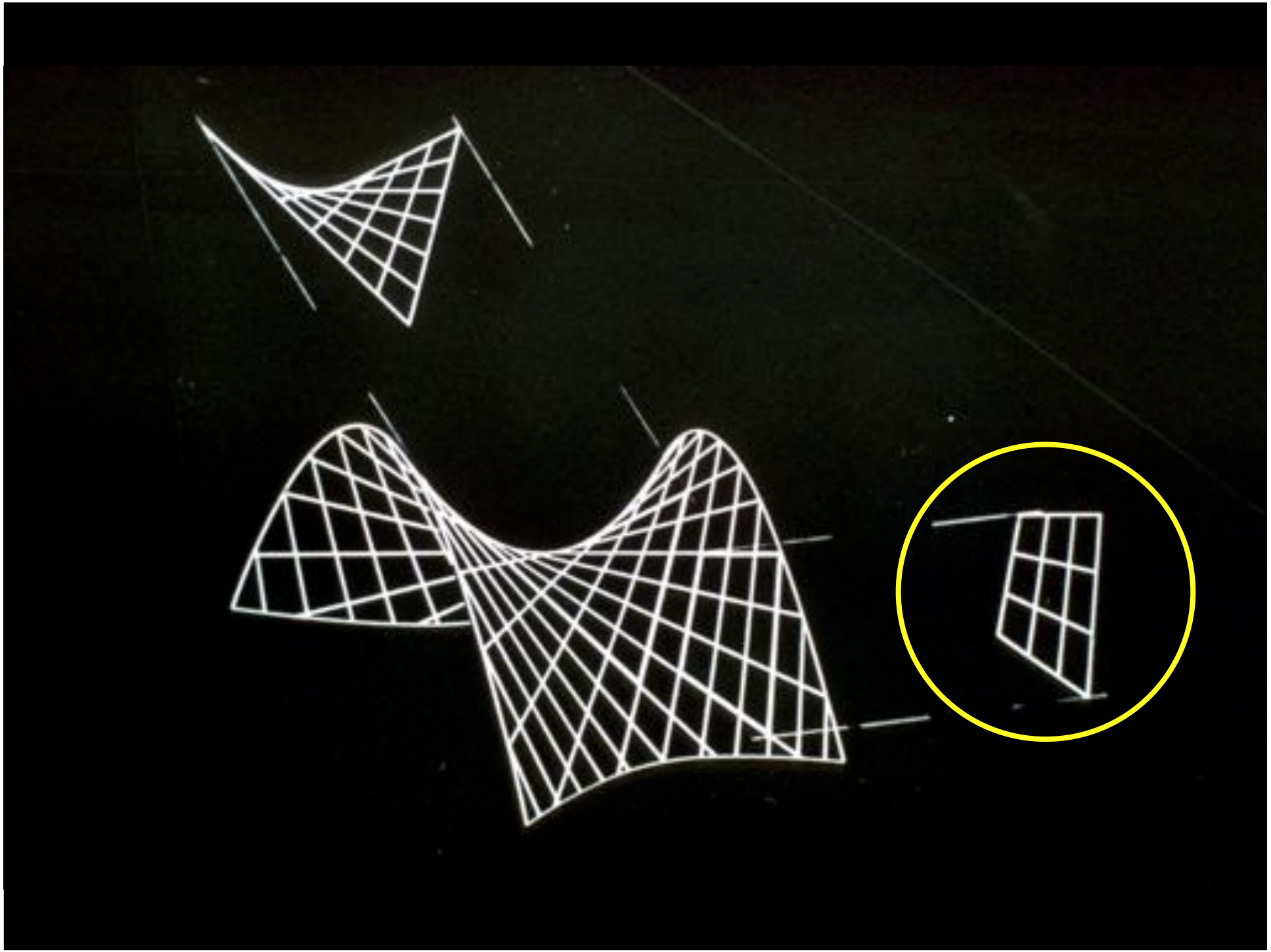
Felix Candela

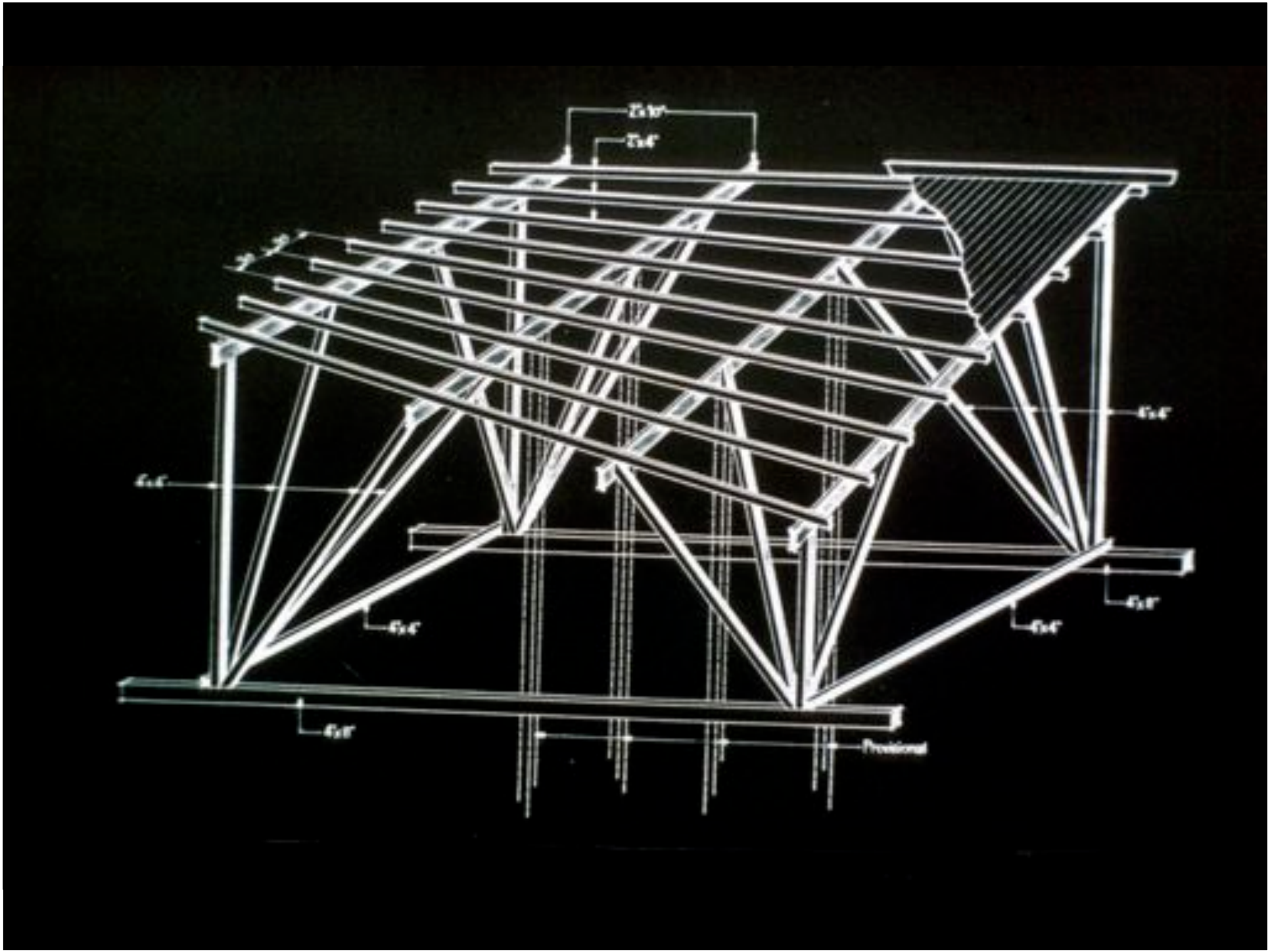


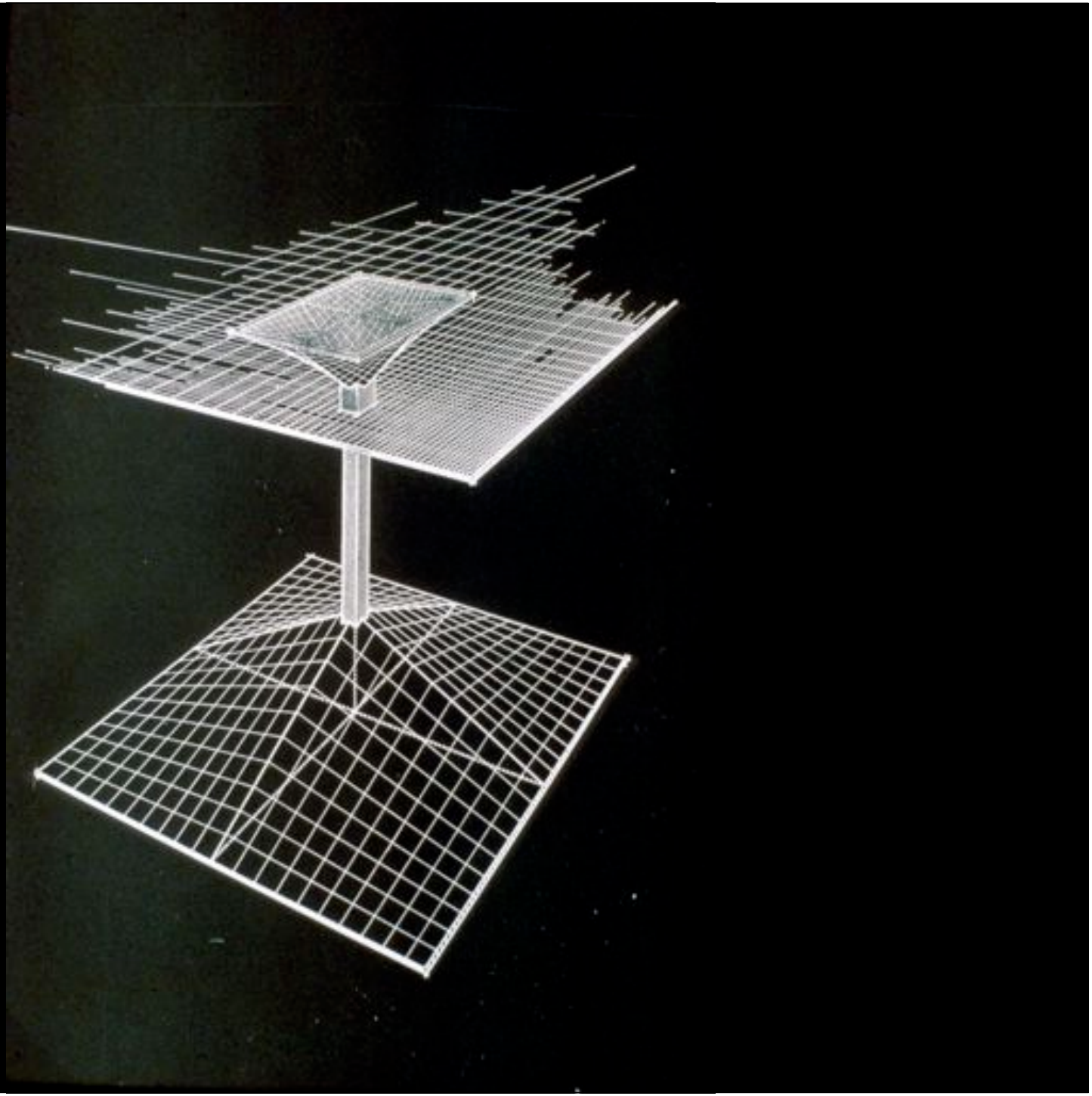
$$z = \frac{y^2}{b^2} - \frac{x^2}{a^2}$$

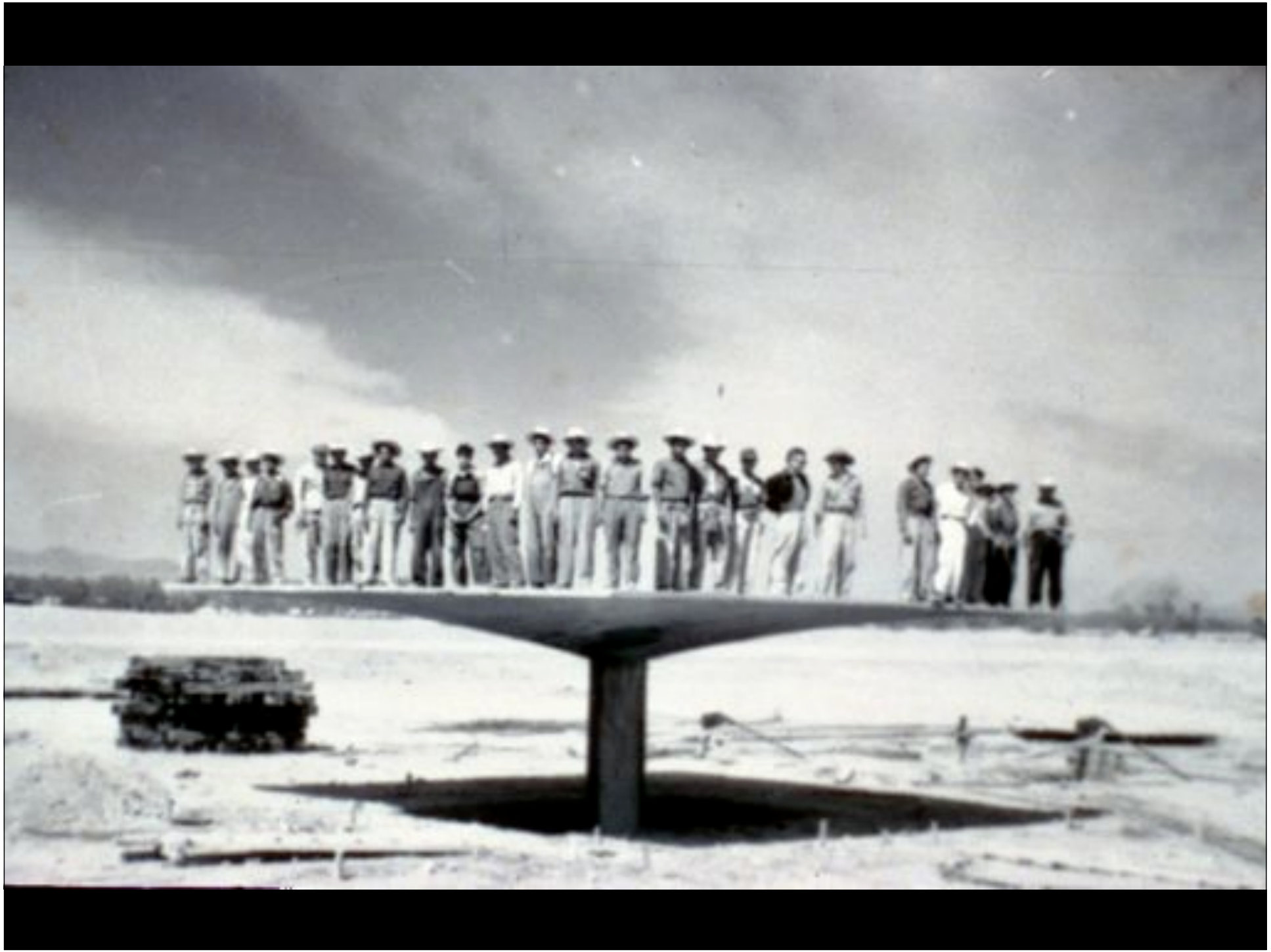


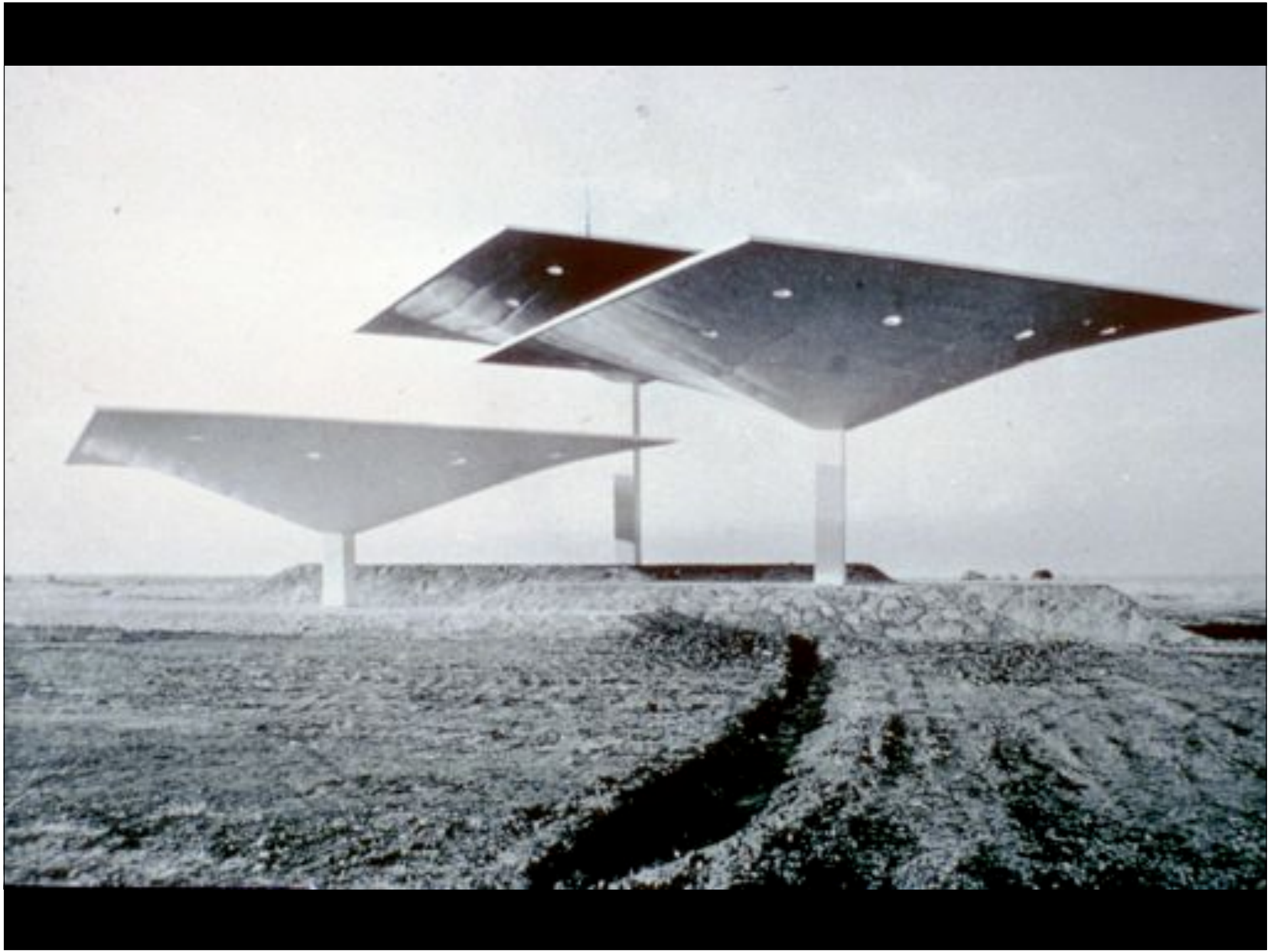


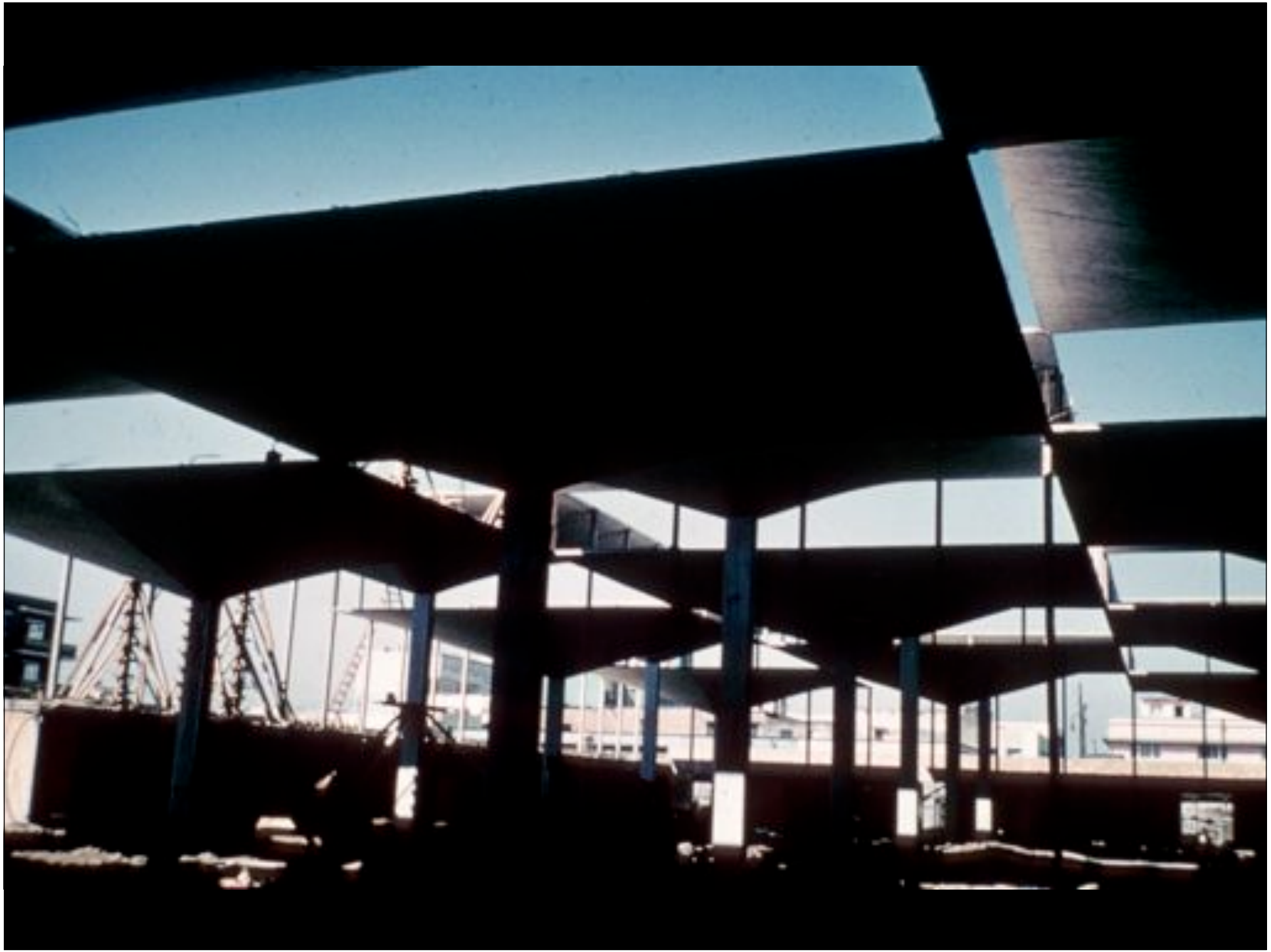



Provisional









Describe the different approaches Gaudi (left) and Candela (right) took to form-finding? Did material choice have any effect on their choices?

TRALISA

Church of Christ Worker

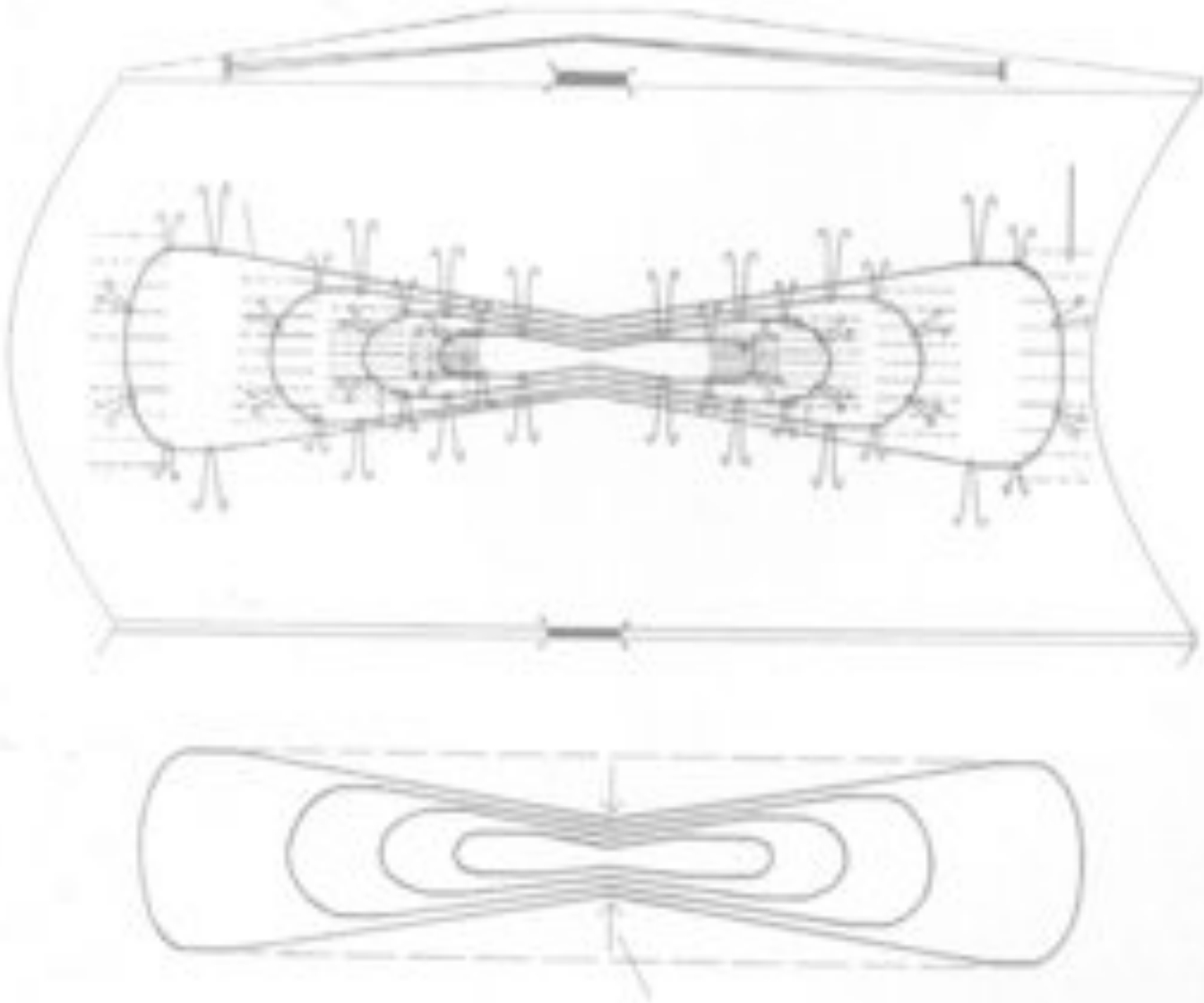


fig. 171

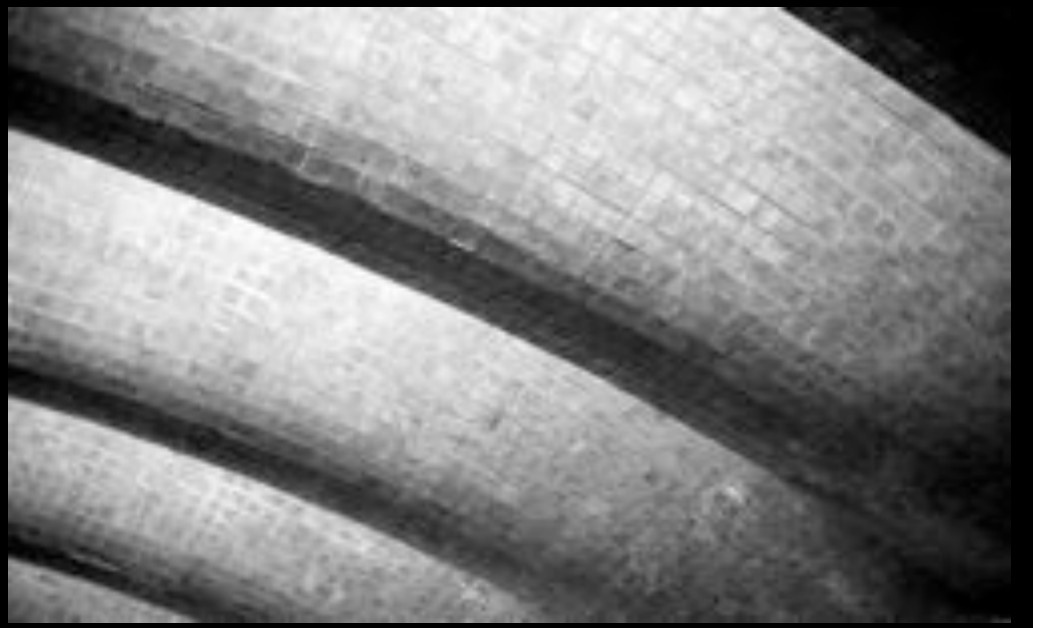
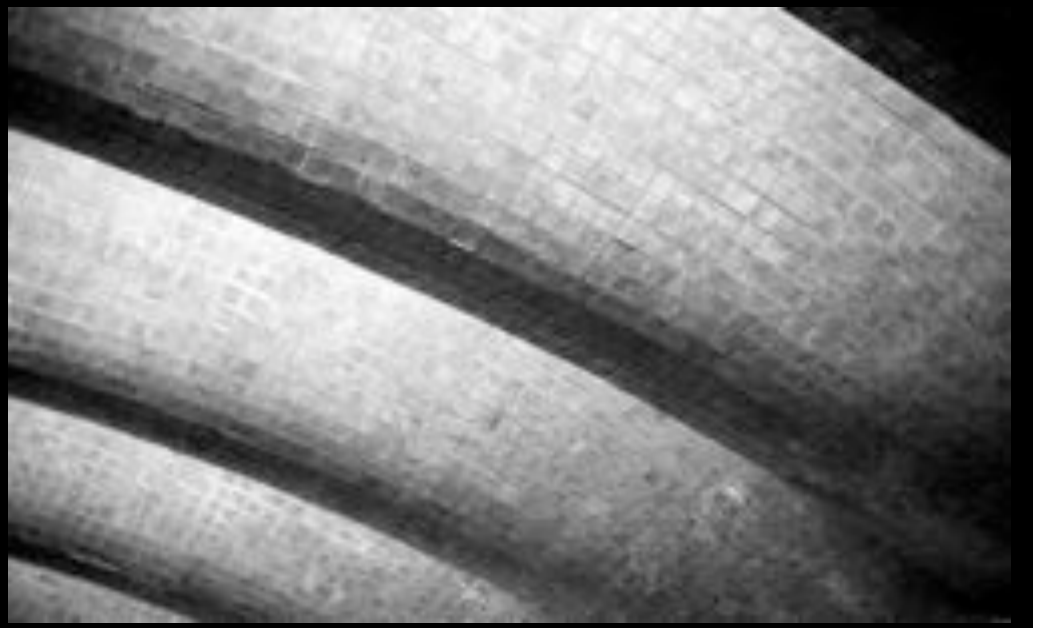


photo credit: Samuel Smith



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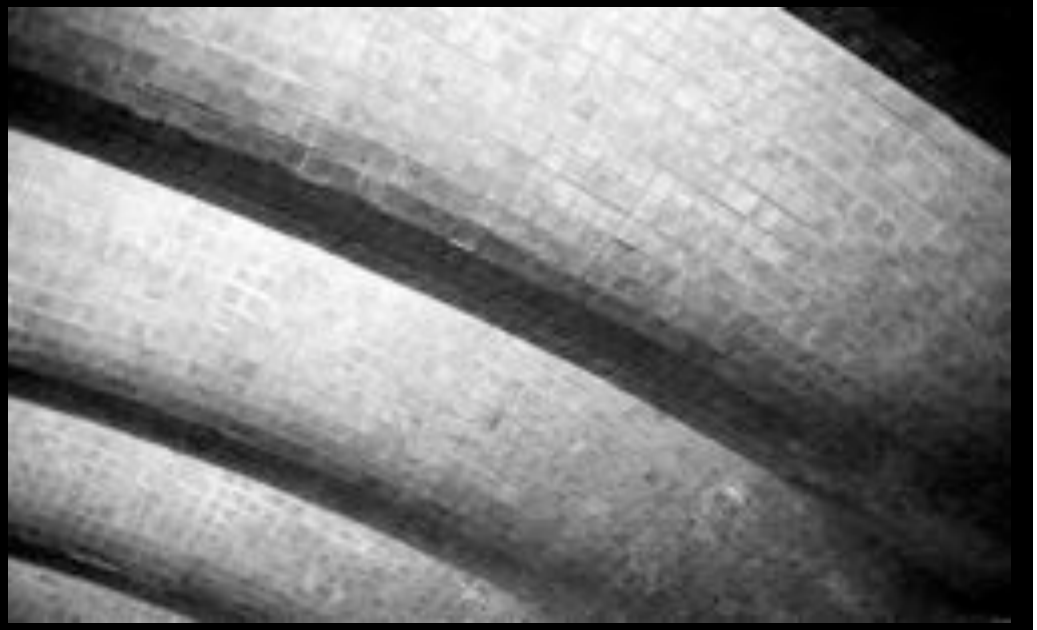


photo credit: Samuel Smith

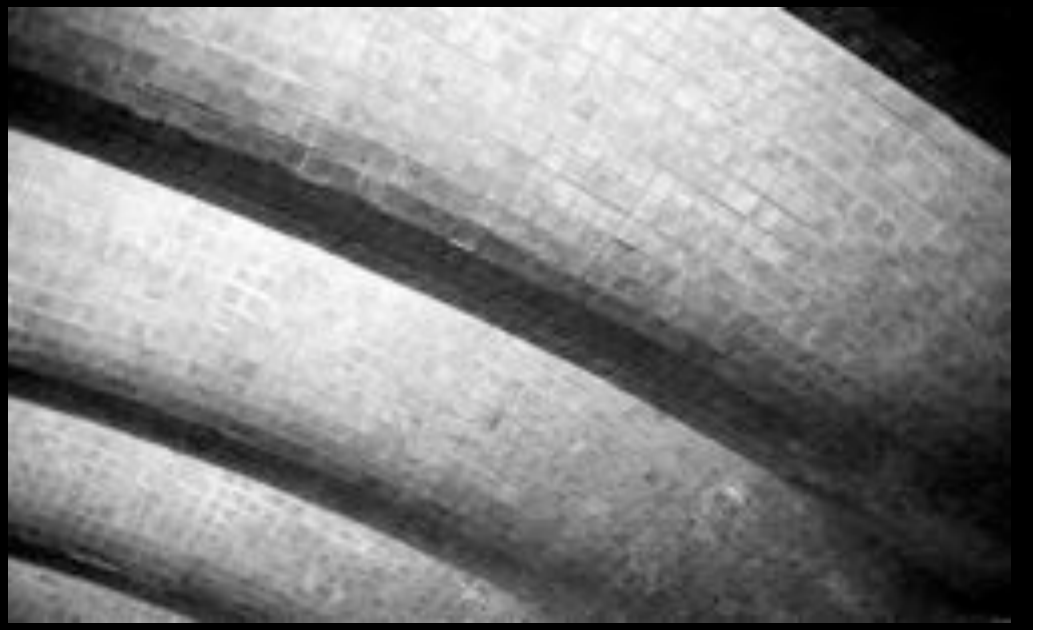
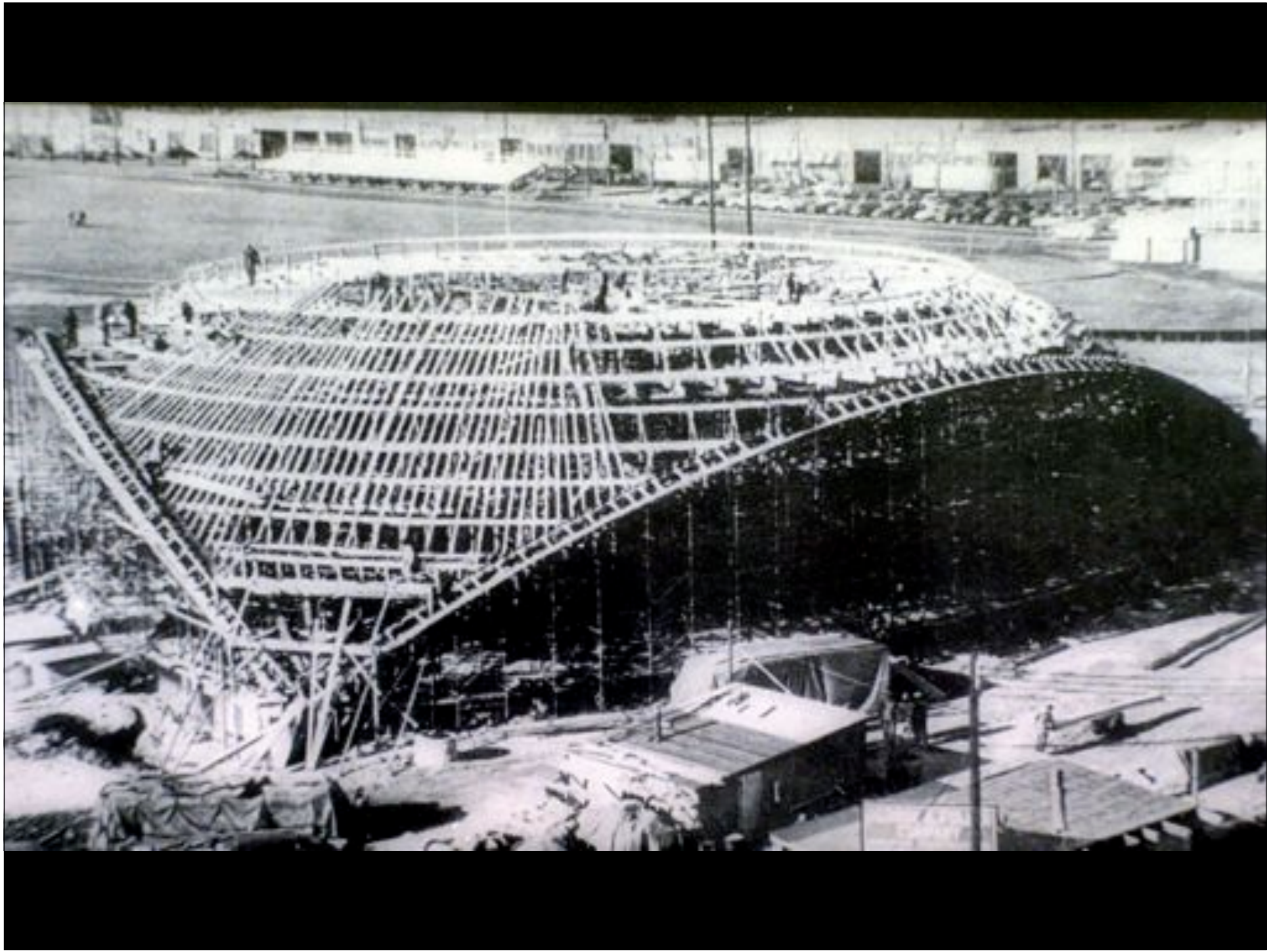
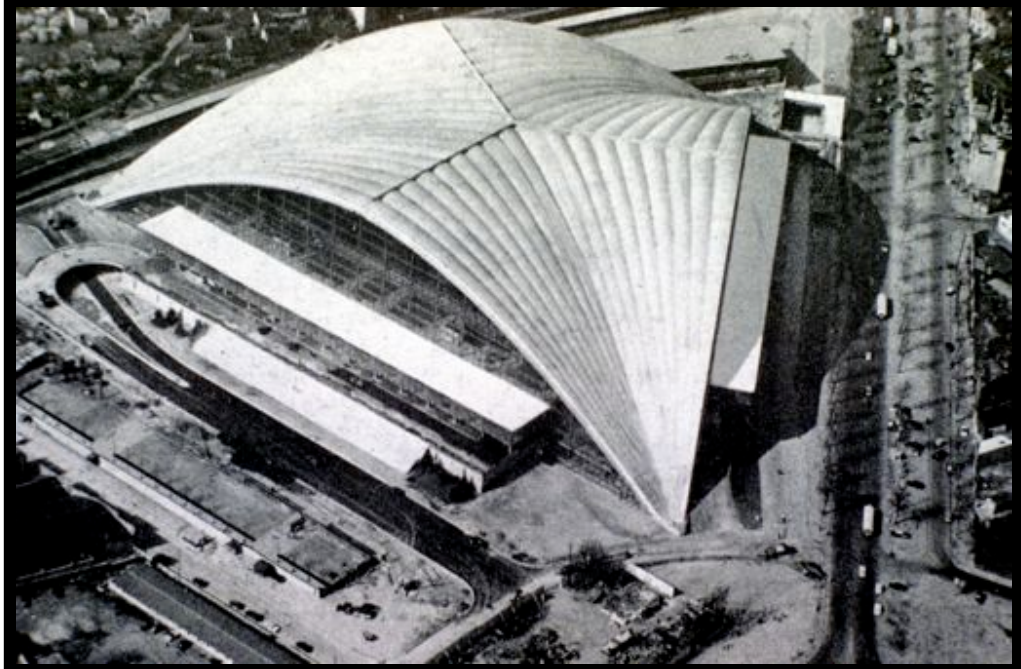


photo credit: Samuel Smith

who needs tradition?

Kresge Auditorium (MIT)





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ID Number 17362
DescriptionSydney Opera House
Taken in 2004
PhotographerIan G. Bowie

German tradition

Italian tradition

Spanish tradition

Exam 1 Next Tuesday

1. Study IDs from online index website > exam review (can be printed)
2. Study Tower and the Bridge. This is the core material for questions
3. Study each lecture theme. Practice writing and answering questions based on them
4. No calculation, but quantitative questions and axial force / moment diagrams are fair game

Format: IDs; multiple choice/matching/blanks