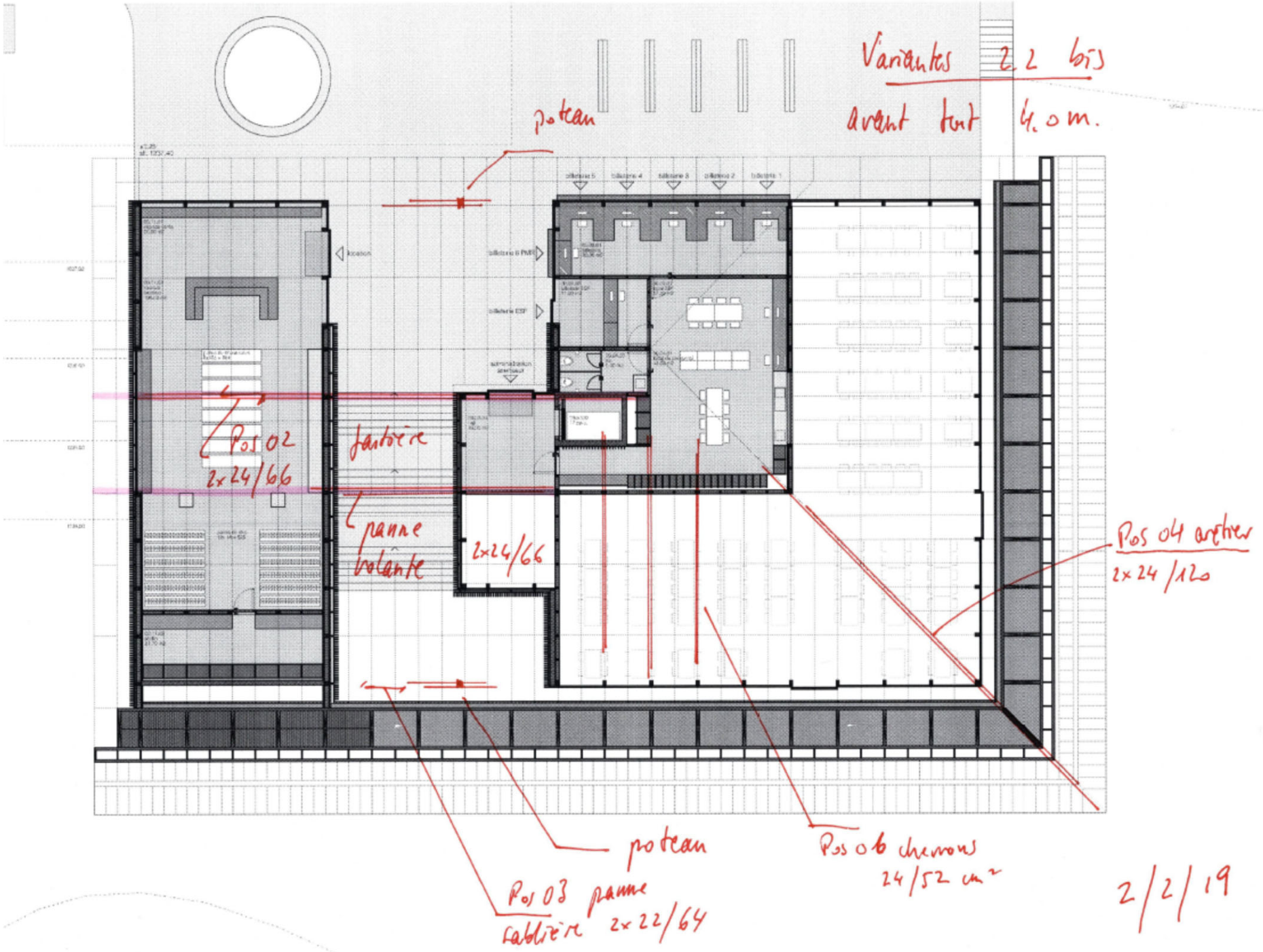
Beam and cantliver systems

Natterer Johannes

Ing. dipl. EPFL

EPFL - SGC


Variantes 2.2 bis
avant tout 4.0 m.
poteau
Pos 02
2x24/66
faitière
panne
volante
2x24/66
Pos 04 arbier
2x24/120
poteau
Pos 03 panne
faitière 2x22/64
Pos 06 chevrons
24/52 cm²
2/2/19

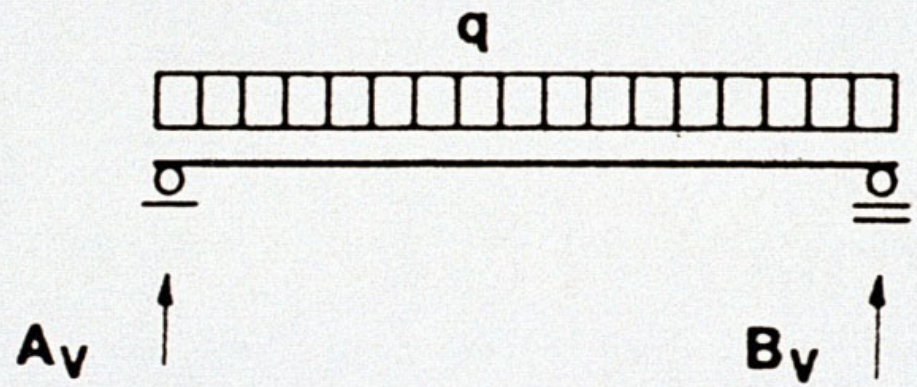
Comparatif des coûts

		non structure	structure	total					
Variantes		**Prix SNP +/- 20% CHF**	**Prix SP +/- 20% CHF**	**Prix total +/- 20% CHF**	Av. toit 5,5m	Av. toit 4,0m	entraxe chevrons Pos.06 = 2,0m	entraxe chevrons Pos.06 = 0,6m	Appui supplémentaire sablière Pos.03
Caisson		340 172	622 009	962 181	x				
chevron	1.1	354 442	432 657	787 099	x		x		
	1.2	354 442	423 326	777 768	x		x		x
	2.1	337 690	359 157	696 847		x	x		
	2.2	337 690	338 882	676 572		x	x		x
	2.2.bis	337 690	315 671	653 361		x	x		x
	3.1	354 442	616 937	971 379	x			x	
	3.2	354 442	597 929	952 371	x			x	x
	4.1	354 442	465 675	820 117		x		x	
	4.2	354 442	447 704	802 146		x		x	x

Konrad Merz, kley und partner

The beam on 2 supports with uniform charged loads

Poutres sur deux appuis, ouvrages porteurs

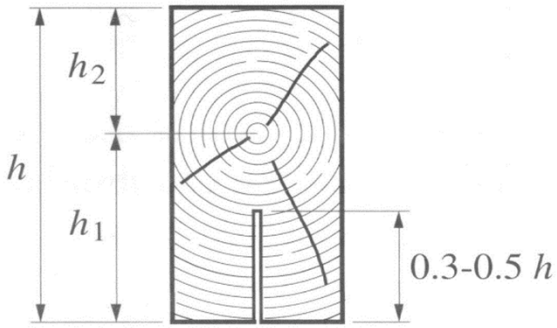


charges:
charges uniformément réparties, verticales

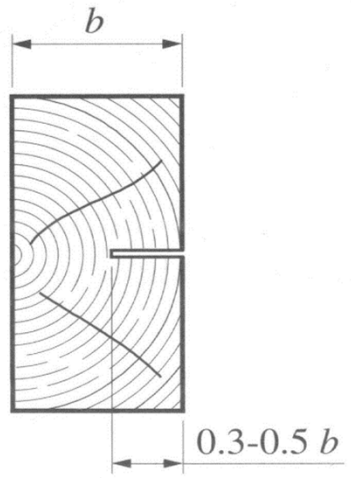
Solid wood

Solid wood

- Limit of the section



section avec cœur ($h_1 \geq h_2$)



section hors cœur ou à cœur fendu

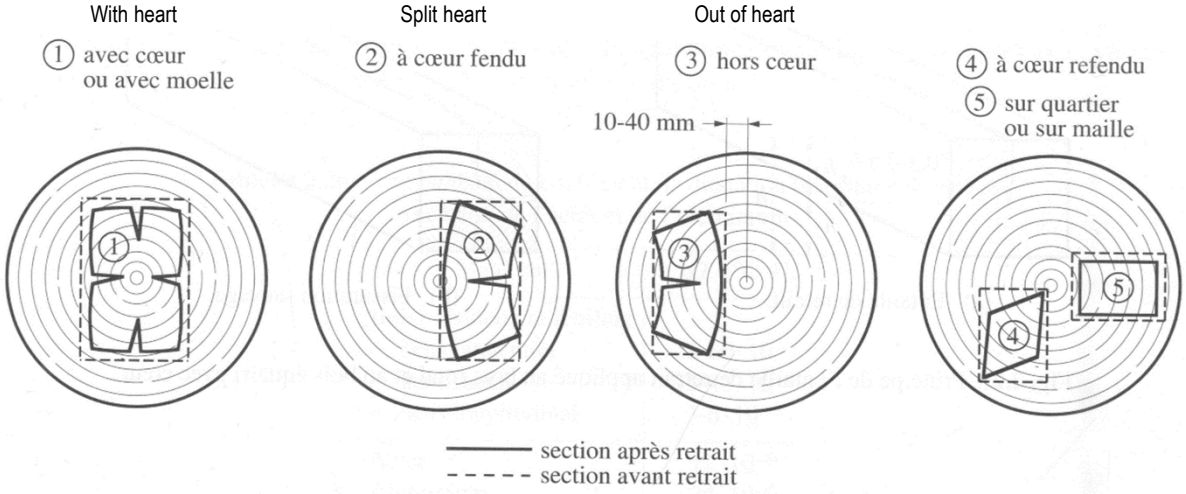


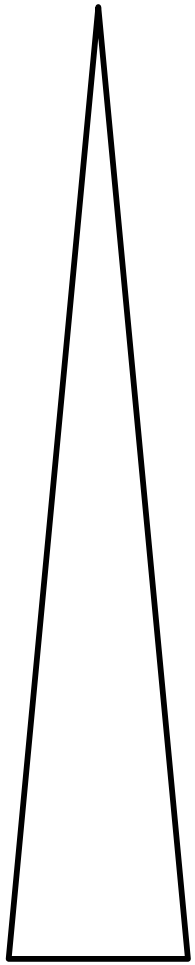
Fig. 2.24 Déformations et fissurations des sections pour les principaux modes de débit.

Voir table de construction en bois

The origin of wood

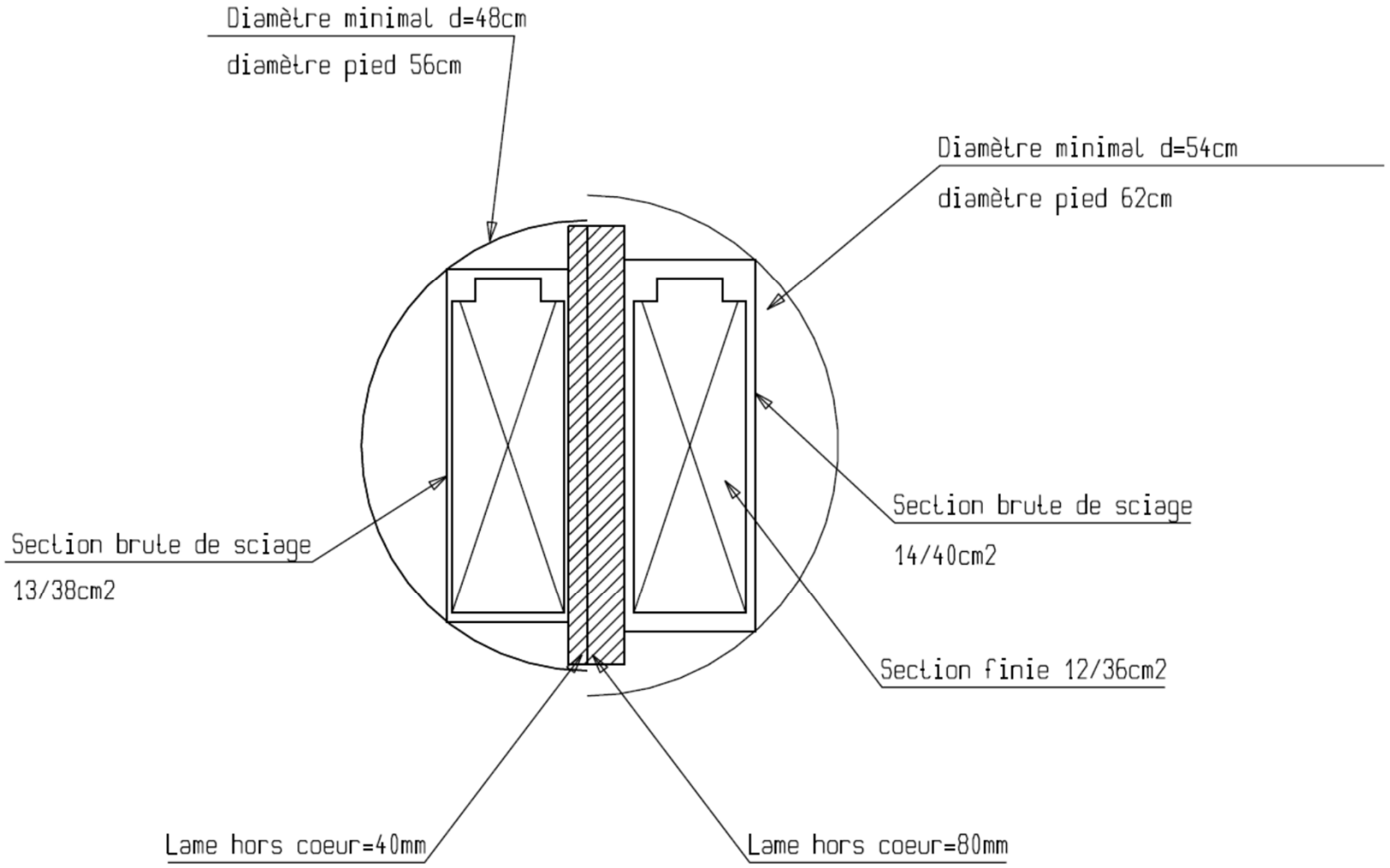
- The trunc of the tree

The shaft of the tree
about 1cm/meter



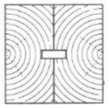
Solid wood beam

- Project of Ursy

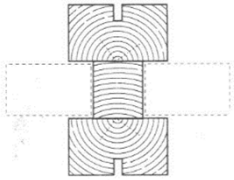


Composed sections

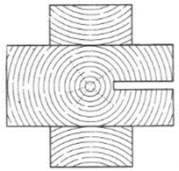
- To increase the surface – inertia -> the resistance



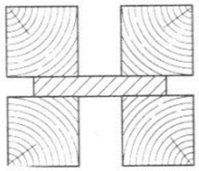
à partir de madriers à cœur refendu,
avec gorge de décharge à l'intérieur



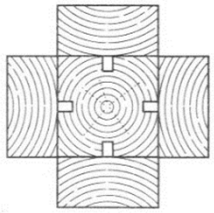
profil en I à partir de madriers



section en croix à partir de trois madriers

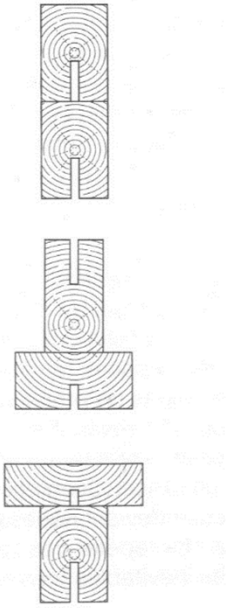


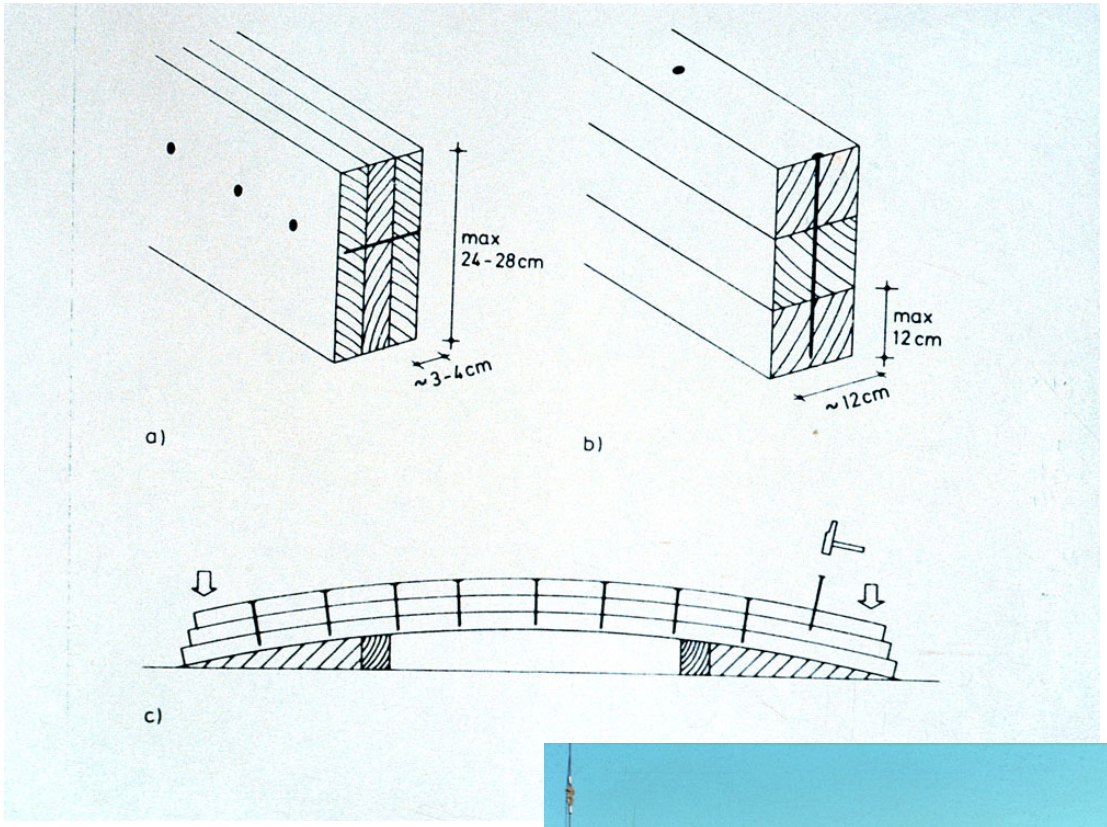
section rectangulaire composée d'un
bastaing et de quatre madriers



section en croix avec madrier et quat:-
bastaings

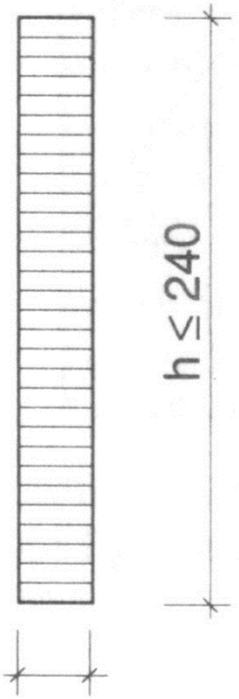
Sections composées de poutres



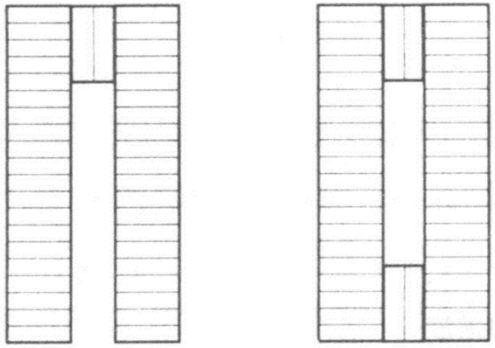

max
24 - 28cm
~3-4cm
a)
max
12 cm
~12cm
b)
c)

Glue laminated beams

Limit section



Multiple de 4cm



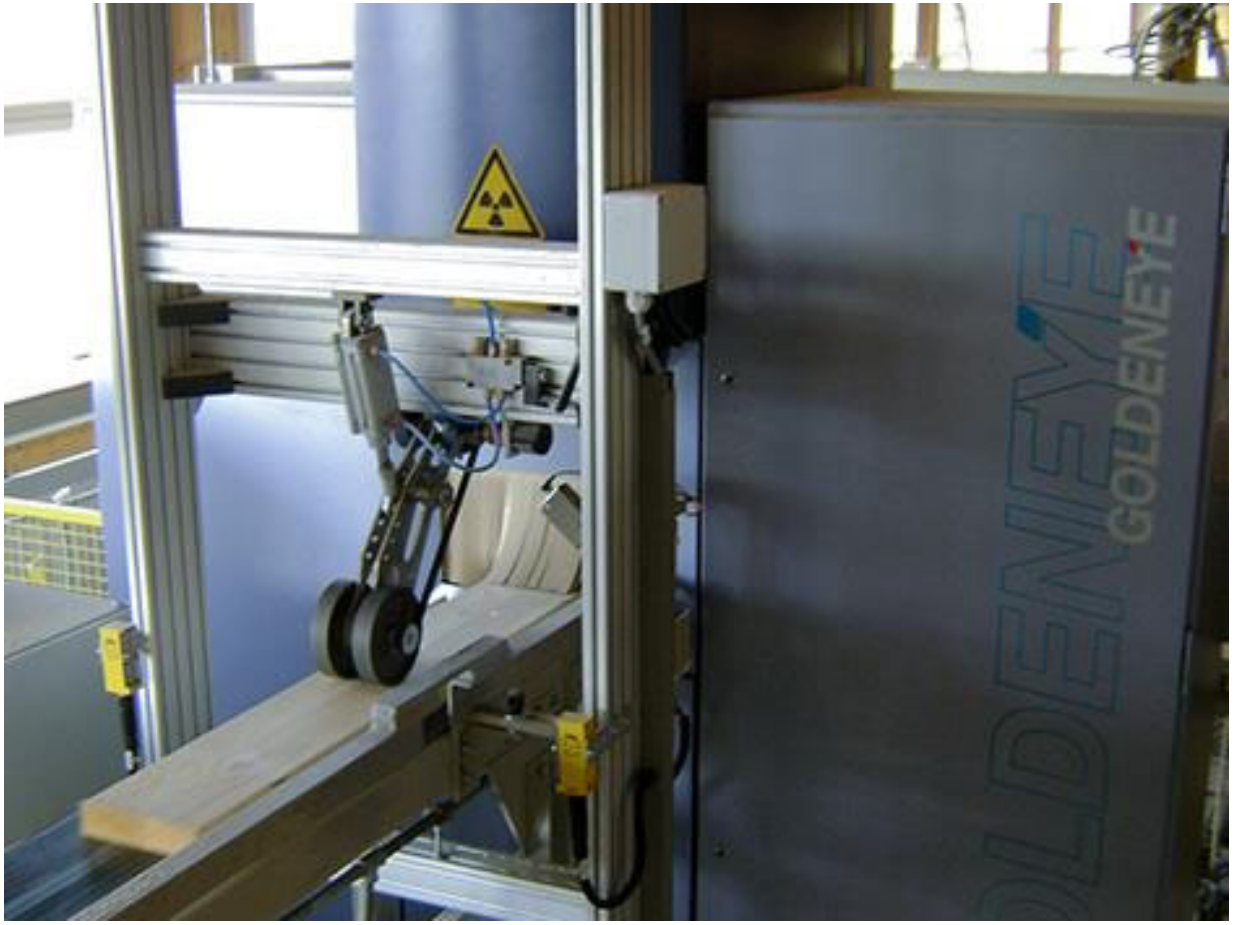
section en U retourné, section à caisson

12 < b < 24 cm

The manufacturing

- Sawing into boards Drying -> 12%
- Sorting
- Jointing
- Gluing
- Clamping and drying
- Size and finishing

Sorting – Golden Eye



Some points:

- Sorting speed: up to 450m/minute
- Measurement:
  - average wood density
  - humidity/moisture
  - rate of knot density

Classification of boards for GlueLam

Propriétés des lames

Les lames et leurs joints longitudinaux (en règle générale des aboutages dentelés) doivent correspondre aux caractéristiques du tableau 11 (EN 1194):

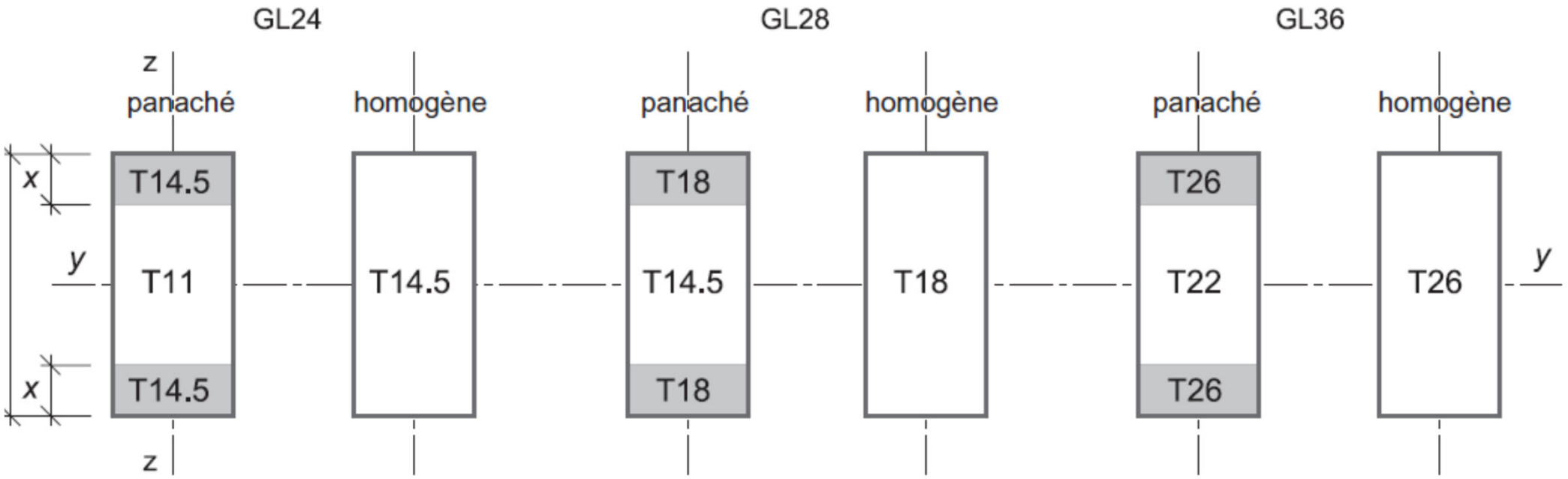
Tableau 11: Exigences relatives aux propriétés des lames et des aboutages

Désignation des lames		T11	T14.5	T18	T22 [3]	T26 [3]
Valeur caractéristique de la résistance à la traction, en N/mm²	$f_{t,0,l,k}$ [1]	11	14,5	18	22	26
Module E moyen en traction, en kN/mm²	$E_{t,0,mean}$	9	11	12	13	14
Valeur caractéristique de la résistance à la traction des aboutages dentelés, en N/mm²	$f_{t,j,k}$ [2]	16	20	23	27	31

[1] définie pour la section totale de la planche, pour une longueur libre de 2000 mm
[2] définie pour la section totale de l'aboutage, pour une longueur libre ≥ 200 mm
[3] vérifier les possibilités de fabrication (nécessite un tri mécanique)

Composition of Gluelam

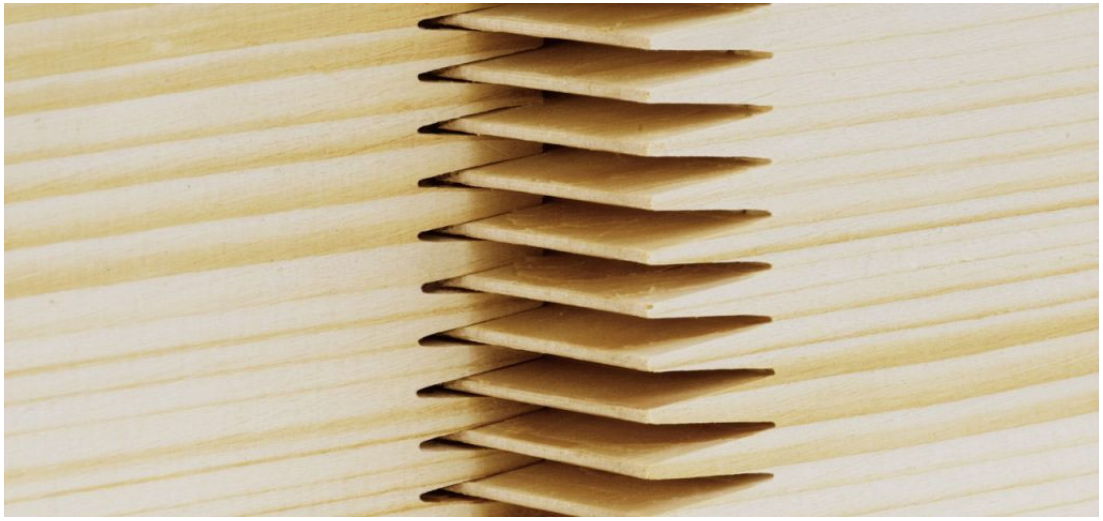
Figure 13: Constitution de la section de bois lamellé collé



$x \geq \frac{h}{6}$, au minimum 2 lames

T11: désignation des lames
T = tension (traction)
11 = valeur caractéristique de la résistance à la traction, en N/mm^2.

Butting



Board gluing

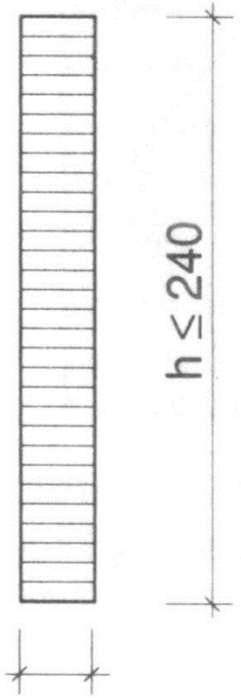
JPF-DUCRET

Machining and assembly

JPF-DUCRET

Technowood.ch

Limit of the sections



multiple of 4cm

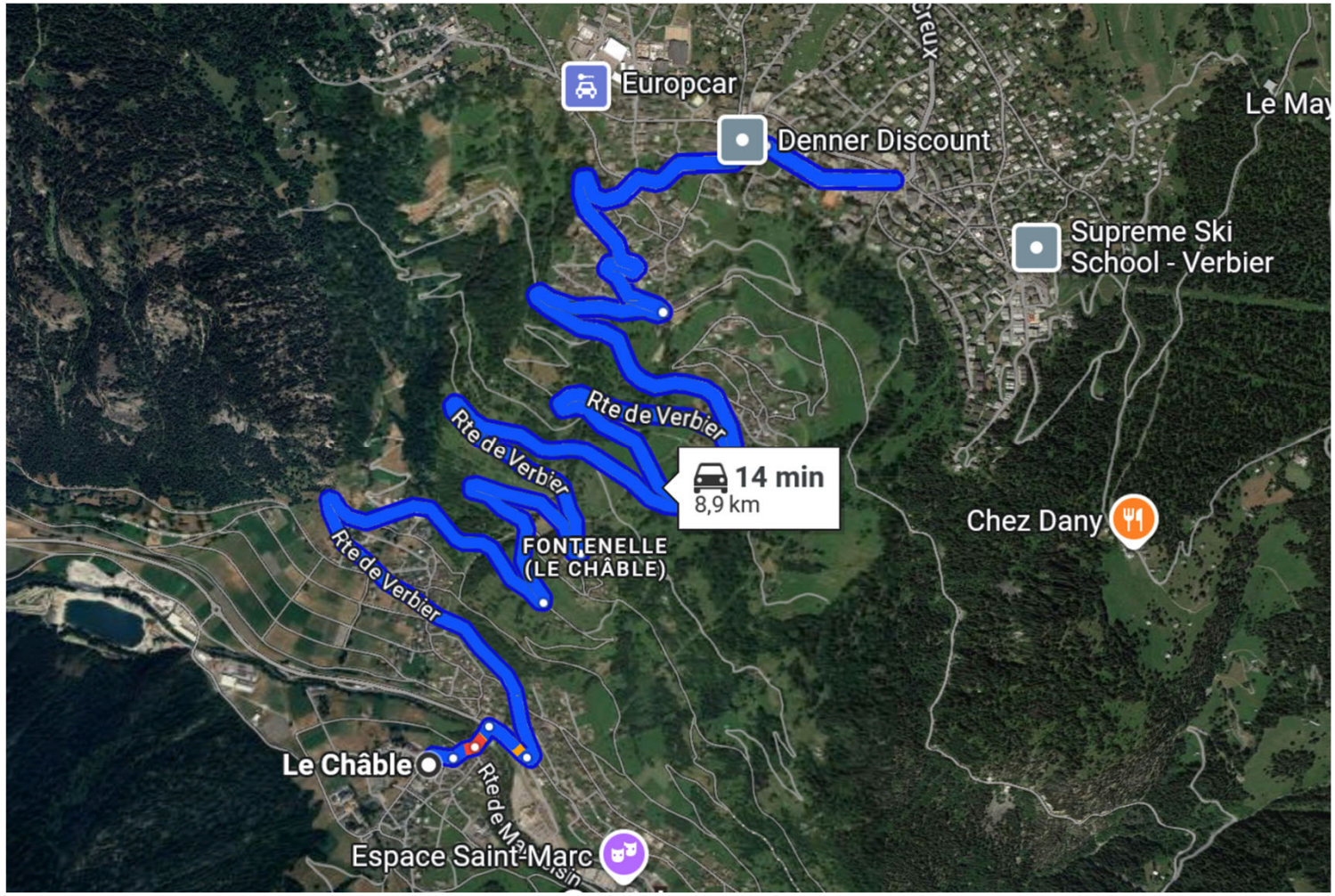
12 cm < b < 24 cm

Limit length

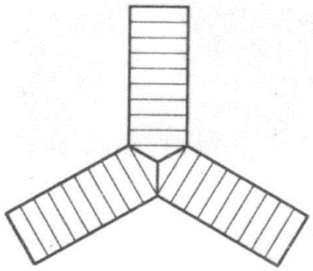
25 m - 38 m

Limit length

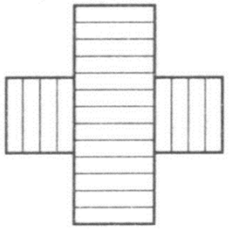
- Take care about the transport



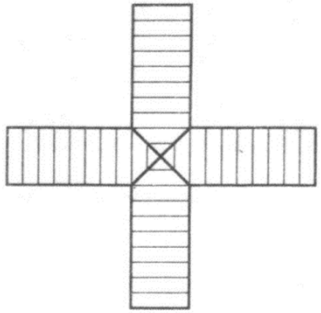
Composed sections



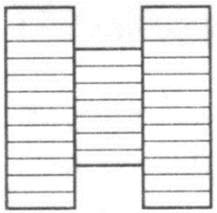
poteau triangulaire non massif

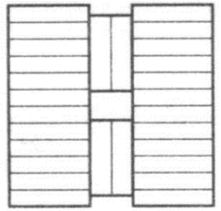


à éléments croisés

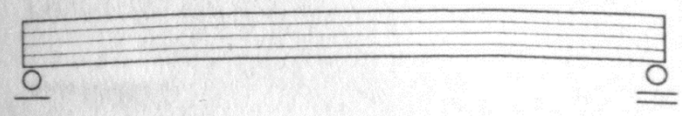


poteau en croix

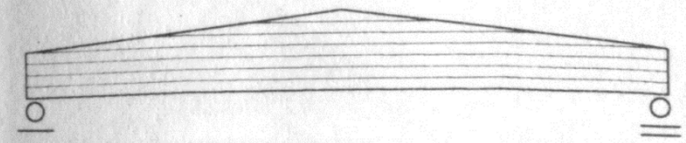




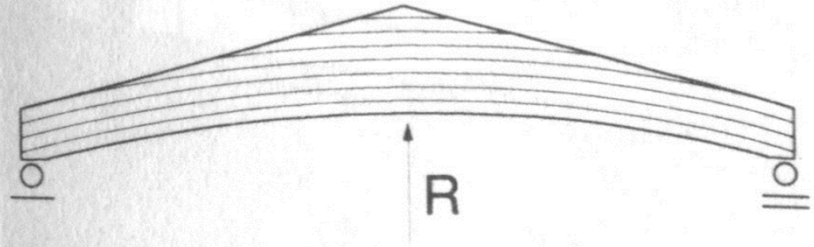
profils en I



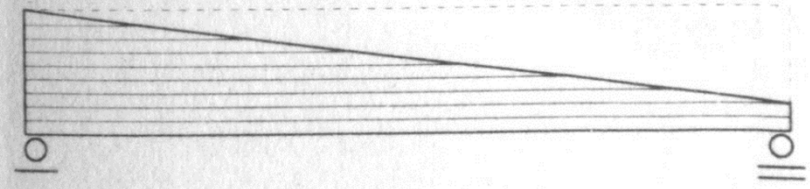
poutre lamellée-collée avec contre-flèche



poutre de toit à deux pans



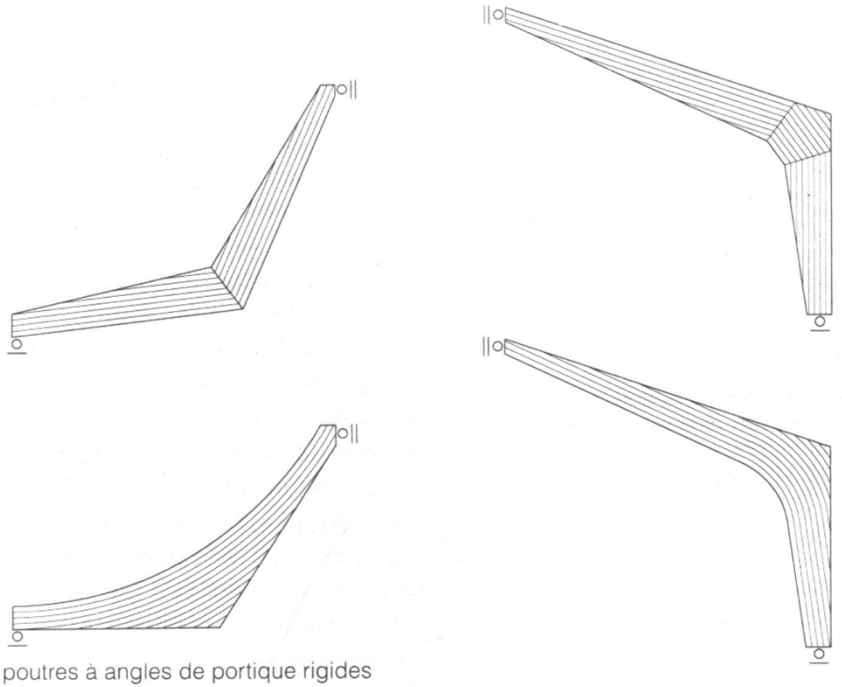
poutre de toit à deux pans, incurvée



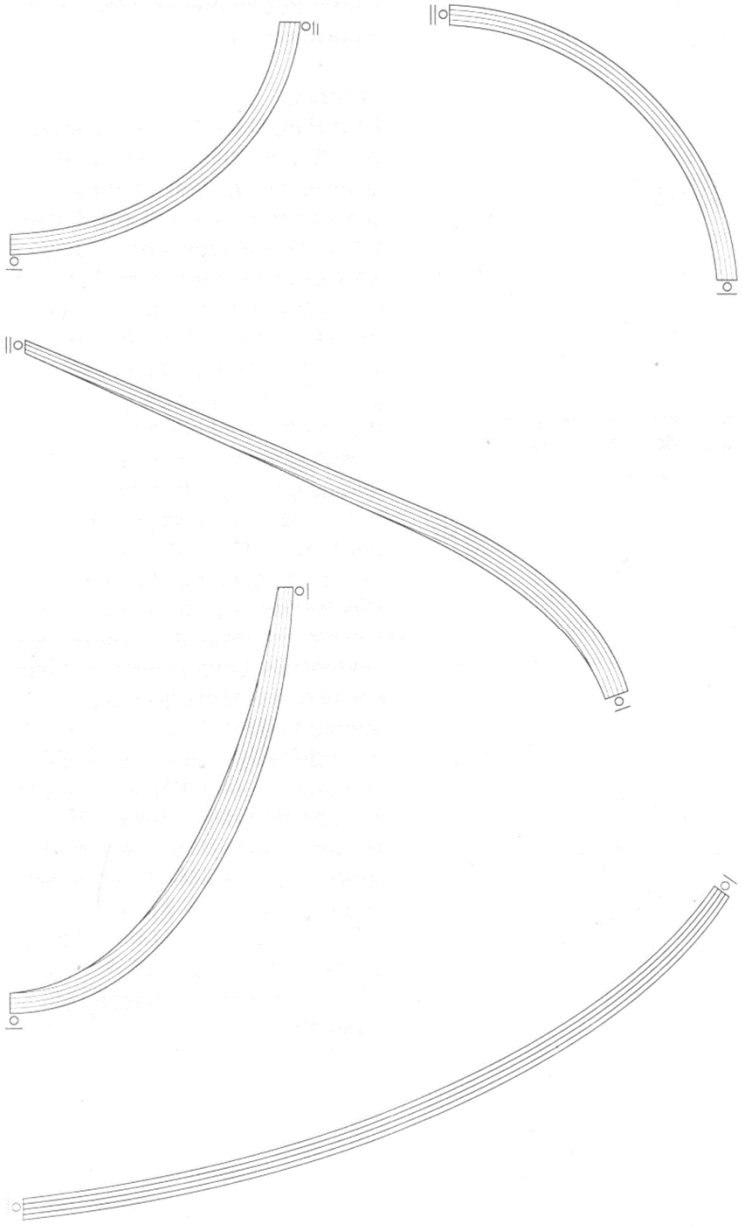
poutre rectangulaire donnant deux éléments de pan de toit

Multi-glued laminated timber

Curved Glulam



poutres à angles de portique rigides



poutres à courbure simple

The curved

- Radius representation – inne constraint

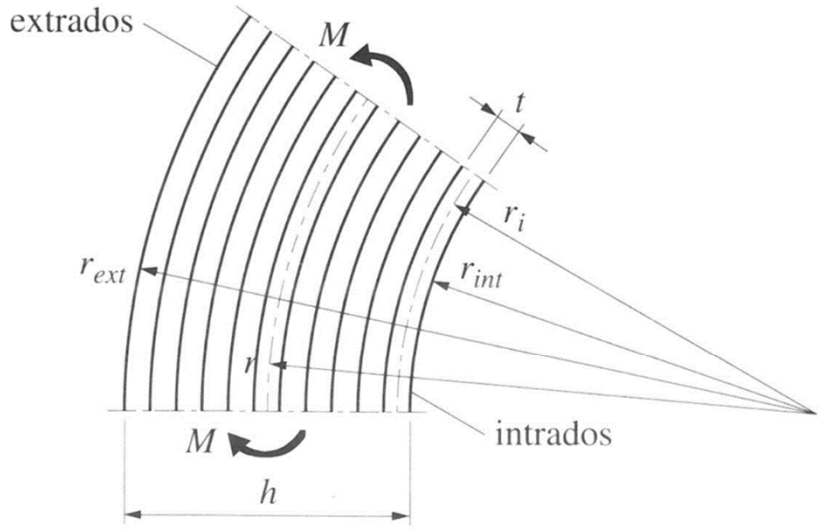


Fig. 6.41 Représentation des différents rayons de courbure à considérer.

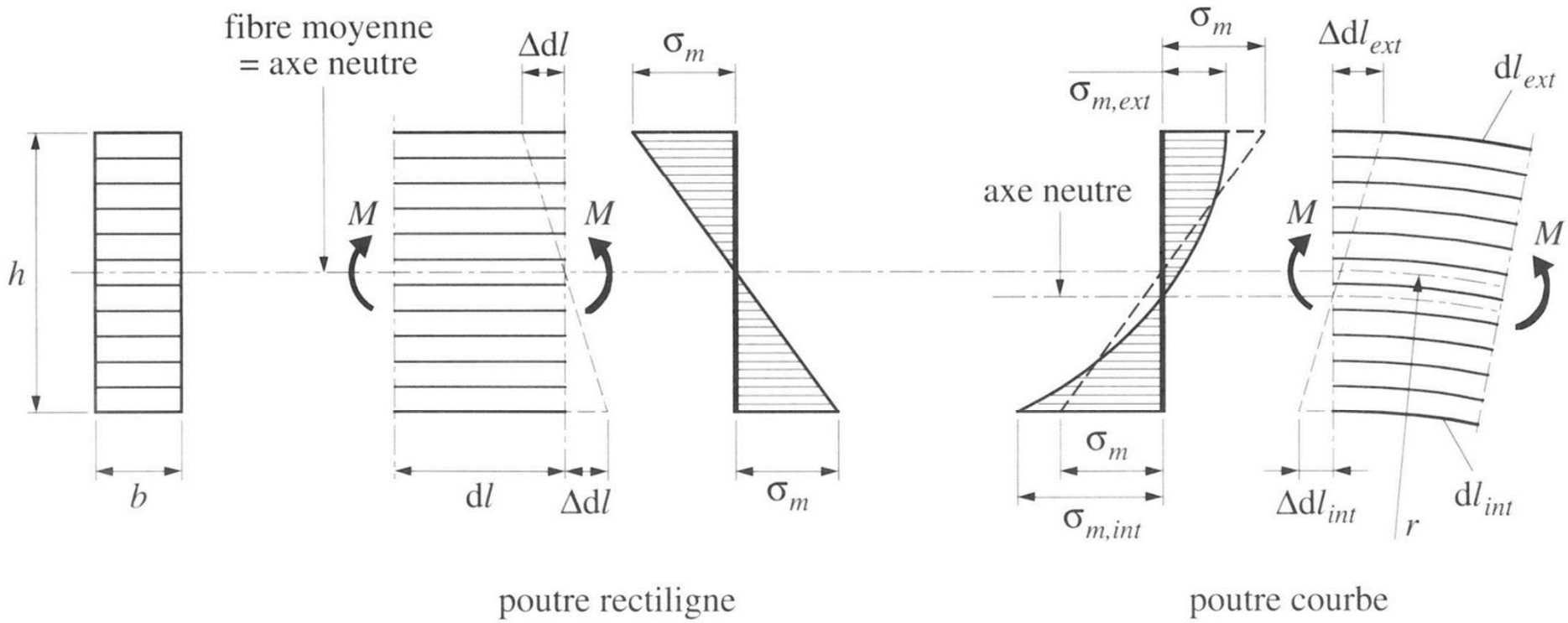
Curved beam

- Inner constraint

$$\sigma = \frac{1}{2}\frac{E\,t}{r_{int}} = \frac{1}{2}\frac{10\,000\ \mathrm{N/mm^2}}{200} = 25\ \mathrm{N/mm^2}$$

Curved beam

- Representation of the flexion



Curved beam

- Factor $k_{//}$

$$\sigma_{m,d} = k_{||} \frac{M_d}{W} \qquad (6.41)$$

$\sigma_{m,d}$: valeur de calcul de la contrainte de flexion
$k_{||}$: coefficient tenant compte de la distribution hyperbolique des contraintes de flexion pour les poutres courbes à inertie constante
M_d : valeur de calcul du moment de flexion

- According to eurocode 5

$$k_{||} = 1 + 0.35\left(\frac{h}{r}\right) + 0.6\left(\frac{h}{r}\right)^2$$

- Selon SIA 164

$$k_{||} = 1 + \frac{h}{2\,r}$$

Curved beam

- According to SIA 265

Contraintes tangentielles (parallèles au fil):

– extrados:

$$\sigma_{ma,d} = \left| -\frac{M_{Ed}}{W} \right| \leq k_r \, f_{m,d}$$

– intrados:

$$\sigma_{mi,d} = \left| +\frac{M_{Ed}}{W} \left(1 + \frac{h}{2r} \right) \right| \leq f_{m,d}$$

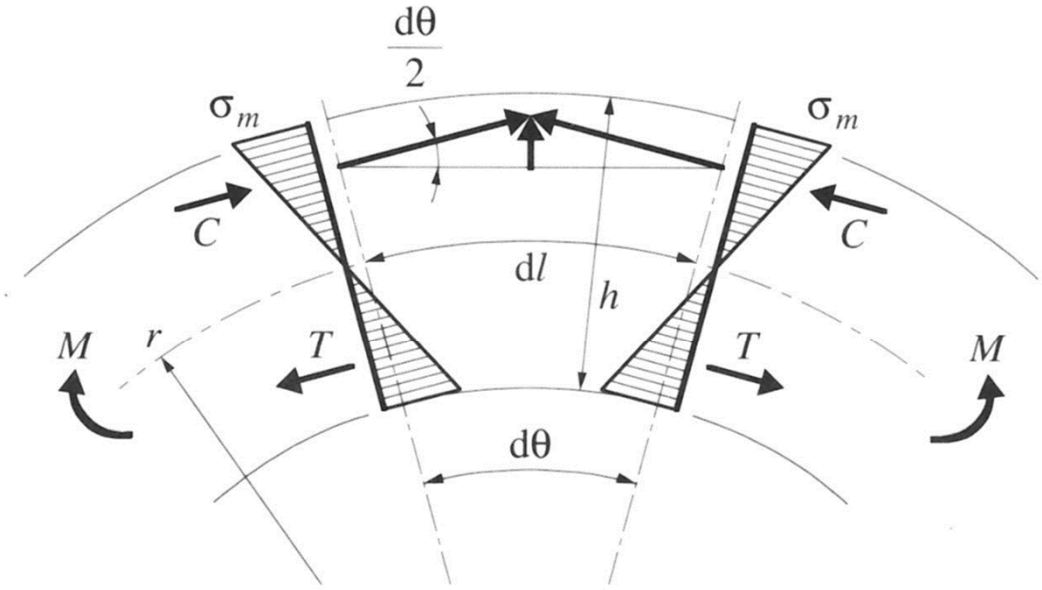
$$k_r = 1 - 40 \, \frac{t}{r_a}$$

t épaisseur des lames

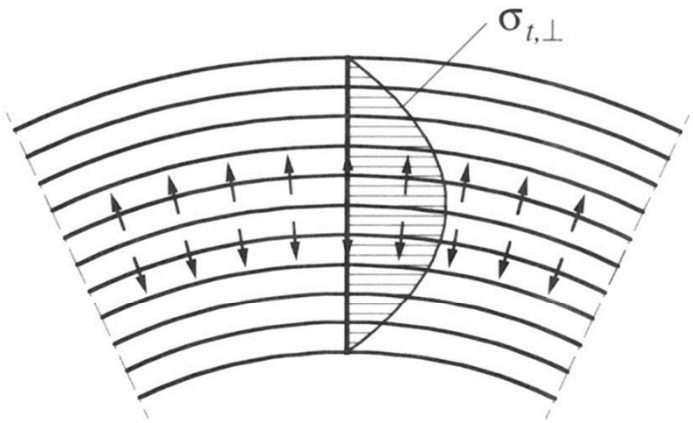
r_a rayon de courbure de l'extrados.

Curved beam

- Another specail feature – traction perpendicular to the fiber



mise en évidence de la composante transversale



contrainte transversale

Curved beam

- Traction perpendicular to the beam

$$\sigma_{t,\perp,d} = k_{\perp} \frac{M_d}{W} \qquad (6.46)$$

$\sigma_{t,\perp,d}$: valeur de calcul de la contrainte de traction perpendiculaire aux fibres
$k_{\perp}$: coefficient lié à la géométrie de la poutre ($k_{\perp} = h/(4\ r)$ pour une poutre courbe d'inertie constante)
M_d : valeur de calcul du moment de flexion
W : module de flexion de la section

Curved beam

- Reinforcement perpendicular to the beam

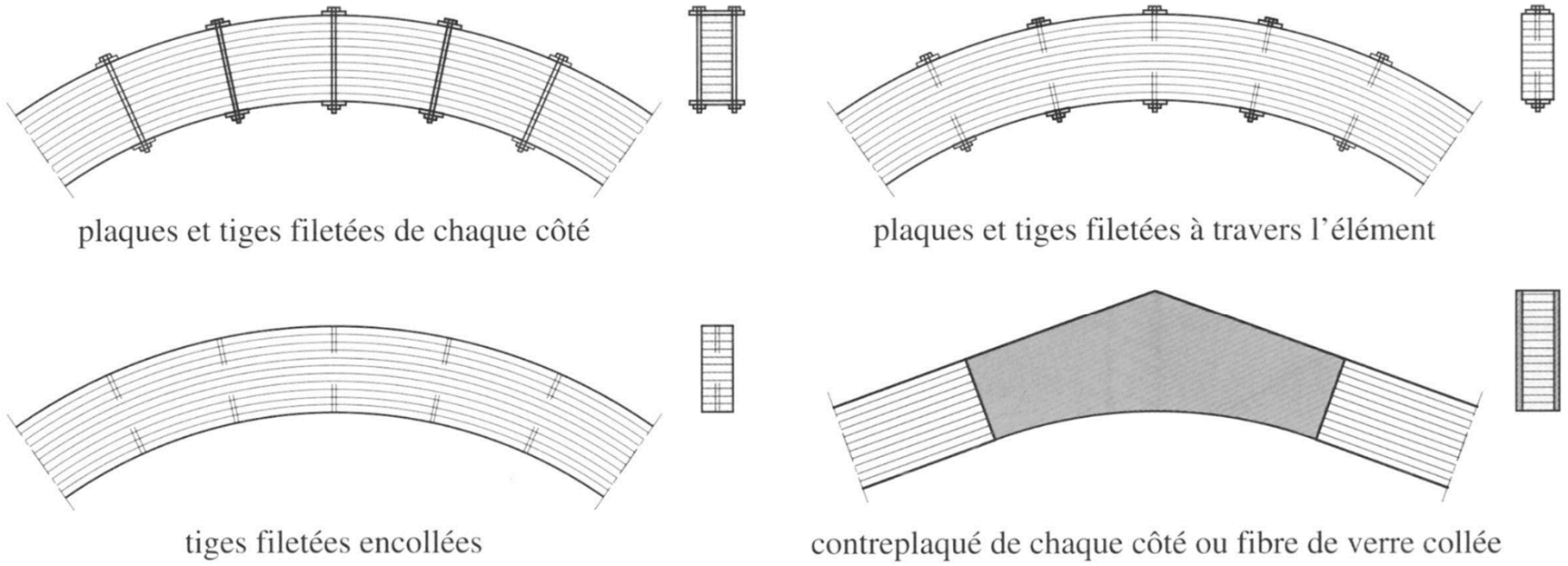
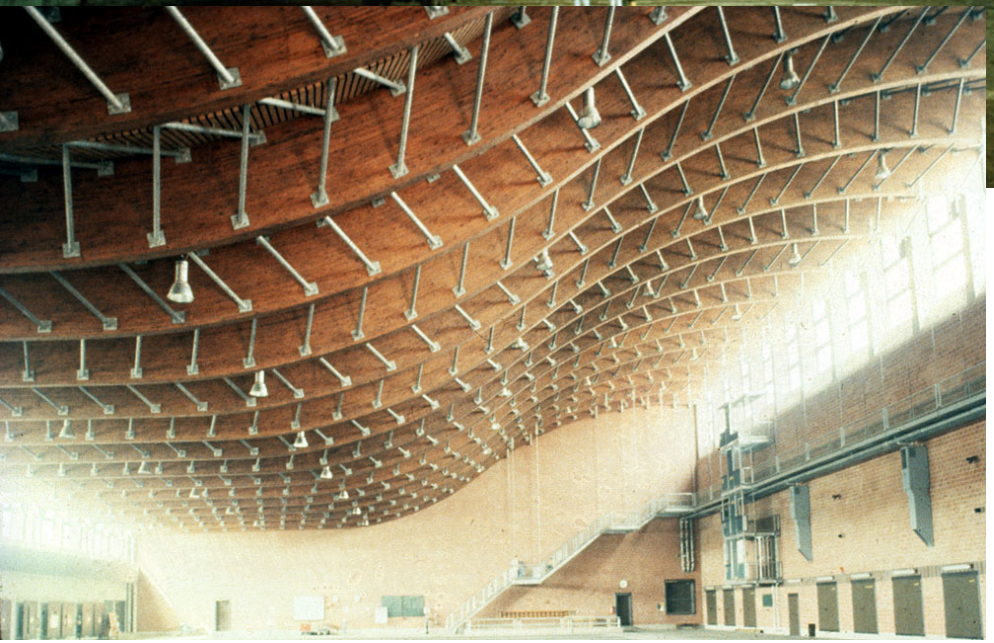
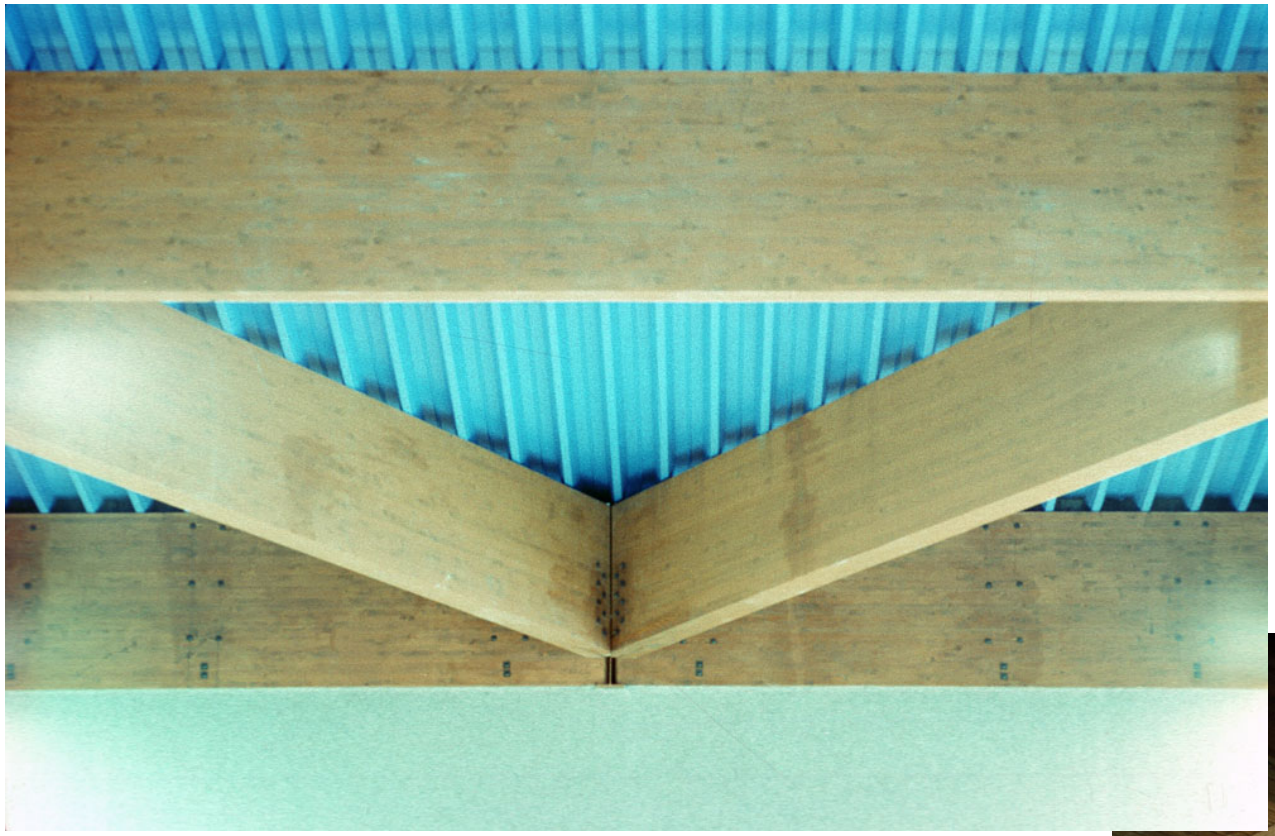
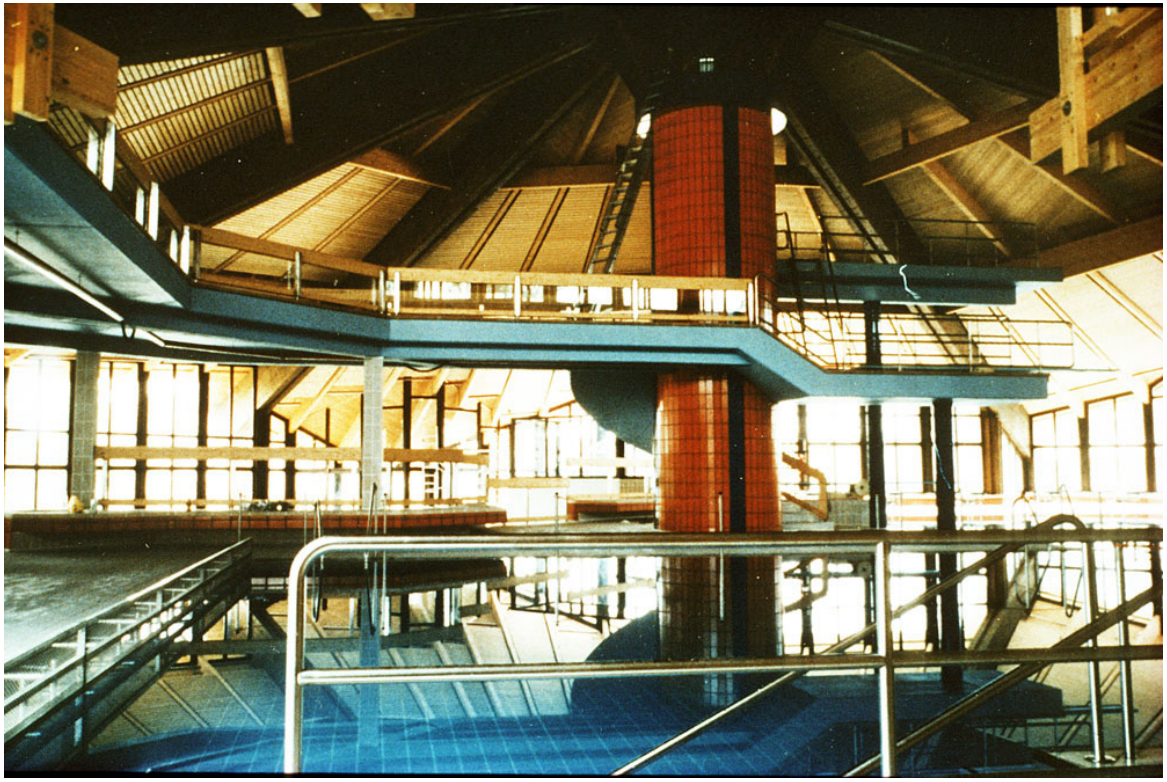
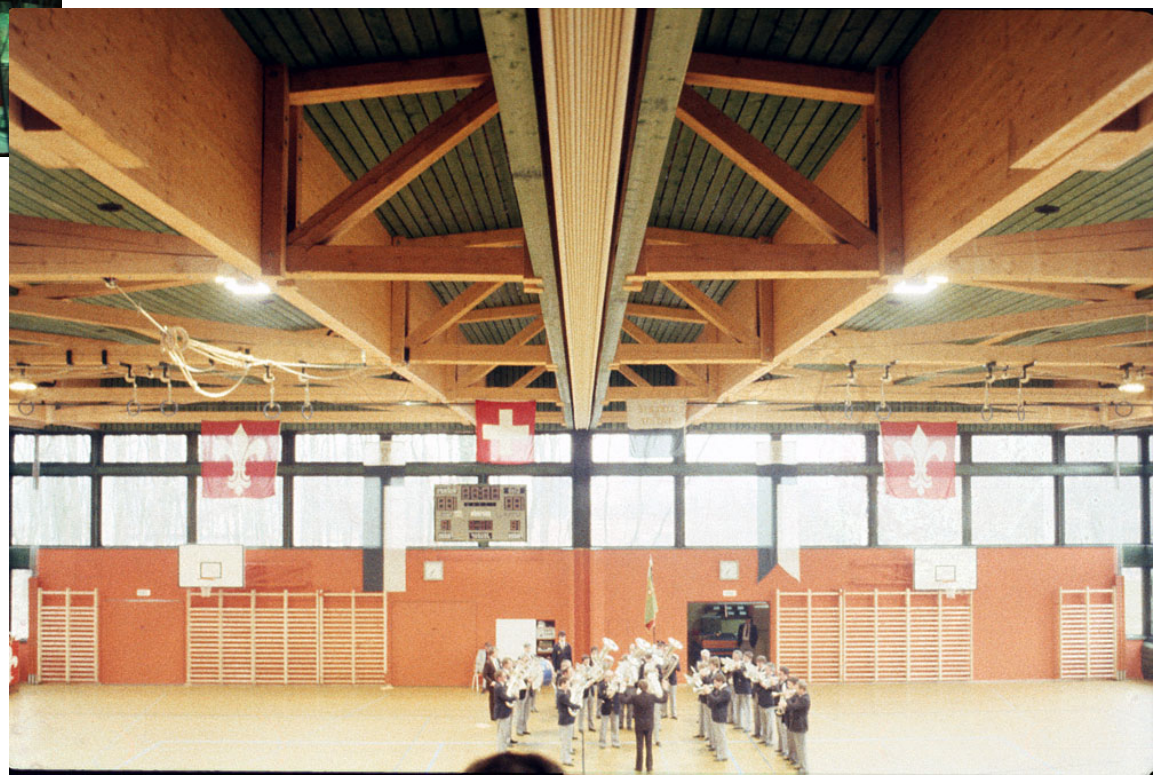


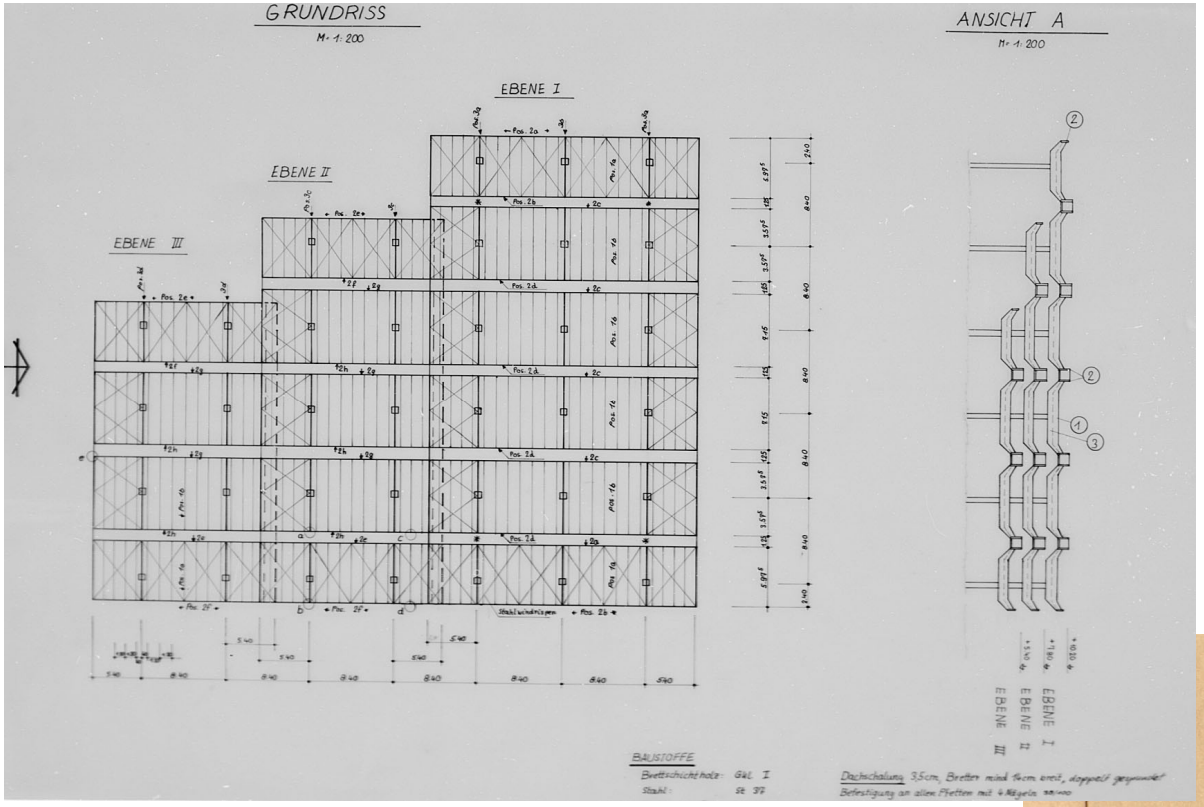
Fig. 6.44 Systèmes de renforcements en traction perpendiculaire des arcs cintrés en bois.

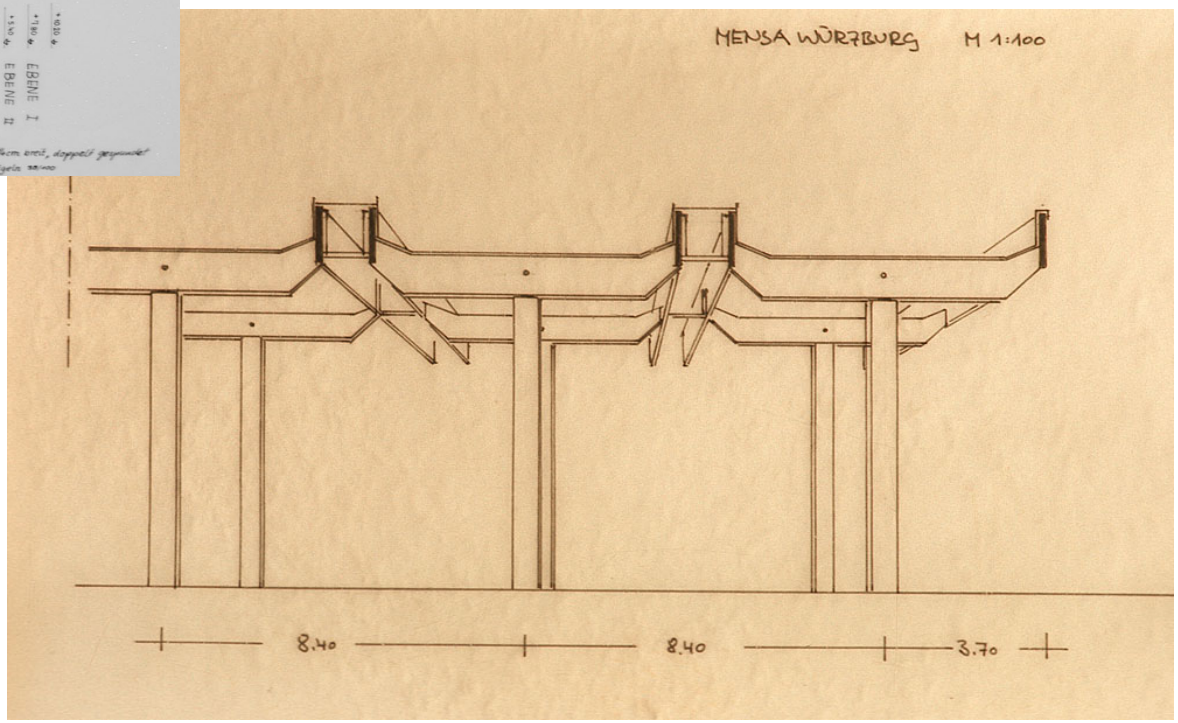


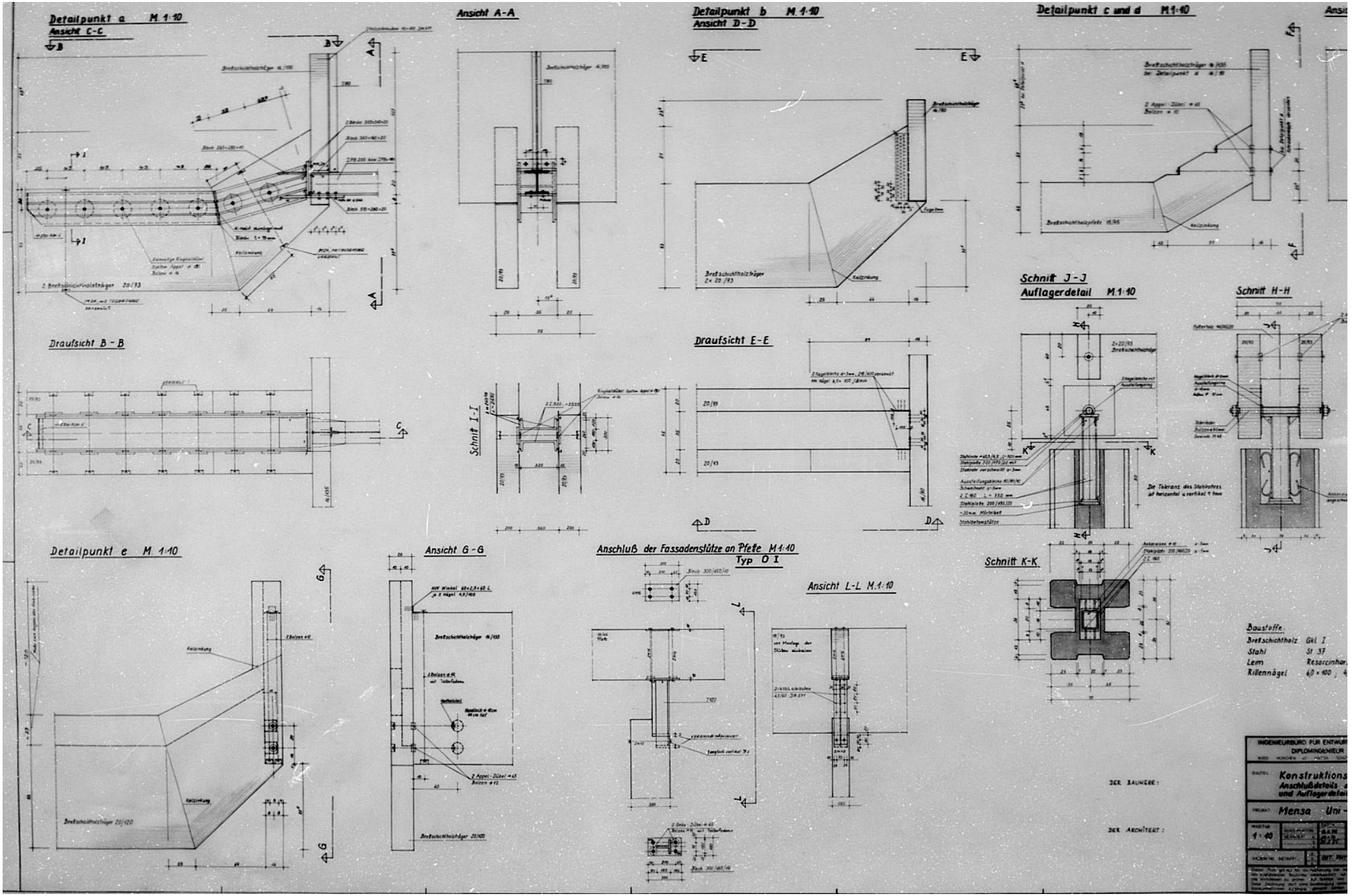


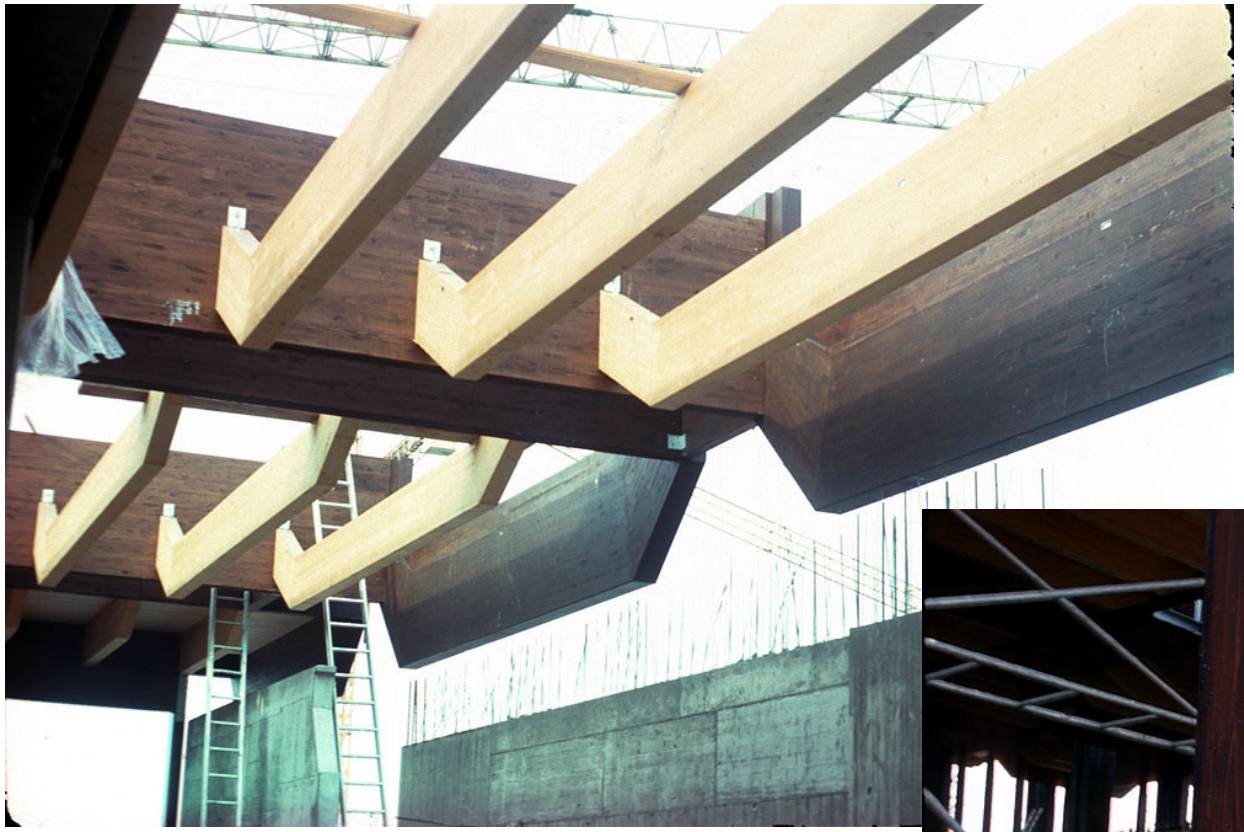


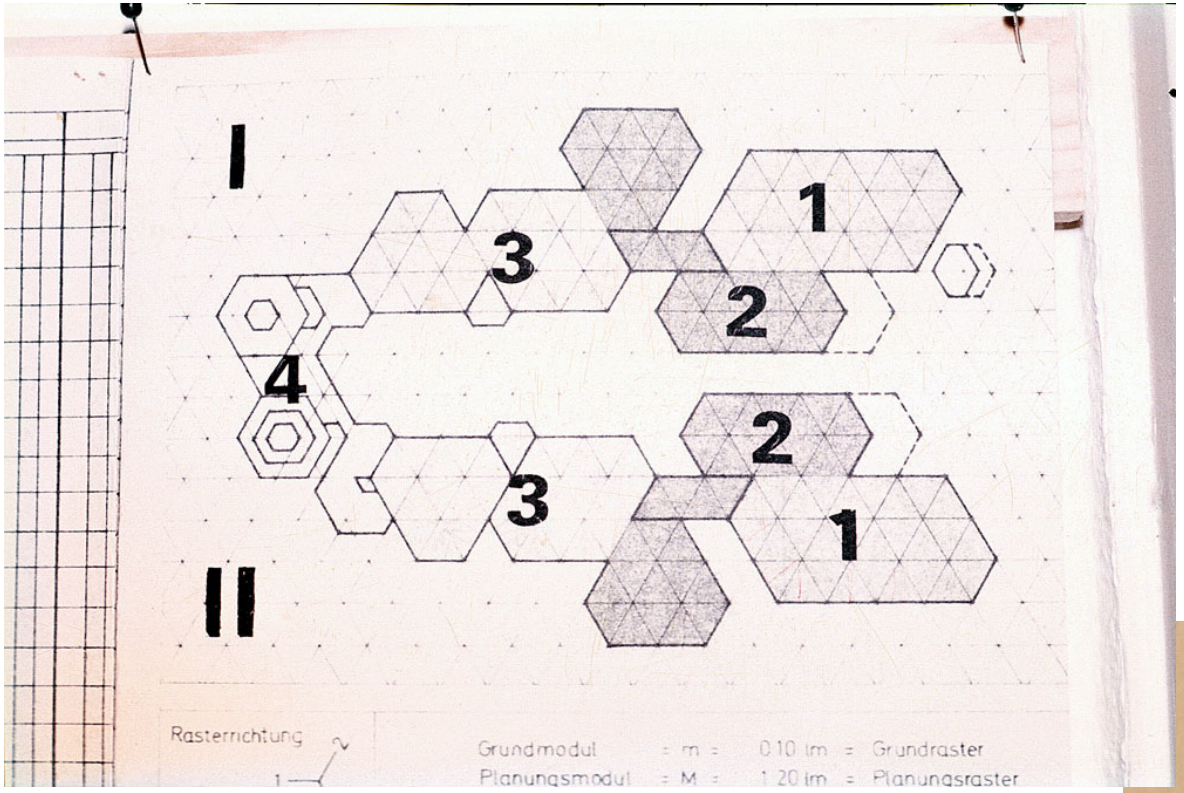


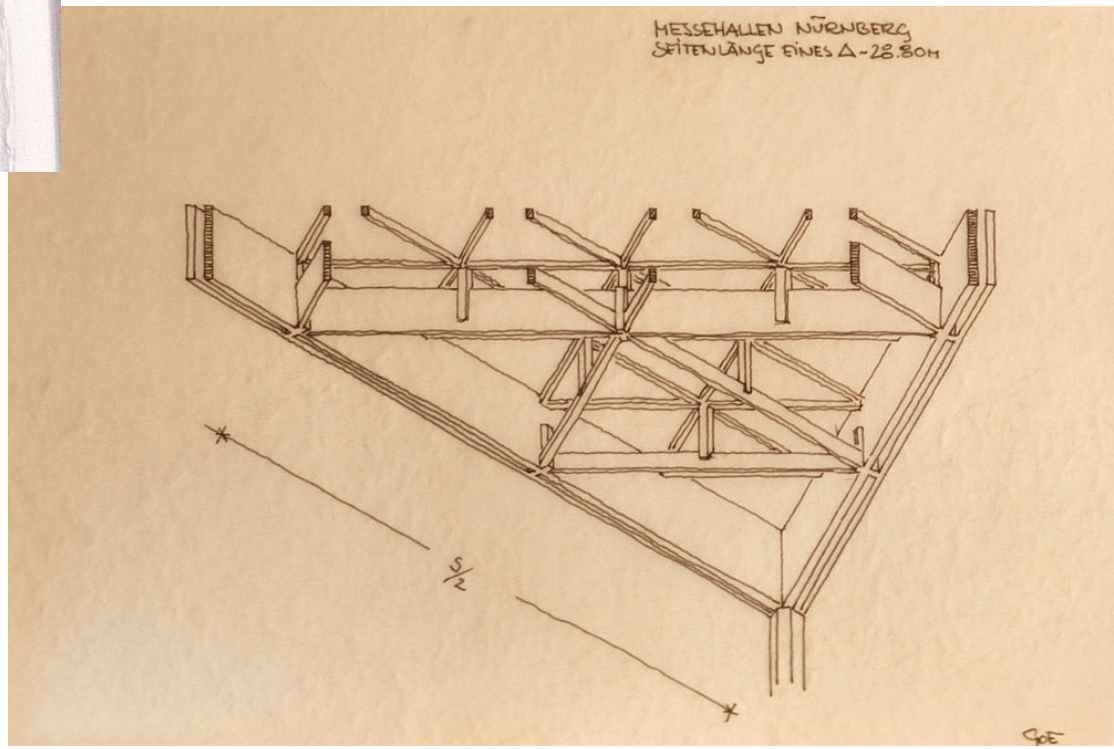

GRUNDRISS
M 1:200
ANSICHT A
M 1:200
EBENE I
EBENE II
EBENE III
BAUSTOFFE
Dachschalung 3,5cm, Bretter mind 9cm breit, doppelt gegenwinkelt
Befestigung an allen Pfetten mit 4 Nägeln

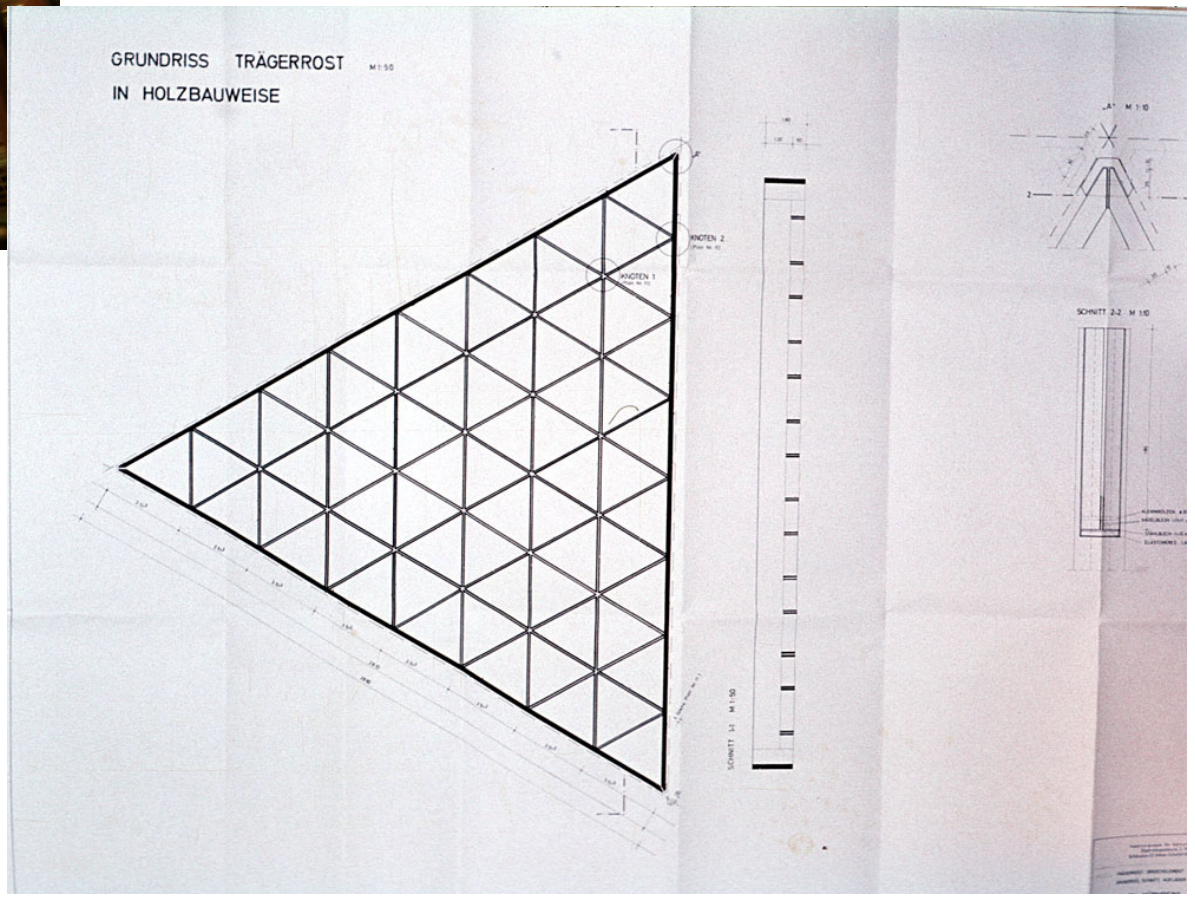

MENSA WÜRZBURG M 1:100
8.40
8.40
3.70


Detailpunkt a M 1:10
Ansicht C-C
Ansicht A-A
Detailpunkt b M 1:10
Ansicht D-D
Detailpunkt c und d M 1:10
Schnitt J-J
Auflagerdetail M 1:10
Schnitt H-H
Draufsicht B-B
Schnitt I-I
Draufsicht E-E
Schnitt K-K
Detailpunkt e M 1:10
Ansicht G-G
Anschluß der Fassadenstütze an Pfeile M 1:10
Typ D I
Ansicht L-L M 1:10
Baustoffe:
Brettschichtholz GKl I
Stahl St 37
Leim Resorcinharz
Rillennägel 4,0 x 100
Konstruktions
Anschlußdetails
und Auflagerdetail
Mensa Uni
1 : 10

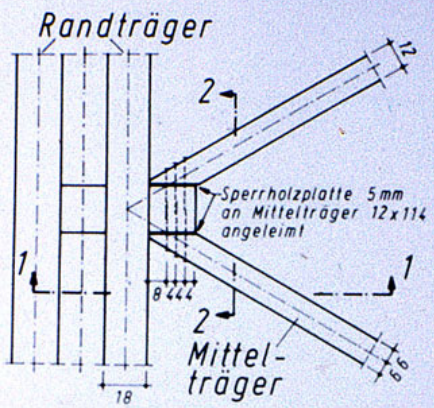



I
1
3
2
4
2
3
1
II
Rasterrichtung
Grundmodul = m = 0.10 lm = Grundraster
Planungsmodul = M = 1.20 lm = Planungsraster

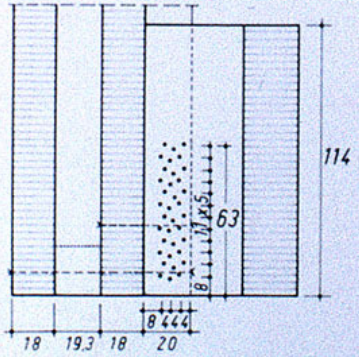

MESSEHALLEN NÜRNBERG
SEITENLÄNGE EINES Δ ~ 28.80M
S/2


GRUNDRISS TRÄGERROST M 1:50
IN HOLZBAUWEISE
KNOTEN 2
KNOTEN 1
SCHNITT 1-1 M 1:50
A M 1:10
SCHNITT 2-2 M 1:10

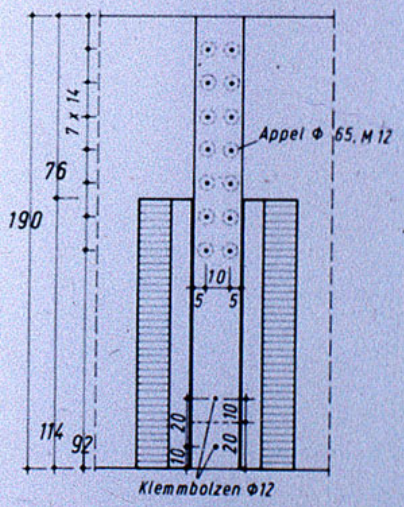
Anschluß Mittelträger an Randträger



Schnitt 1-1

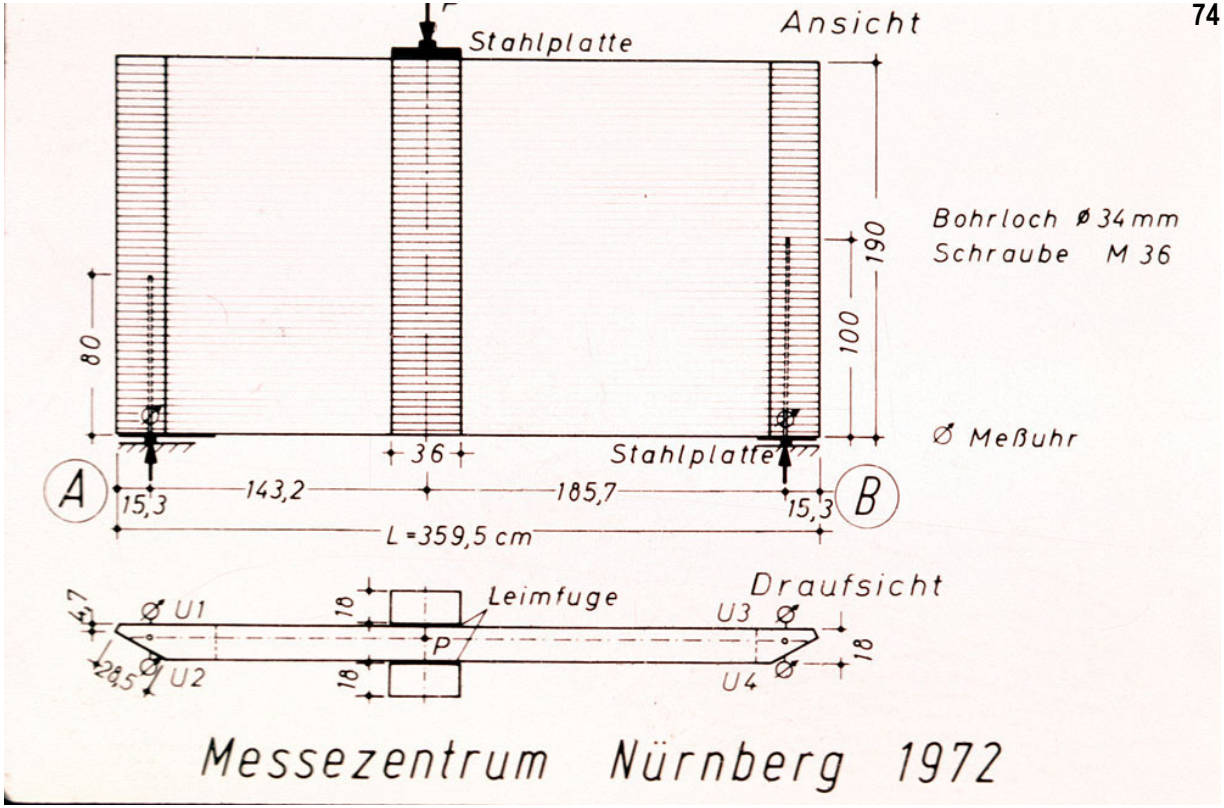


Schnitt 2-2

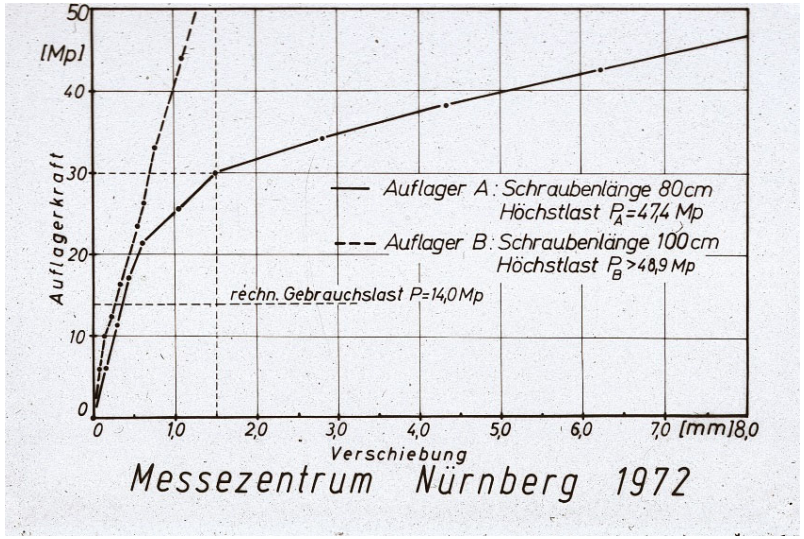


2x36 Nägel 70x210 verzinkt, vorgebohrt, Nagelbild um 25mm versetzt!

Messezentrum Nürnberg 1972



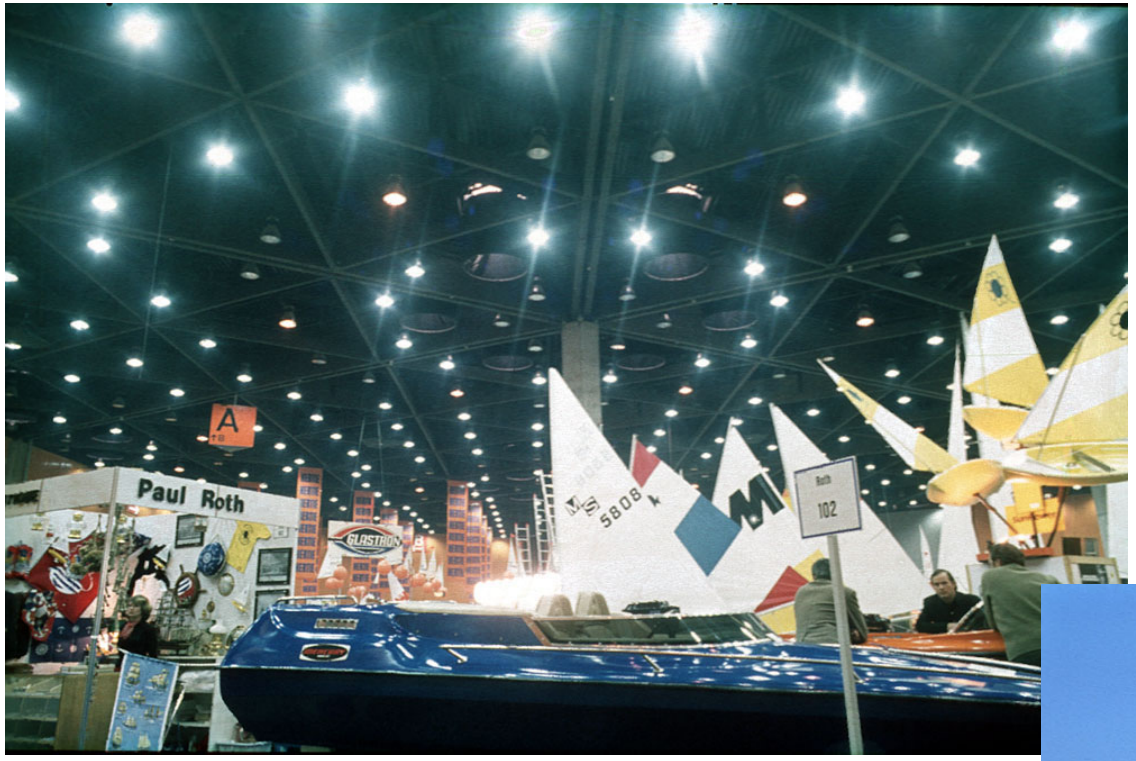
Messezentrum Nürnberg 1972



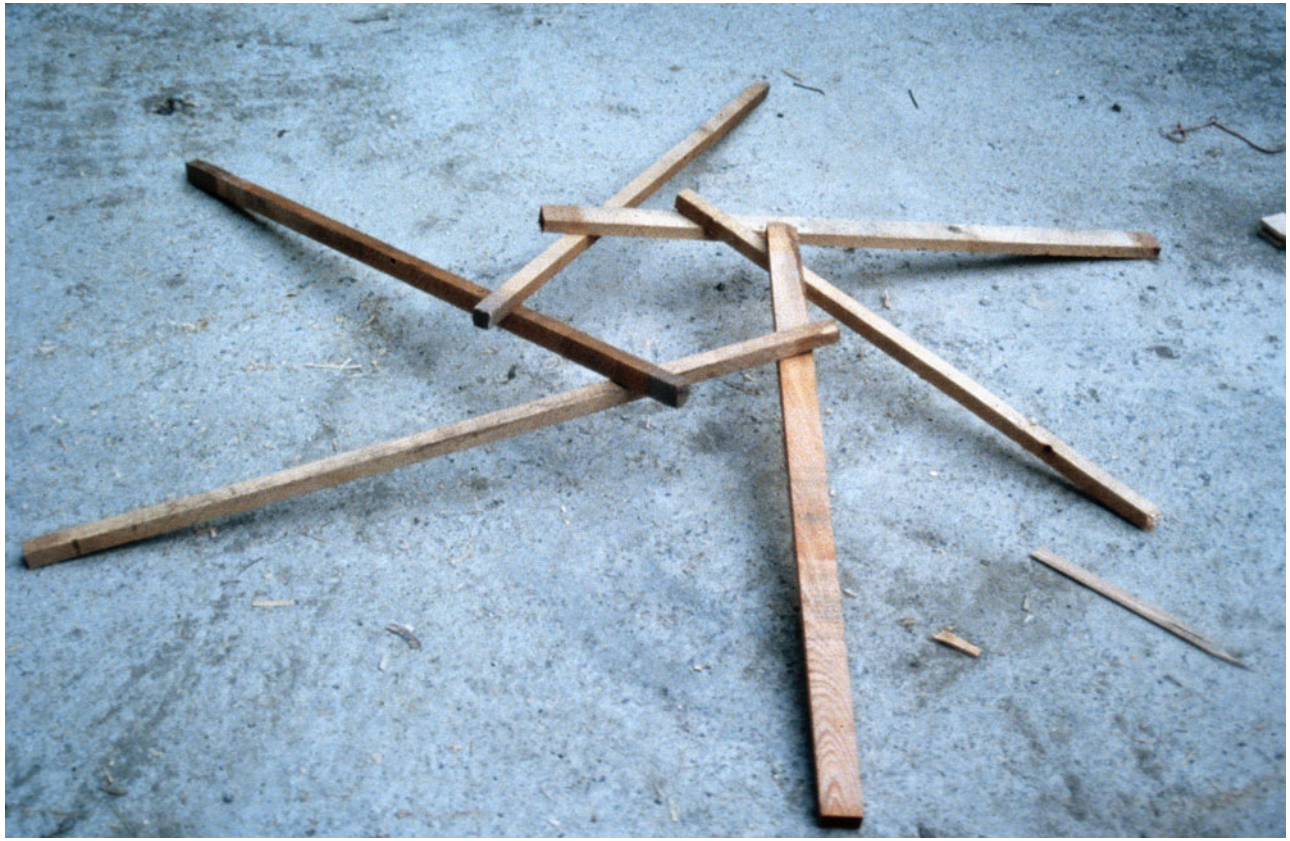
Messezentrum Nürnberg 1972


ROSENKRANZ


ROSENKRANZ

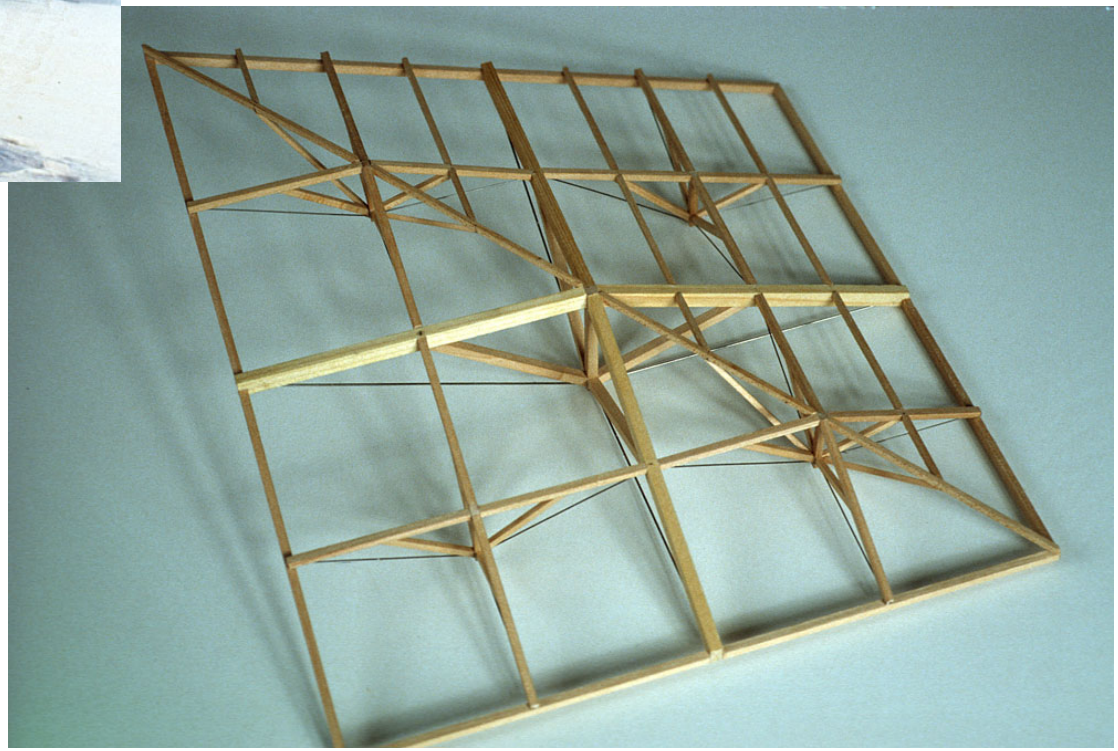

A
Paul Roth
GLASTRON
MS 5808
Roth
102

Reciprocal beam systems

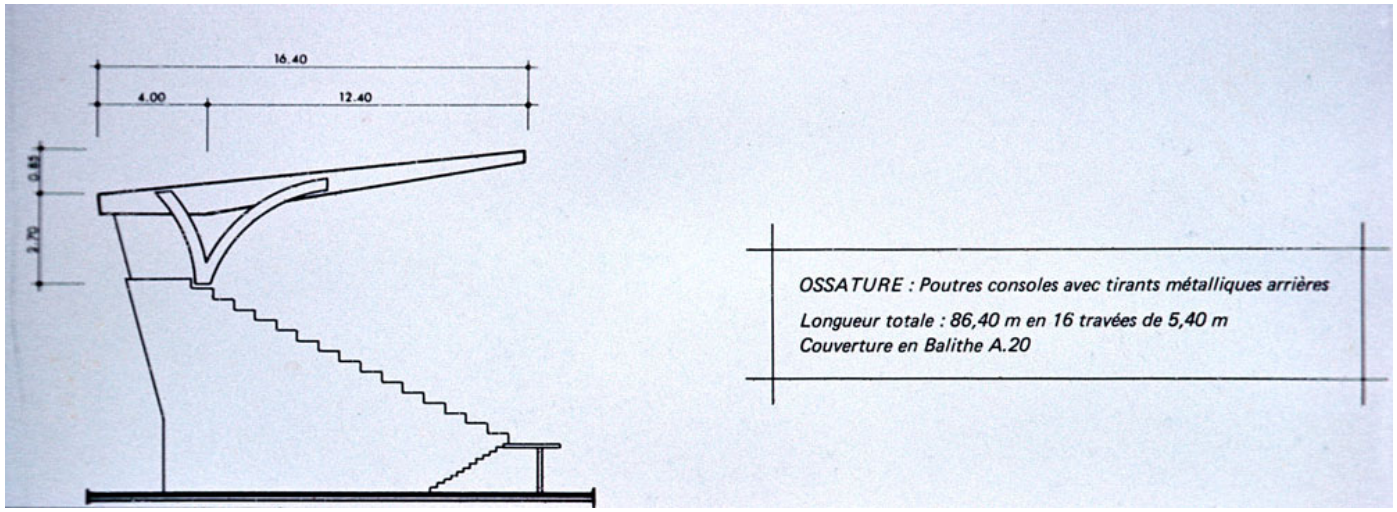


Poutre sous-tendue


SCHÜBEL SCHUHE
WESTERN STORE
STADTSPARKASSE
radio blank
Tack
Tack VORSORGE

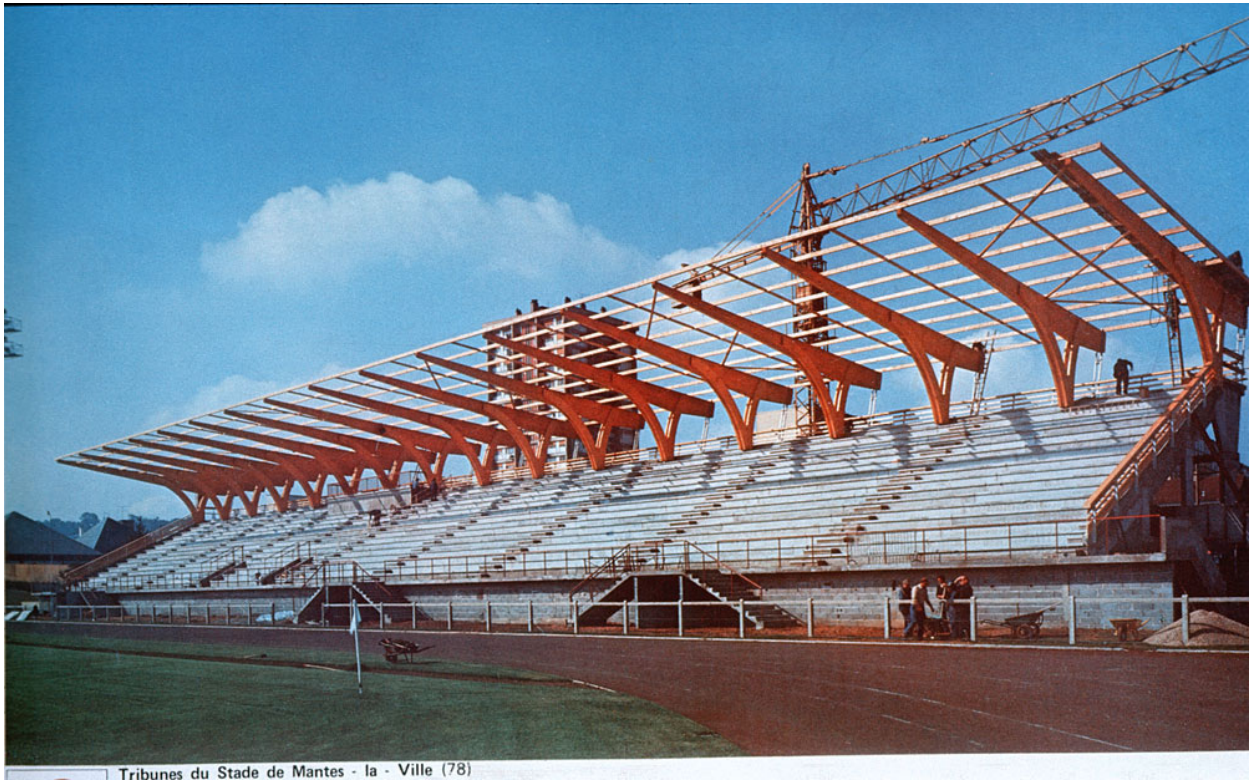


Système à porte à faux

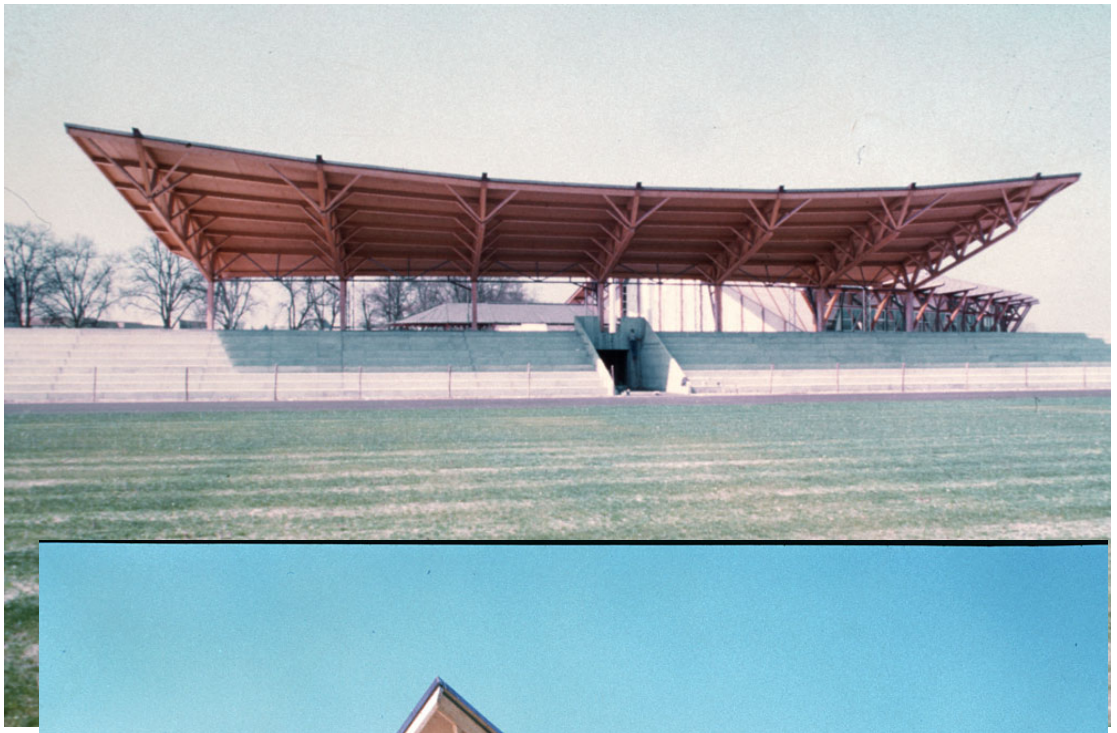


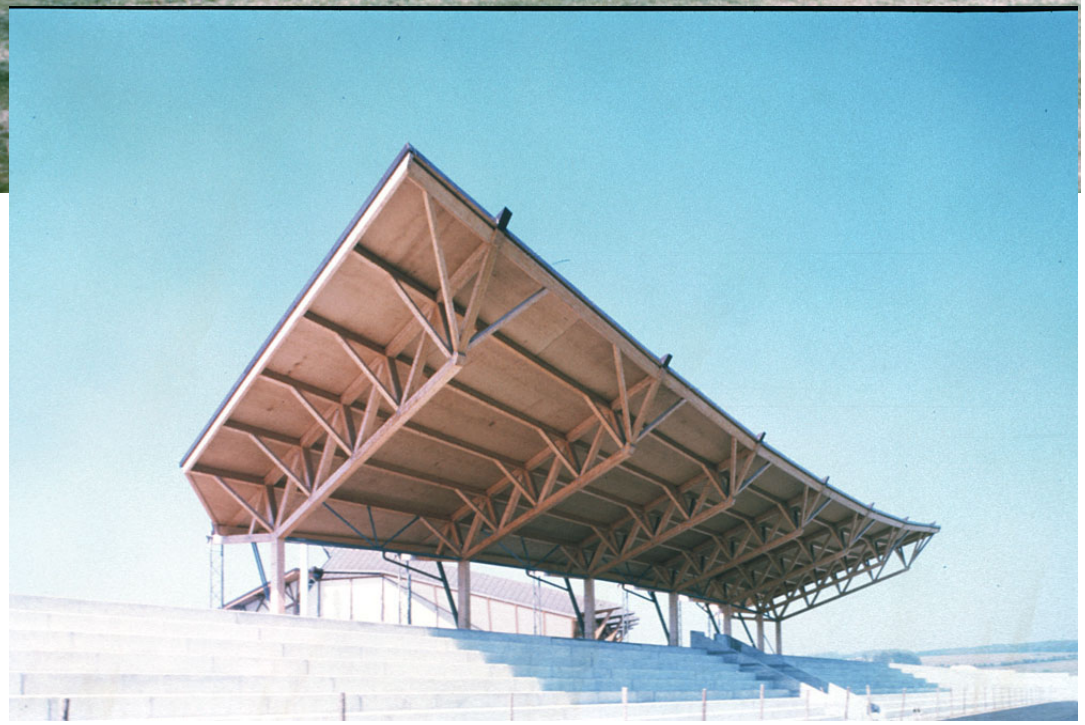
OSSATURE : Poutres consoles avec tirants métalliques arrières

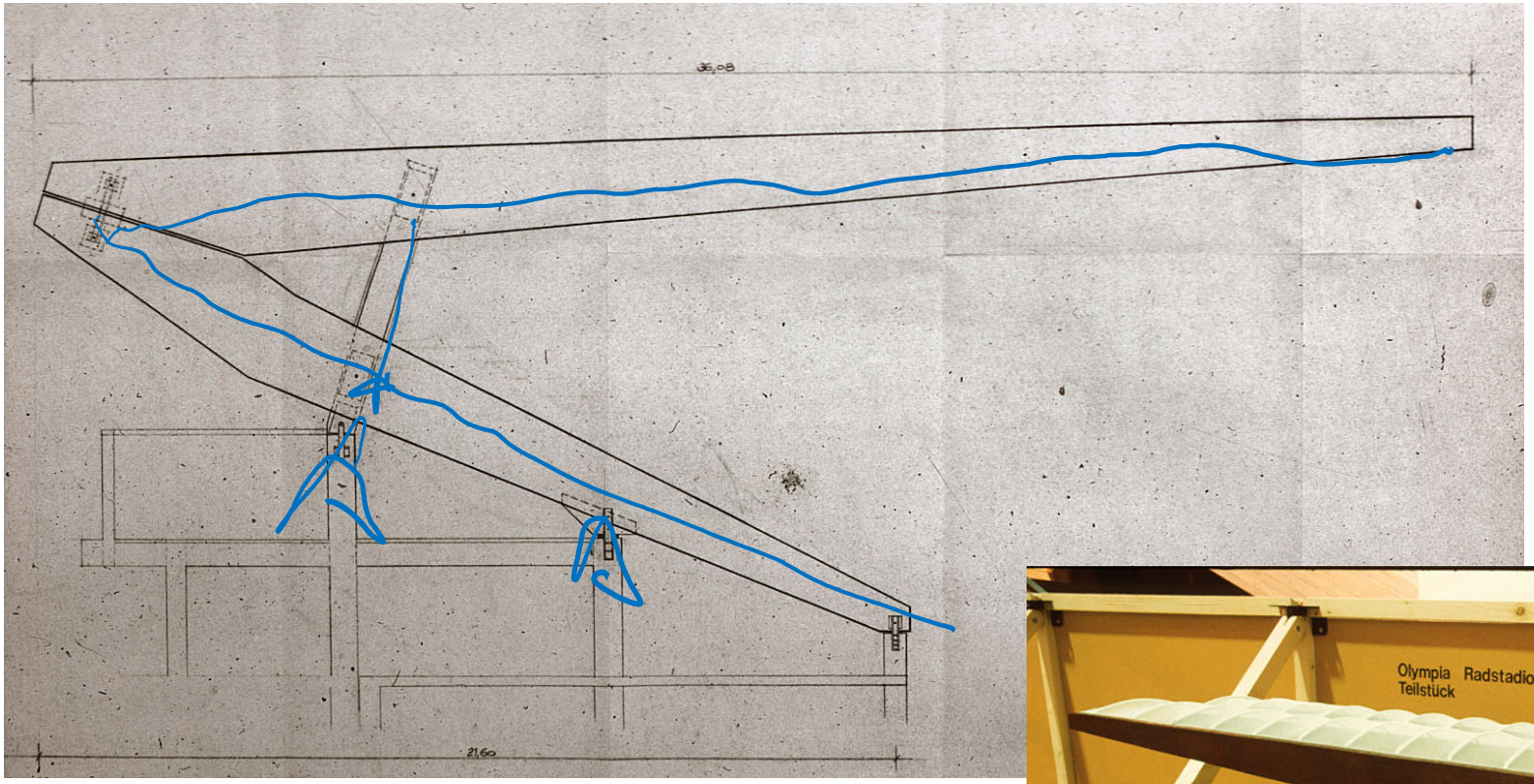
Longueur totale : 86,40 m en 16 travées de 5,40 m
Couverture en Balithe A.20

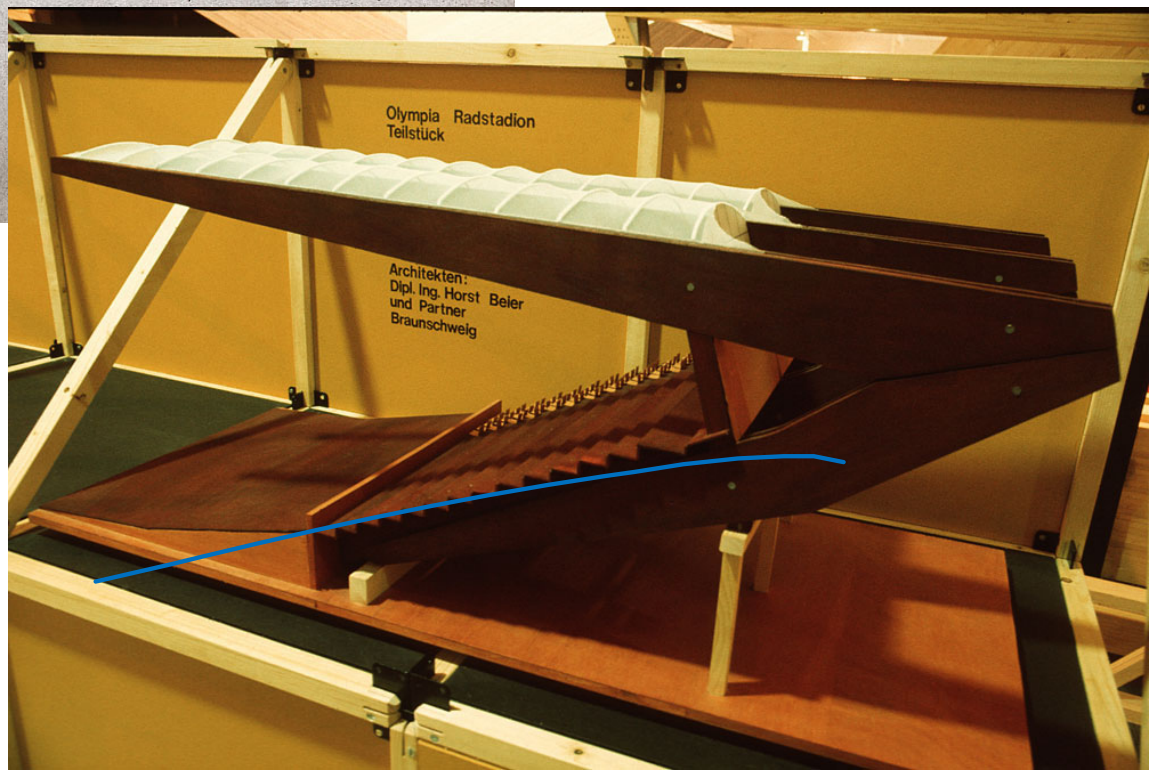


Tribunes du Stade de Mantes - la - Ville (78)






36,08
21,60


Olympia Radstadion
Teilstück
Architekten:
Dipl. Ing. Horst Beier
und Partner
Braunschweig

merci