

Charpente traditionnel en bois

Natterer Johannes

Ing. dipl. EPFL

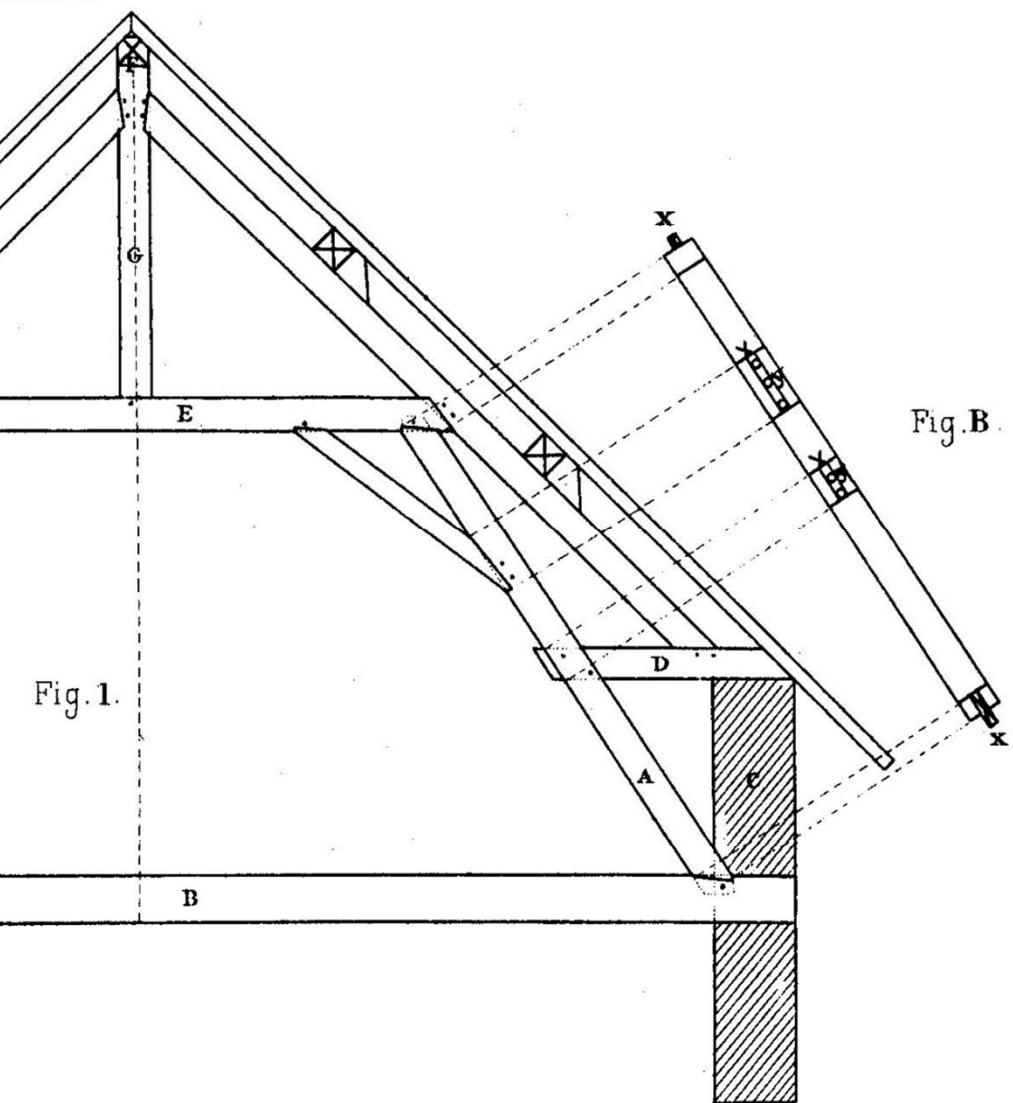
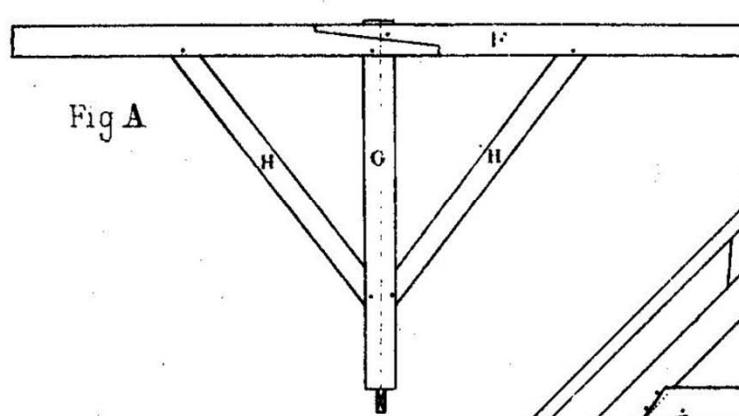
EPFL

Source

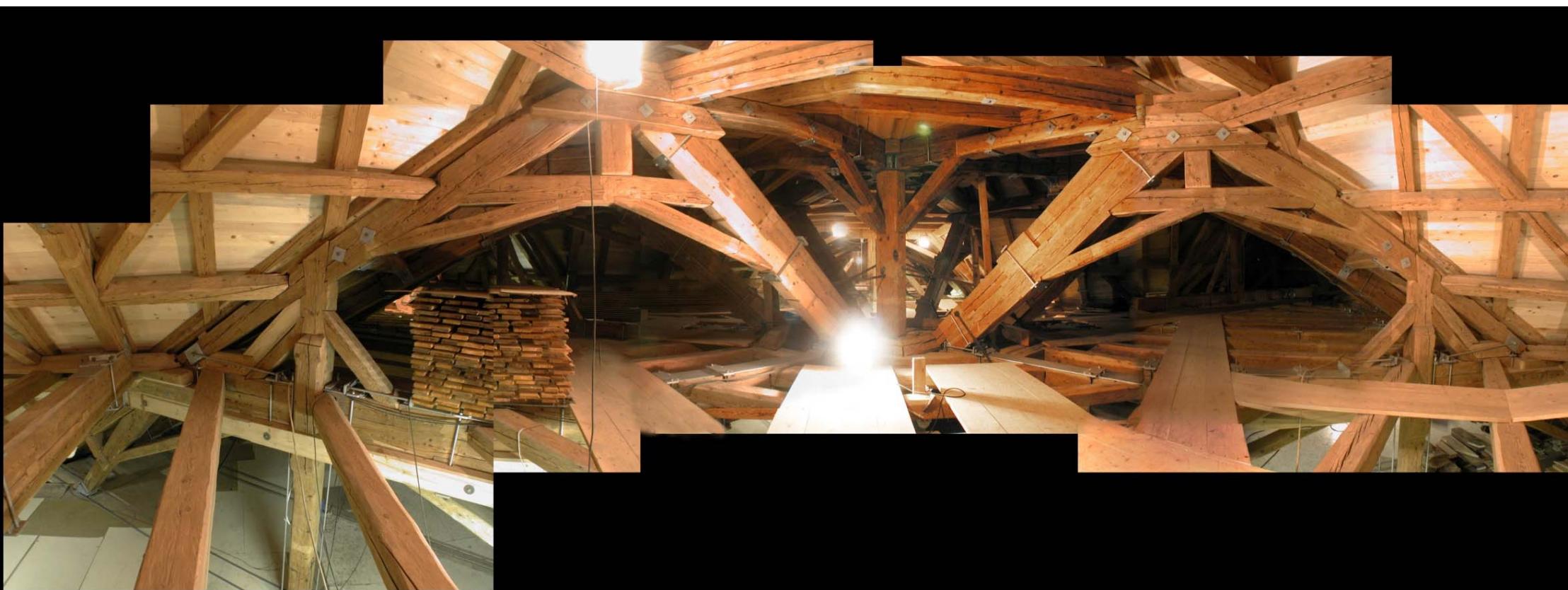
- L'art du Trait de Charpenterie, Billon Frères, Ed. H. Vial
- Assemblage du bois, l'Europe et le Japon face à face. Ed. Vial

PLANCHE 11

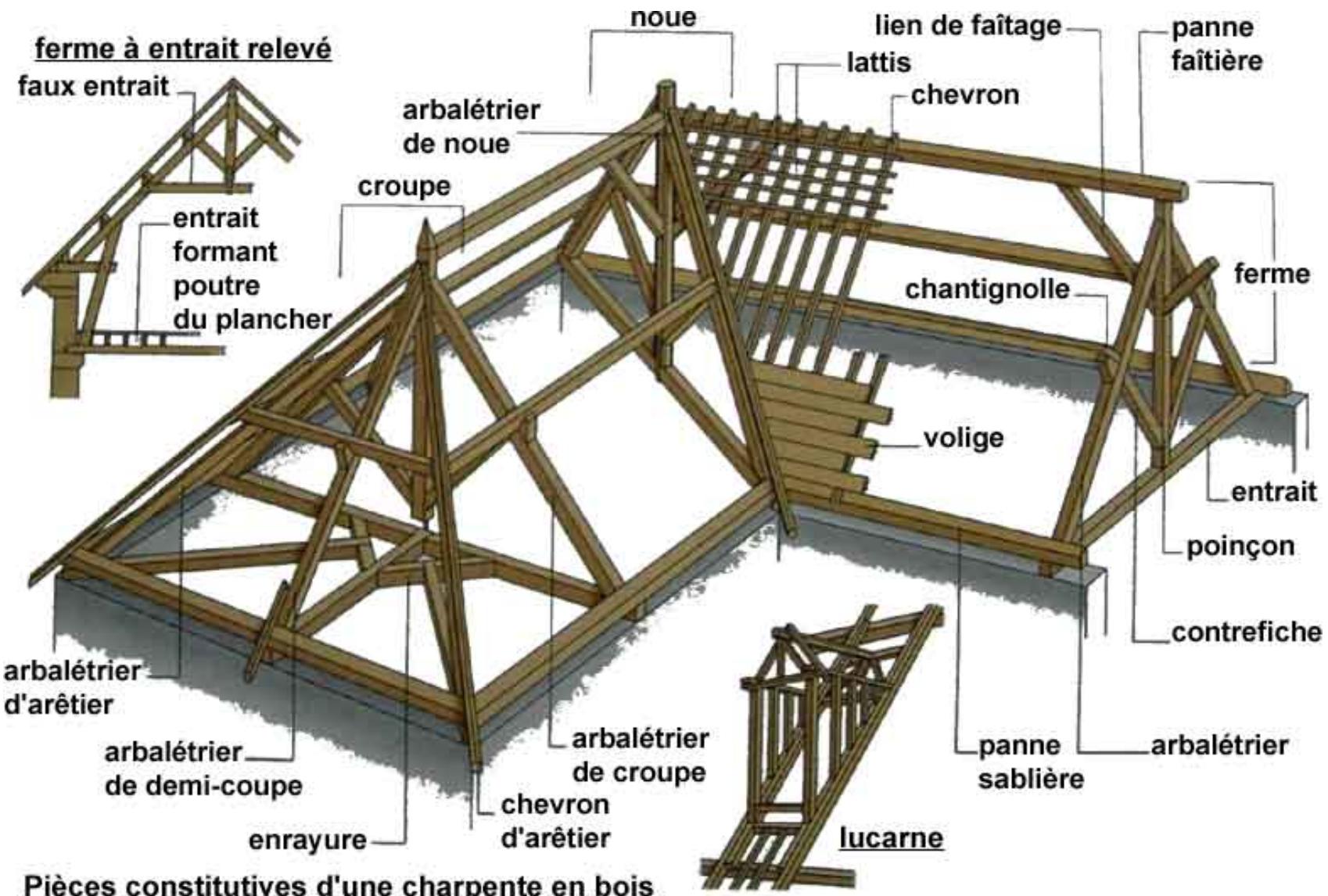
FERMES





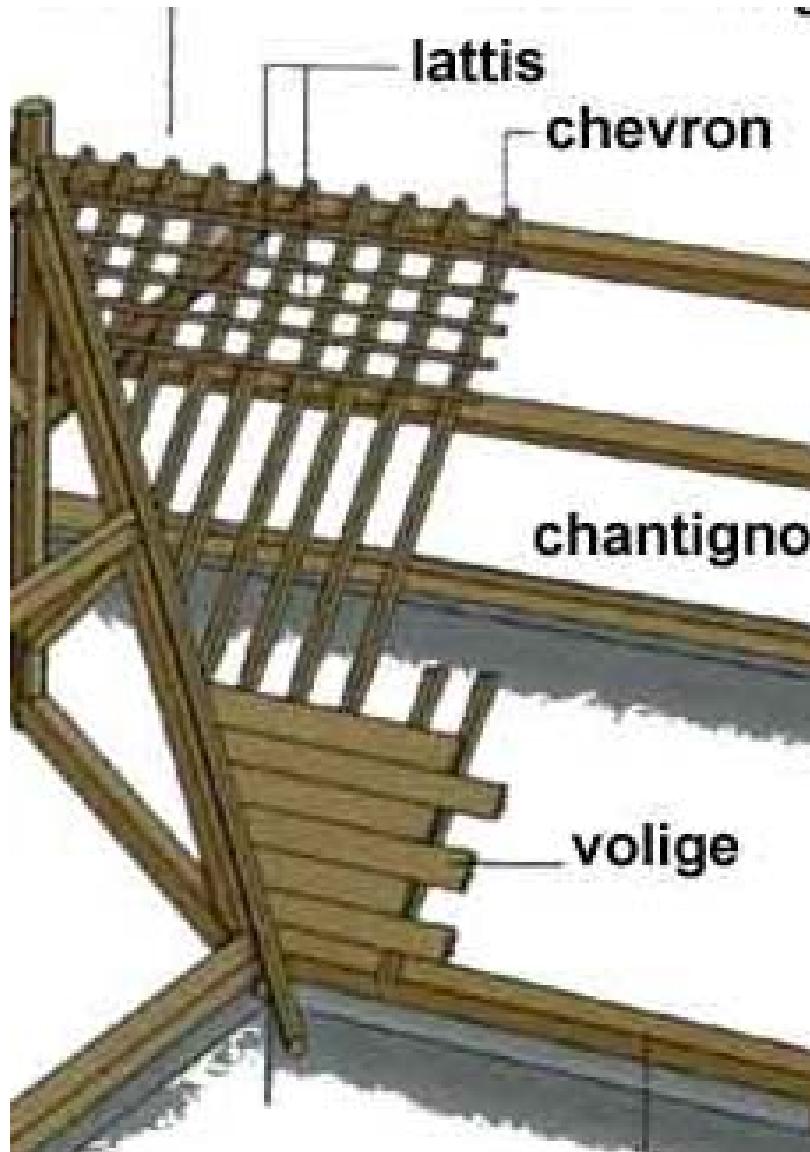


Termes

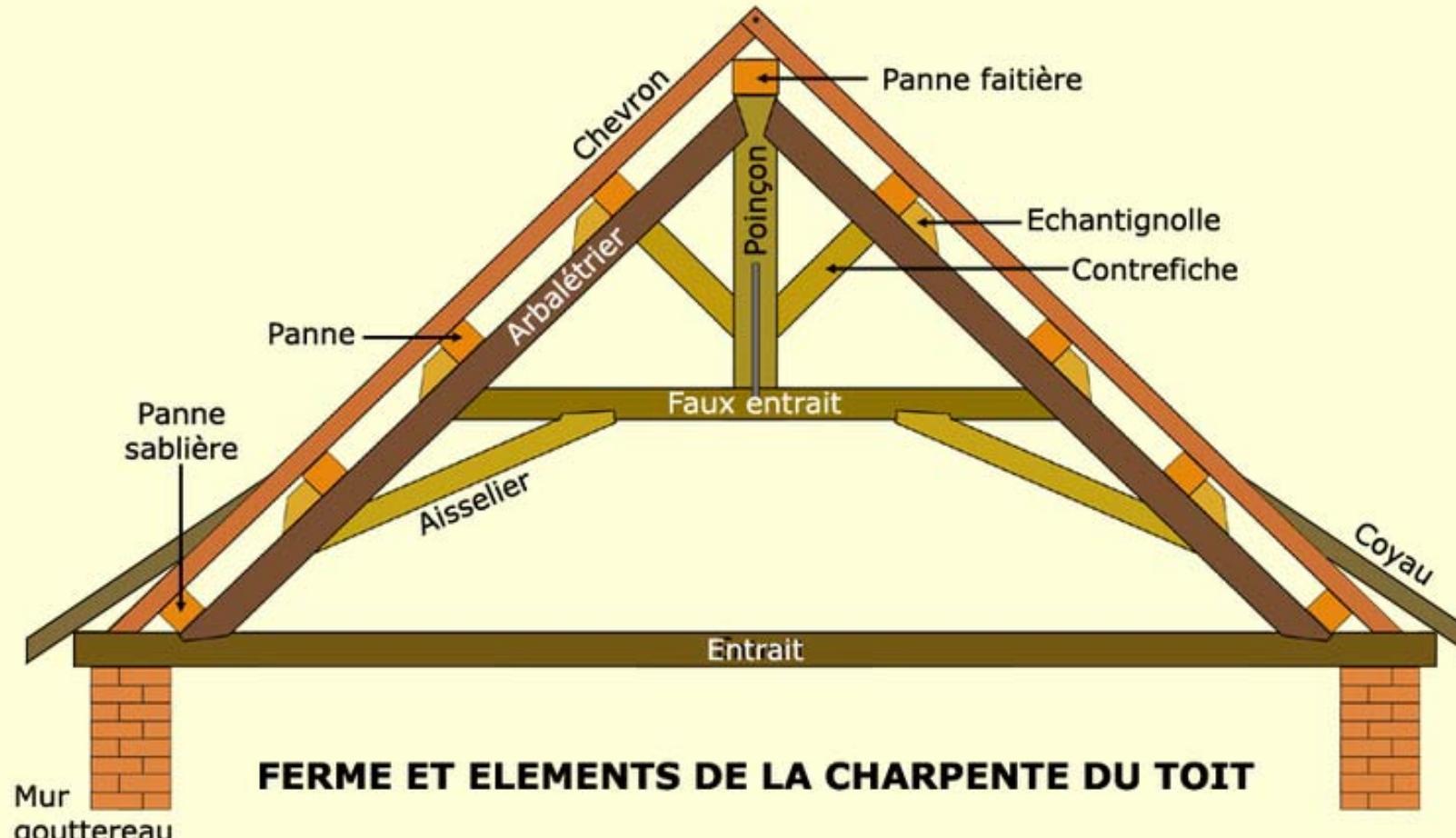


<http://teckisol.fr>

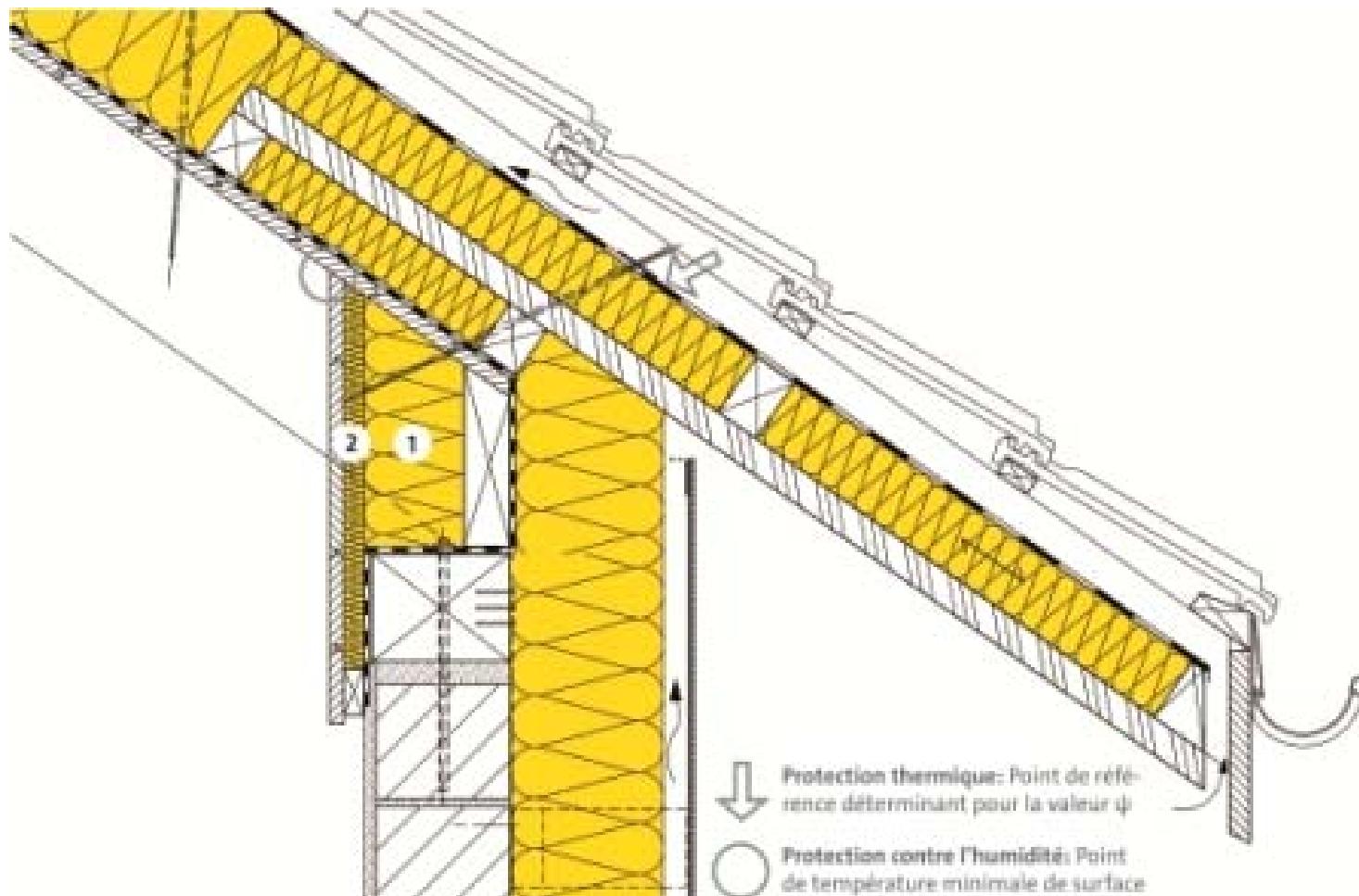
Le chevron



Lattage

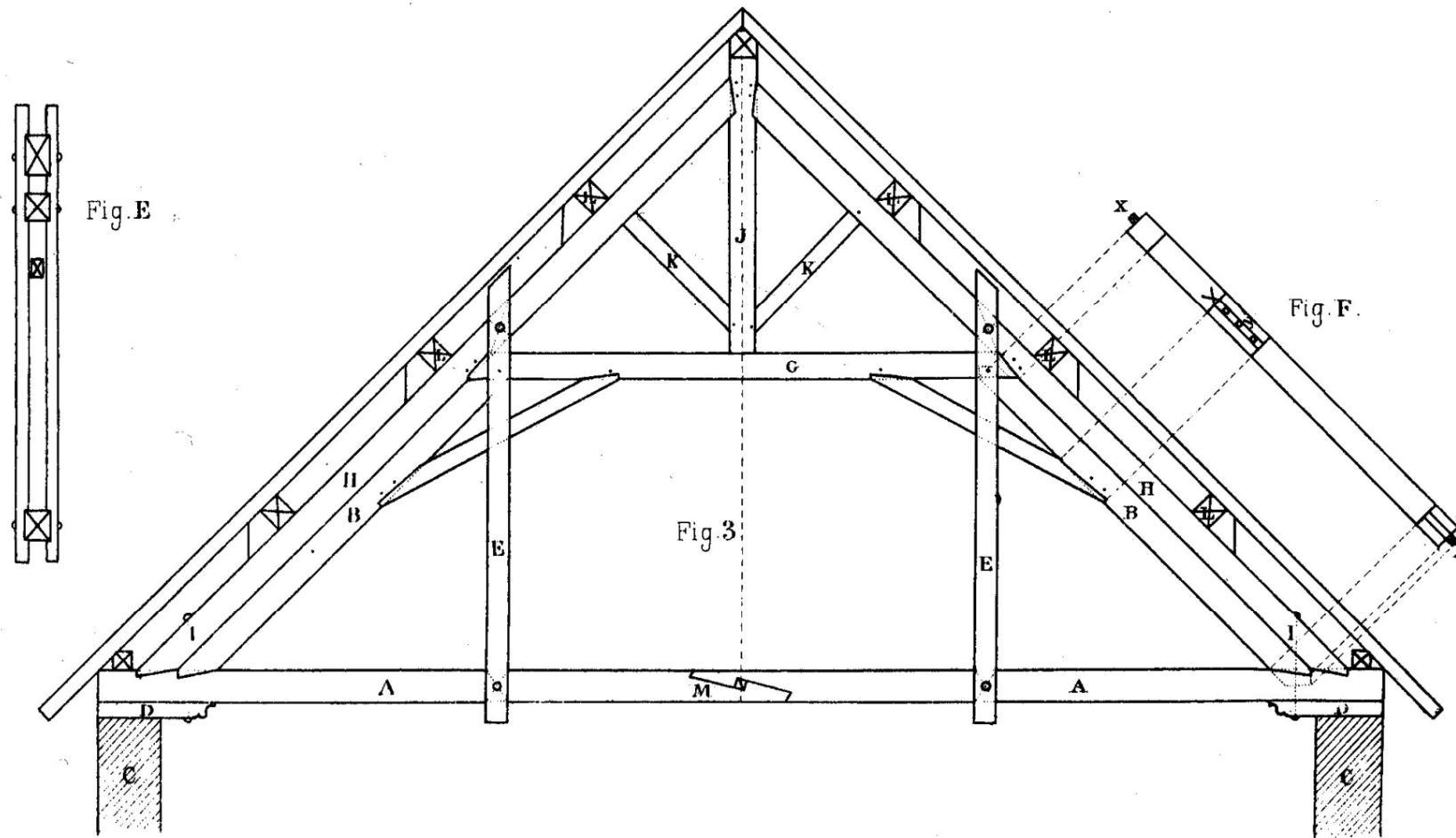


Le lattage - Contrelattage



<http://www.isover.ch>

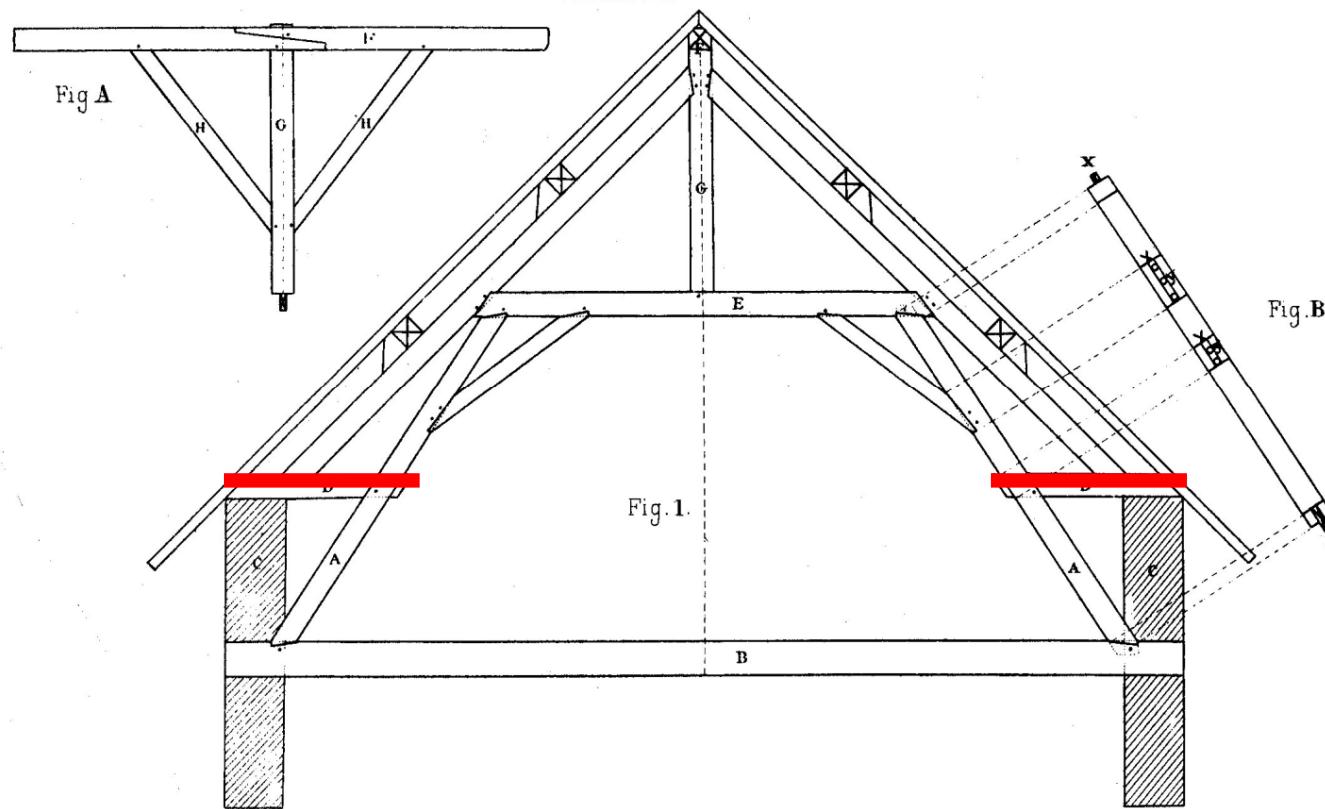
La panne – panne volante – panne faitière



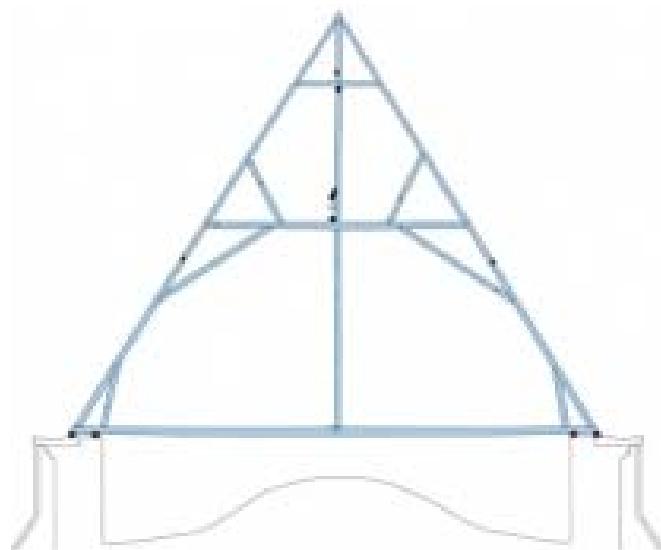
Le blochet

PLANCHE 11

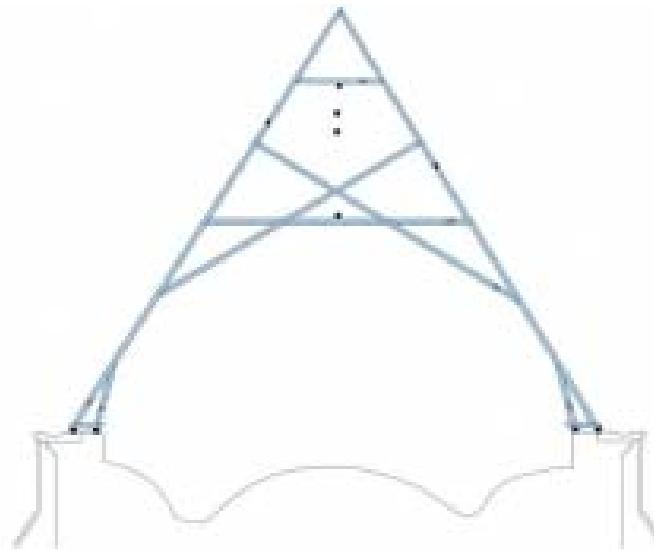
FERMES



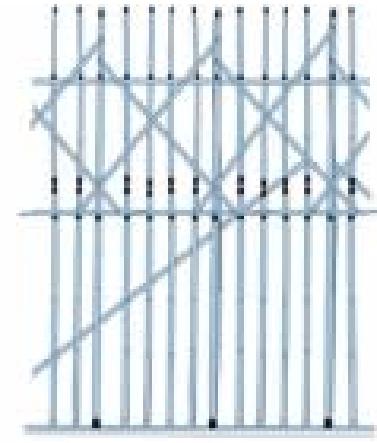
Chevron formant - ferme



Forme principale F10, face ouest



Forme secondaire F12, face ouest



Coupe longitudinale, face nord



Chevron formant-ferme

- La charpente de la nef de la cathédrale de Bourges;



Source:

Frédéric Epaud

Chevêtre – solive - sommier

Fig. 2.

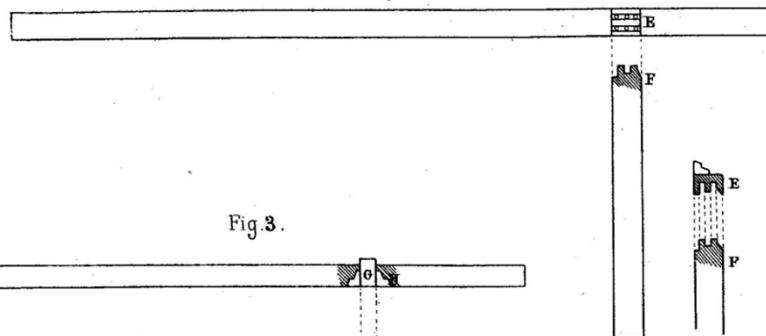
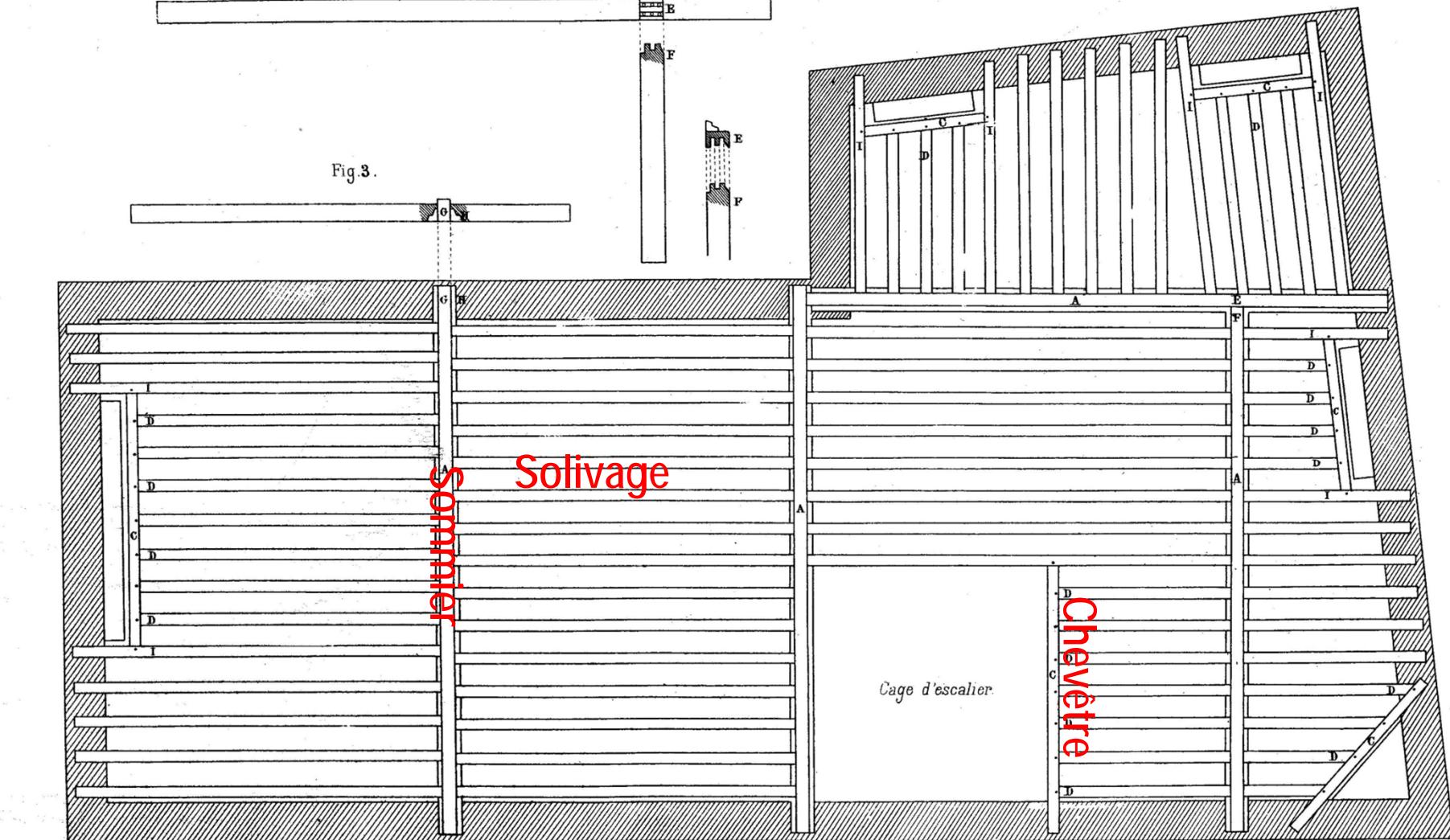
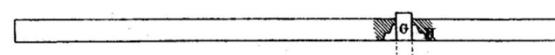
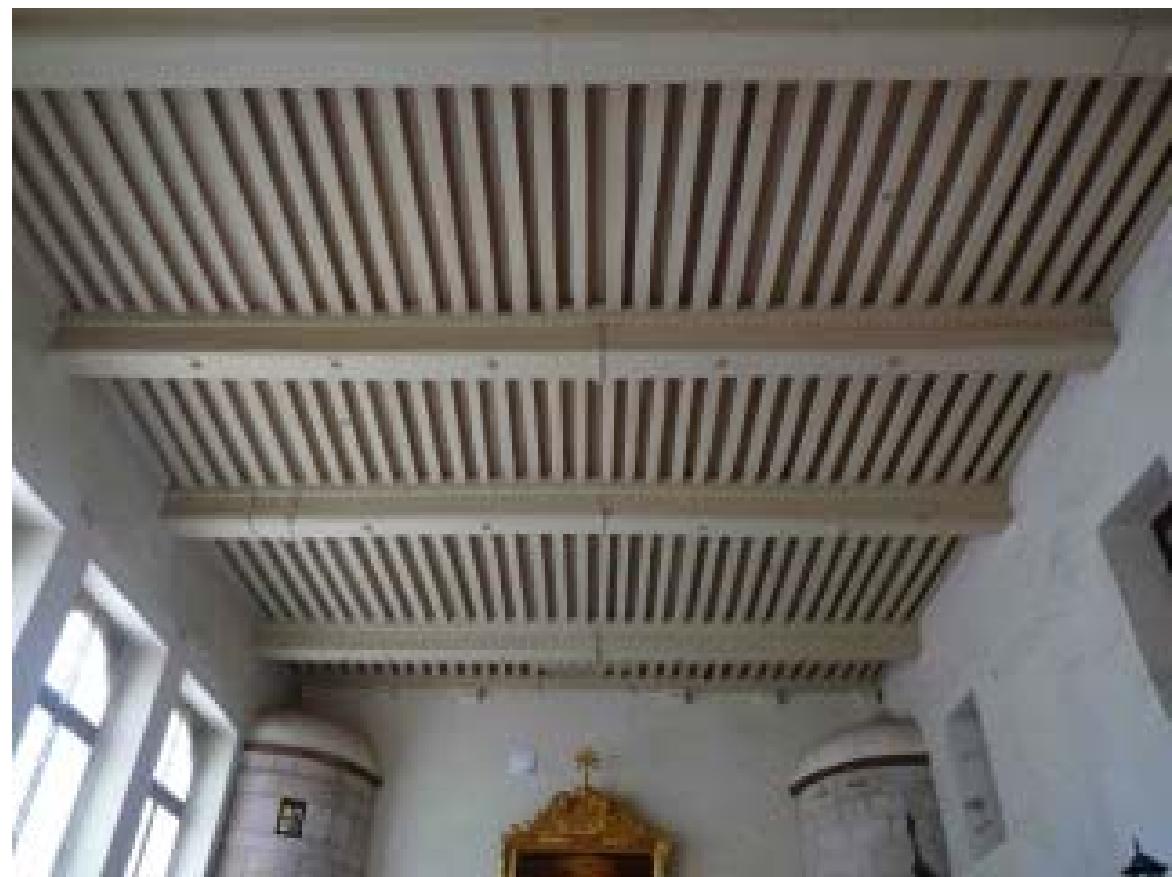
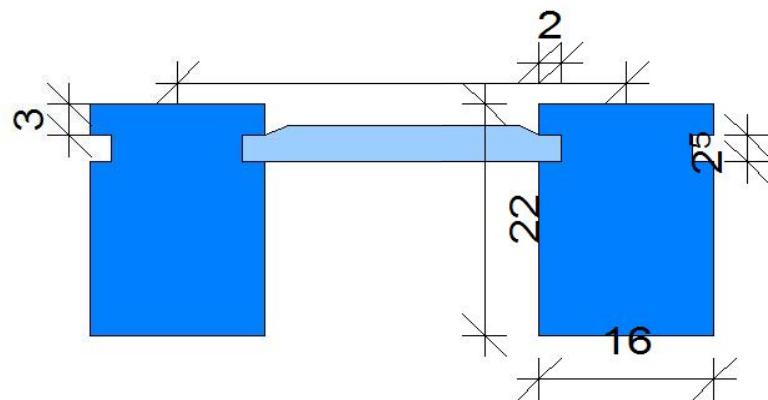


Fig. 3.



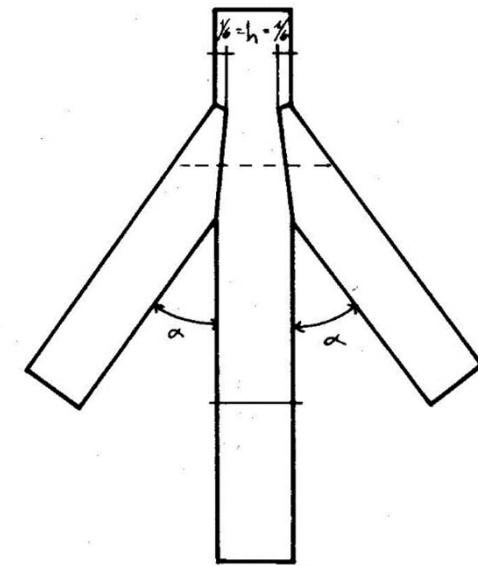
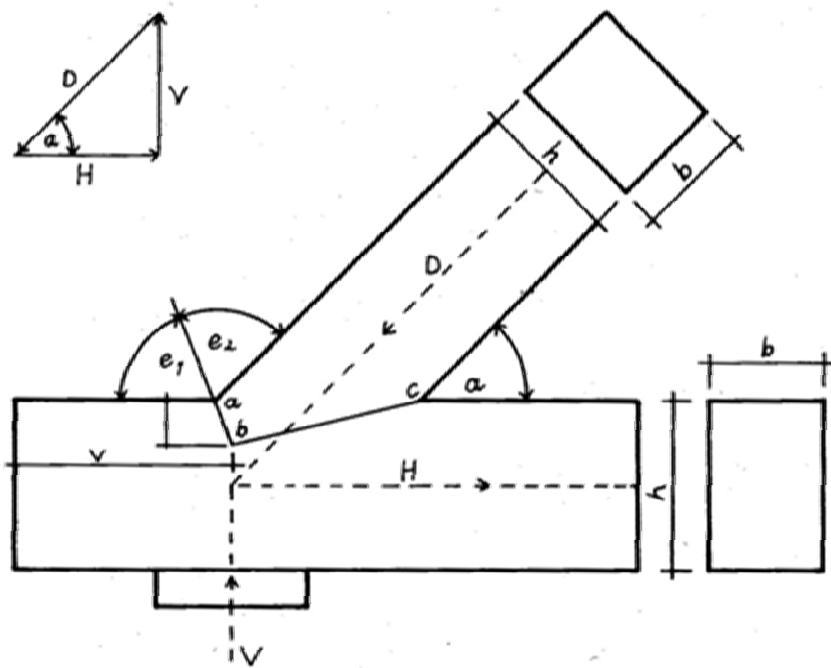
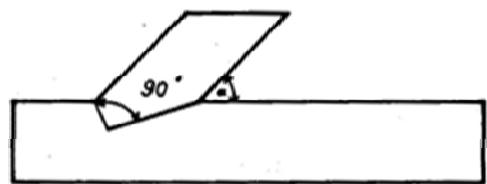
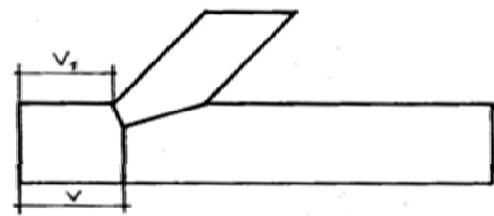
Plancher à la française

- Tant plein que vide
- Ai entrevou

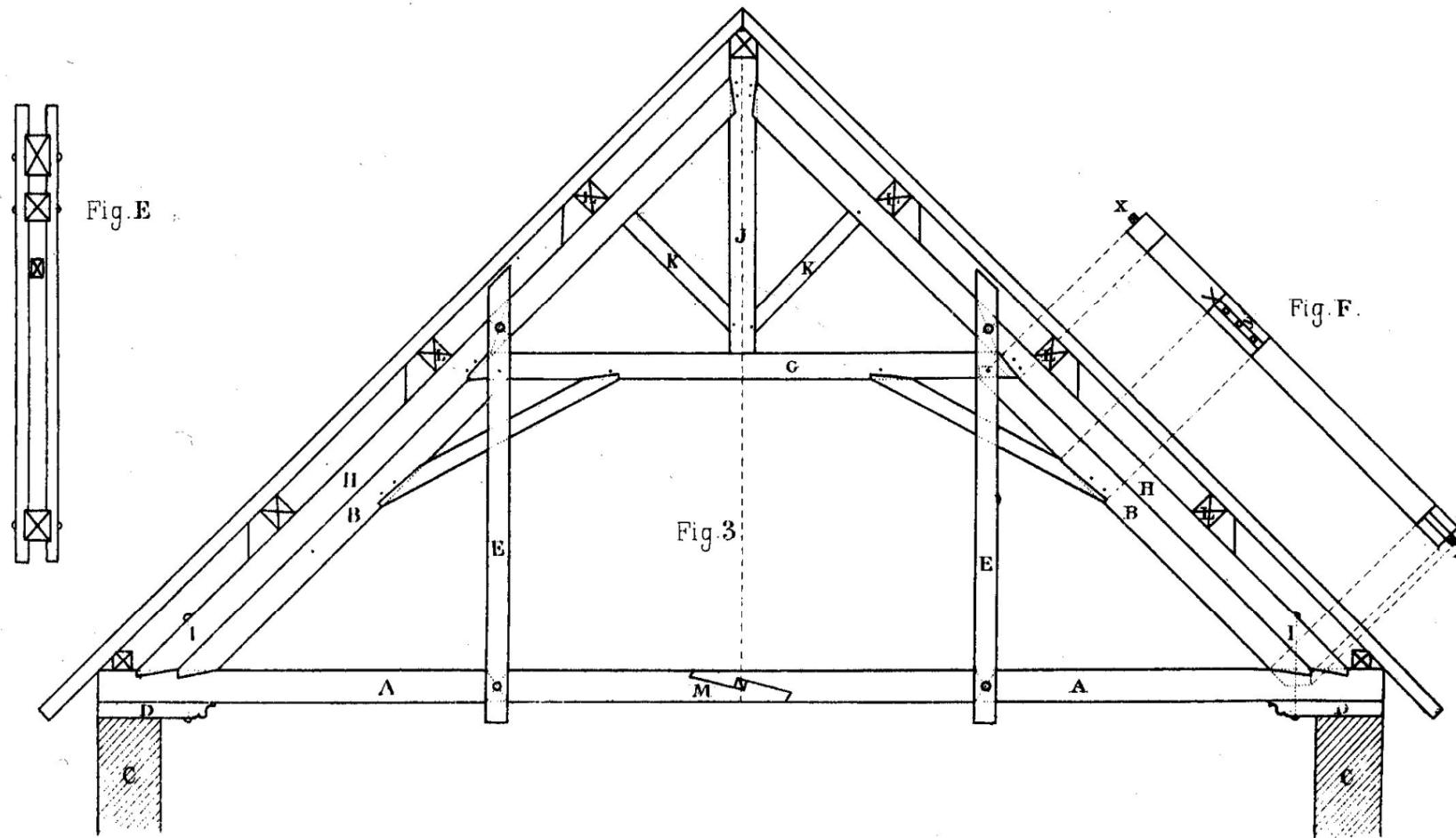


Détails de charpente

Embrèvement



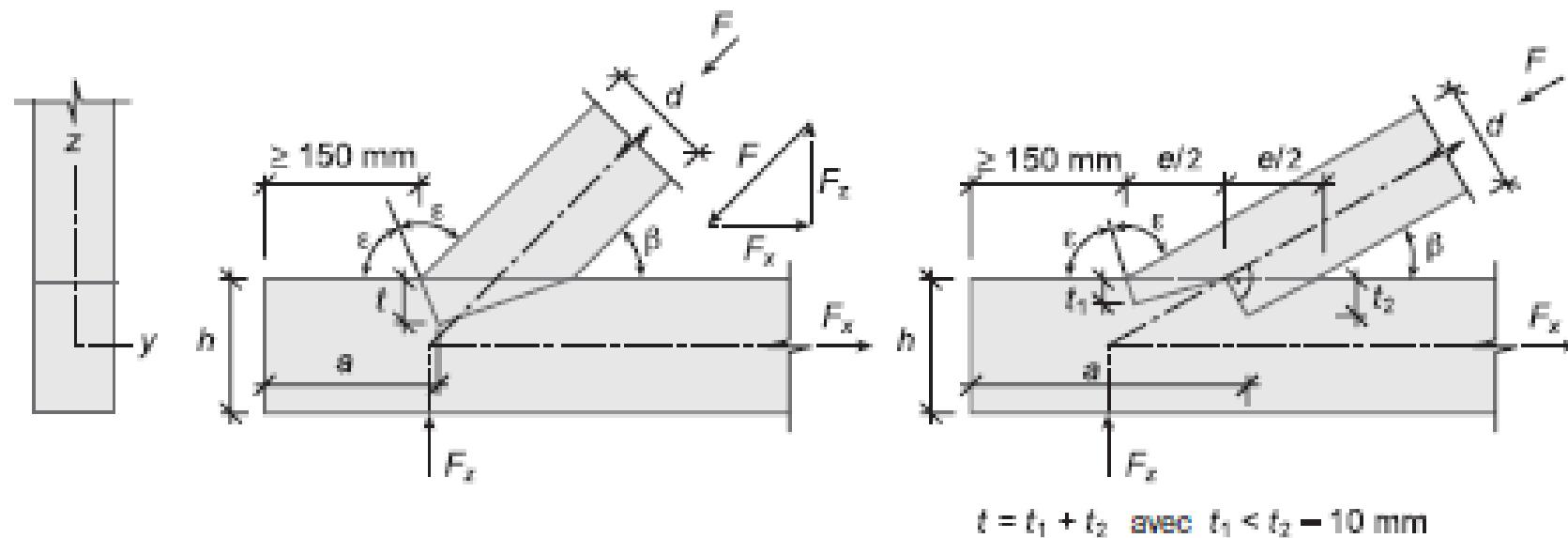
La panne – panne volante – panne faitière



Embrèvement double

- SIA 265 § 6.9.2

Figure 37: Embrèvements simple et double



Embrèvement

■ Vérification § 6.9.2

6.9.2

Embrèvement

6.9.2.1

La transmission d'un effort de compression F selon la figure 37 est conditionnée par les relations:

– avant-bois: $a \geq \frac{F_d \cos\beta}{b k_{red} f_{v,d}}$ avec: – $k_{red} = 0,6$ pour l'avant-bois
– $k_{red} = 0,8$ pour le bois lamellé-collé

(111)

– entaille: $t \geq \frac{F_d \cos\beta}{b f_{c,\alpha,d}}$ avec: – $\alpha = \frac{1}{2} \beta$ (embrèvement simple)
– $\alpha = \frac{3}{4} \beta$ (embrèvement double)

(112)

– hauteur de l'arbalétrier: $d \geq \frac{F_d}{b f_{c,\alpha,d}}$ avec: – $\alpha = \beta$

(113)

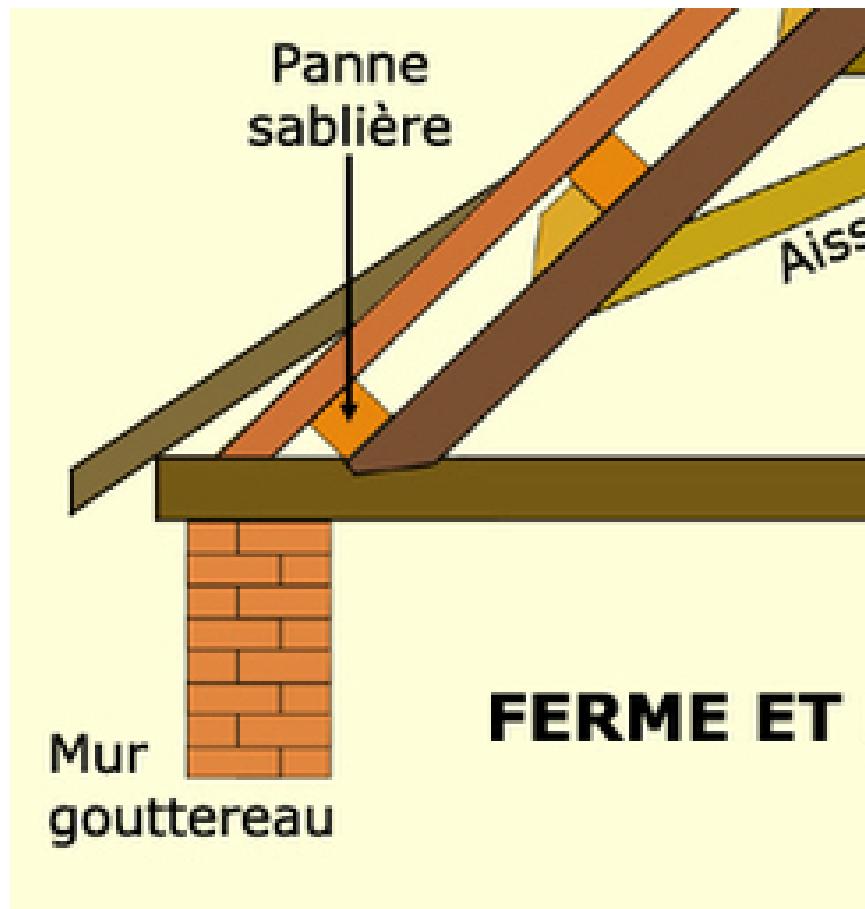
avec: b largeur de la liaison avec l'arbalétrier

β angle entre l'effort F_d et la direction des fibres (cf. figure 37).

$f_{v,d}$ et $f_{c,\alpha,d}$ sont les contraintes de dimensionnement, compte tenu de la teneur en eau du bois, et $f_{c,\alpha,d}$ doit être déterminée selon le chiffre 6.9.1.2.

Embrèvement

- Liaison arbaletrier et entrait



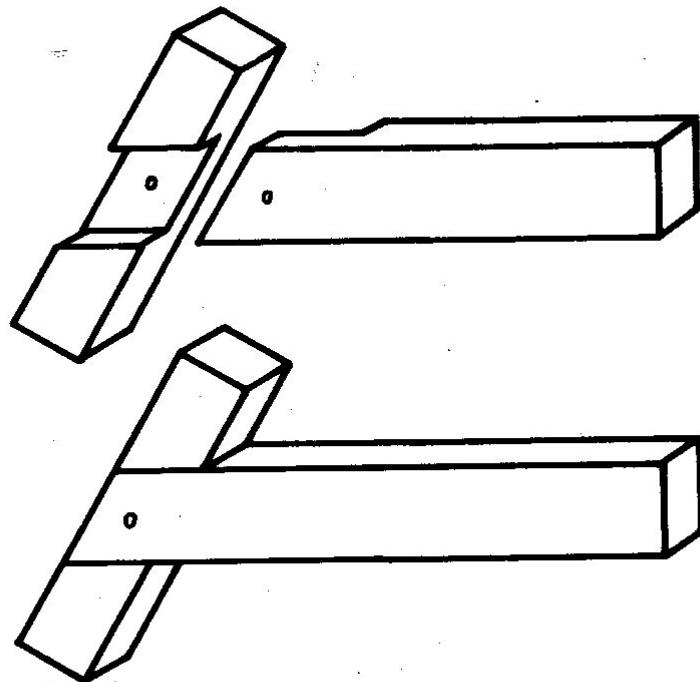
- Assemblage bois-bois

$$f_{c,\alpha,d} = \frac{0,8 f_{c,0,d} f_{c,90,d}}{0,8 f_{c,0,d} \sin^2 \alpha + f_{c,90,d} \cos^2 \alpha}$$

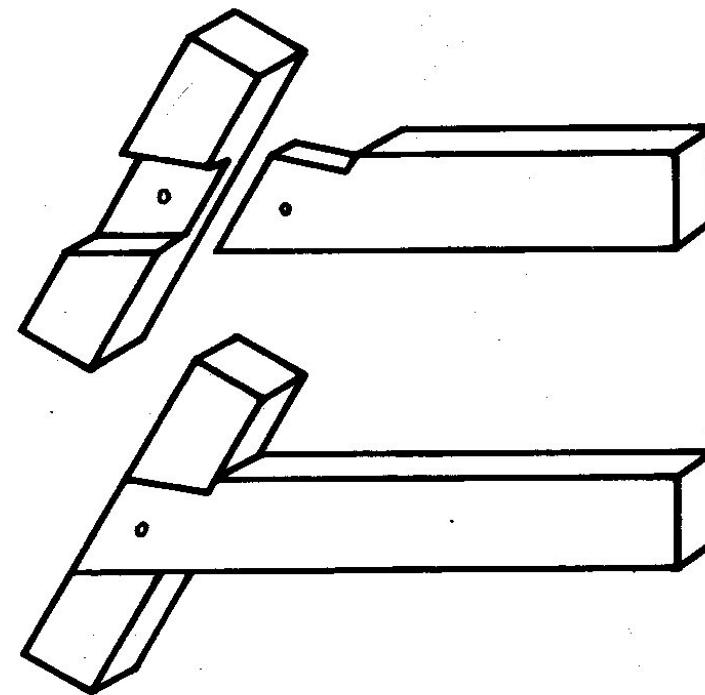
Tenon - mortaise



Entaille à mi-bois oblique



Entaille à mi-bois droite sur un faux entrail



Entaille à mi-bois en queue d'aronde bâtarde sur un faux entrail

Tenon - mortaise



Trait de Jupiter

Fig. 1.



Fig. 2.

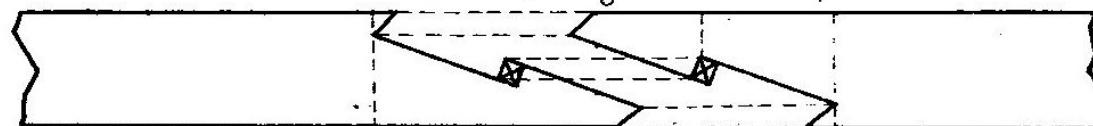


Fig. 3.

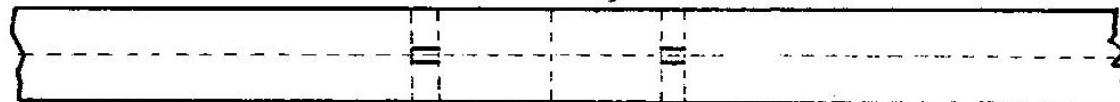


Fig. 4.

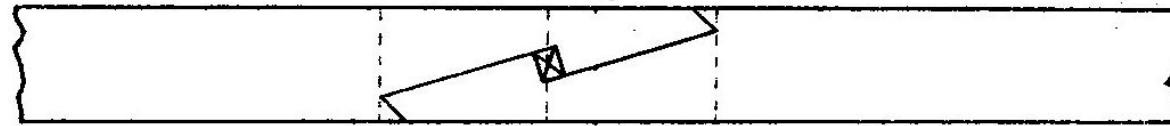
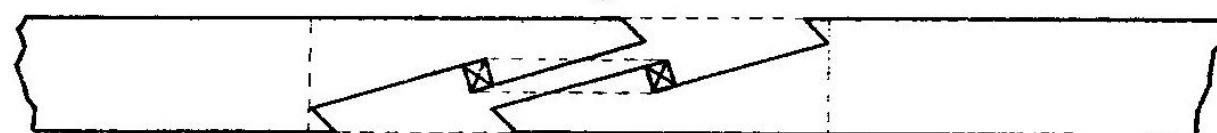
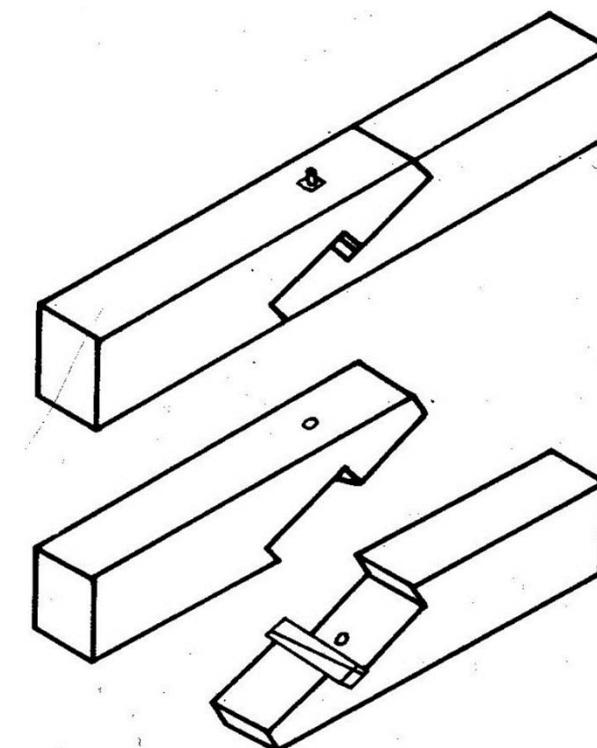
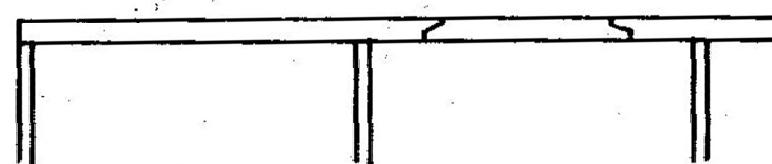
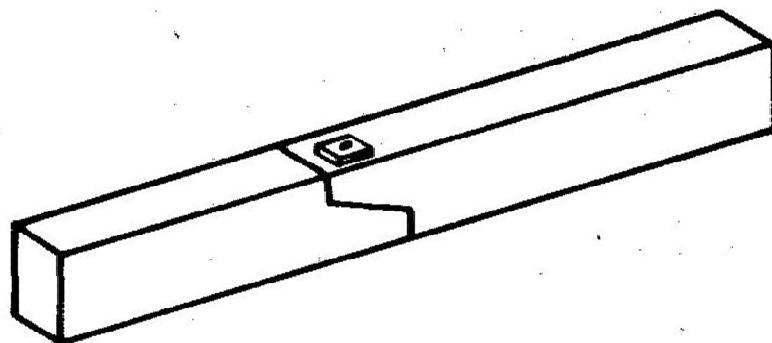


Fig. 5.

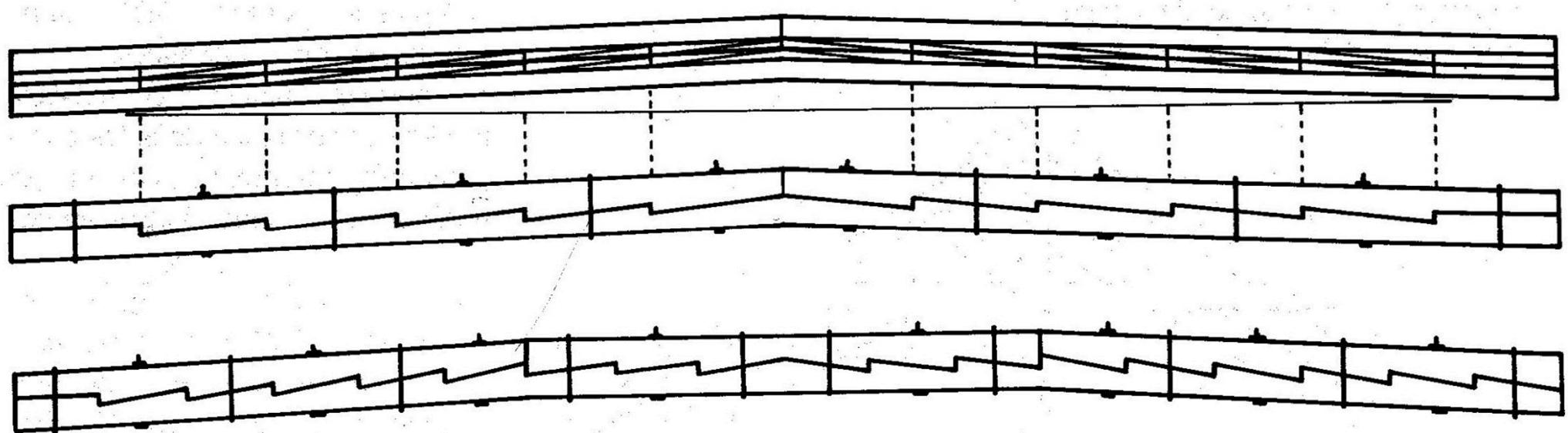


Assemblage Gerber

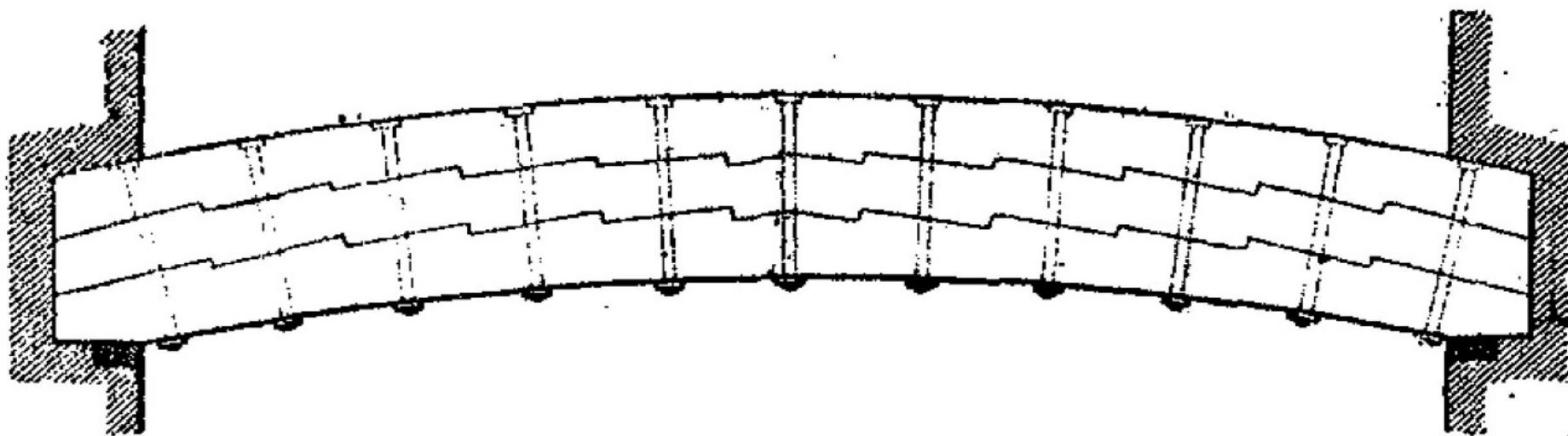


Variantes de l'assemblage de Gerber

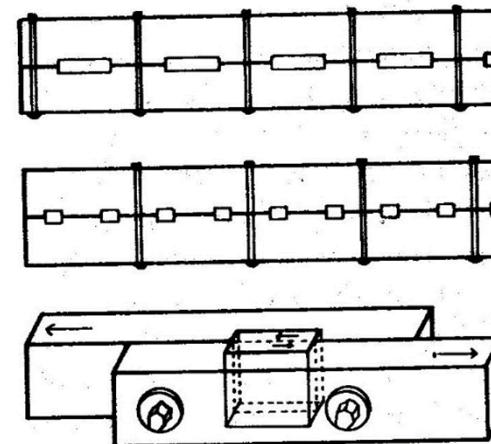
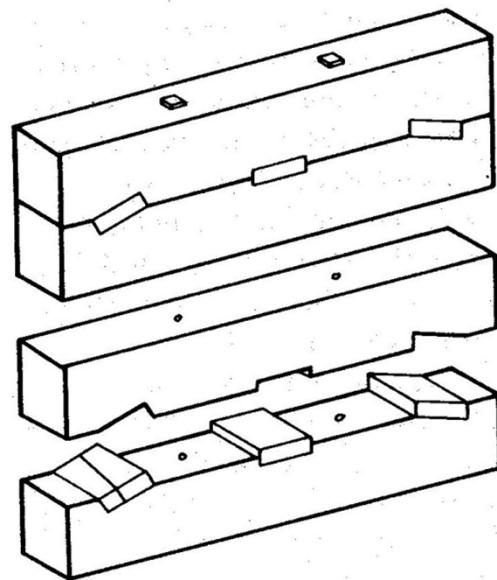
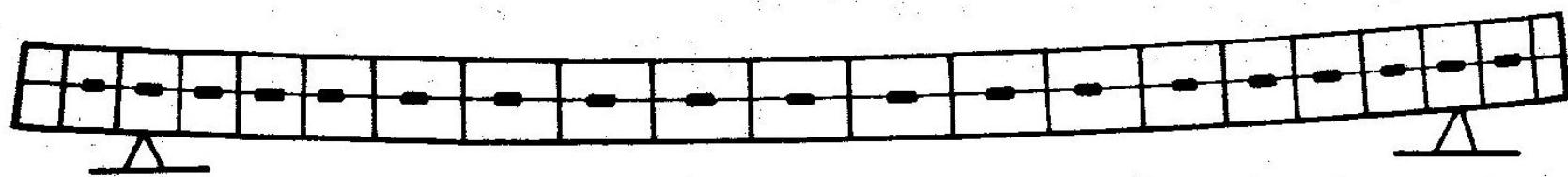
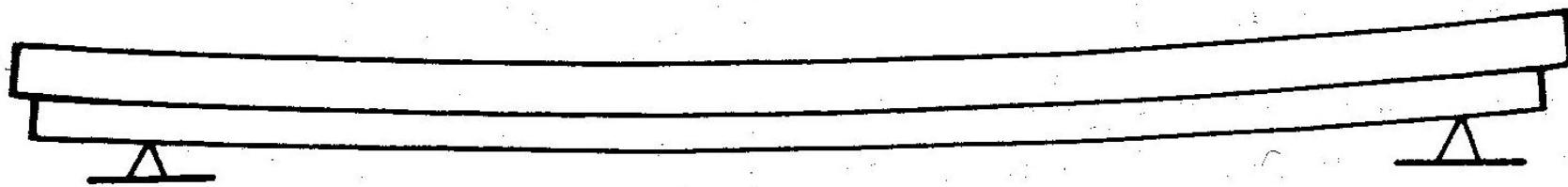
Les poutres adentées



Poutre adentée



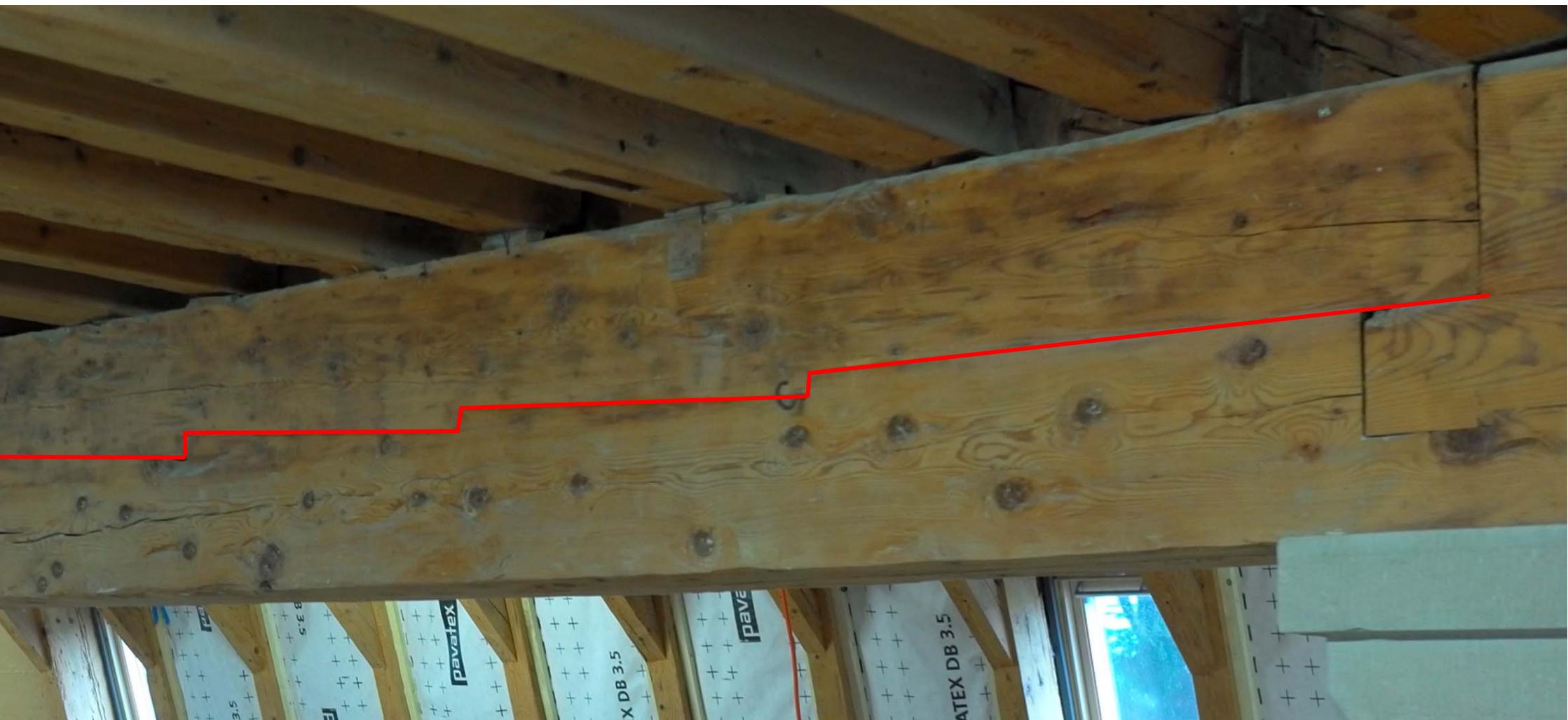
Poutre chevillée



Partie médiane d'une poutre chevillée
avec coin double et coin simple





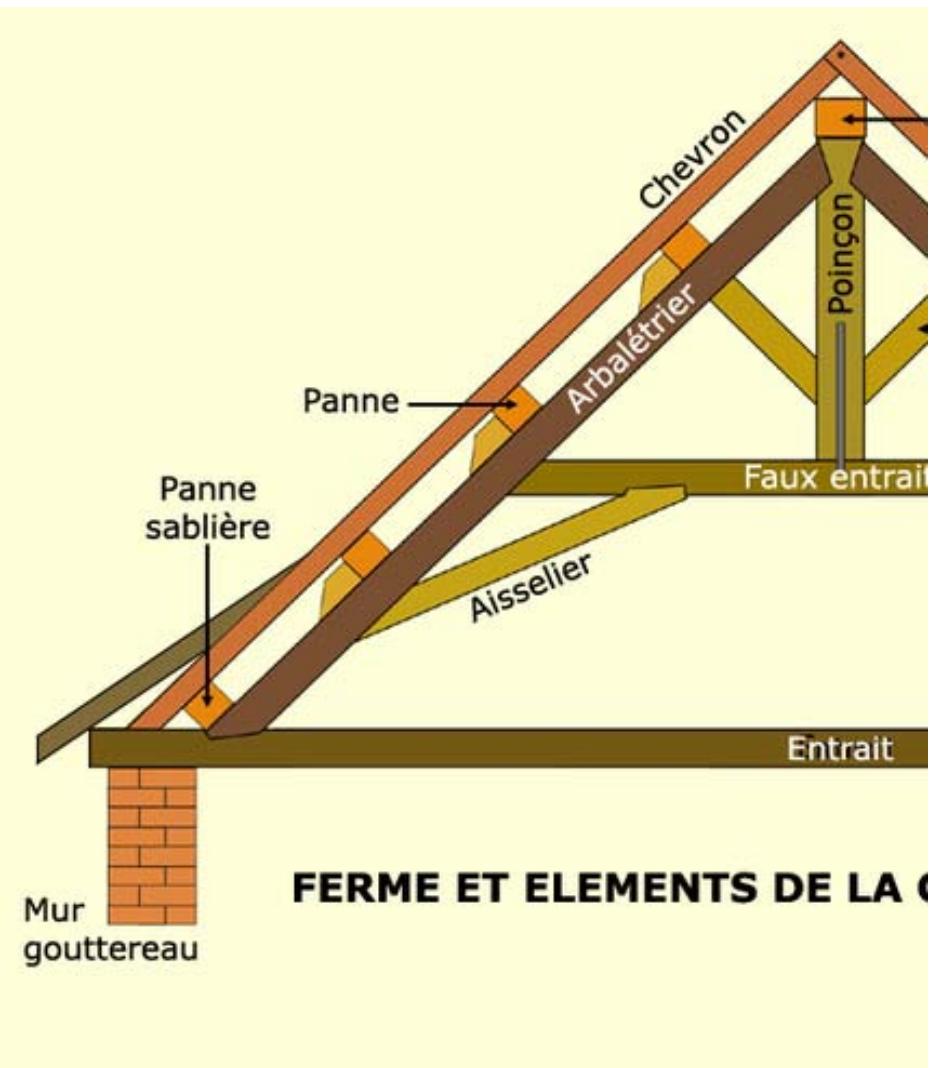


Poutre en flexion



Pathologie

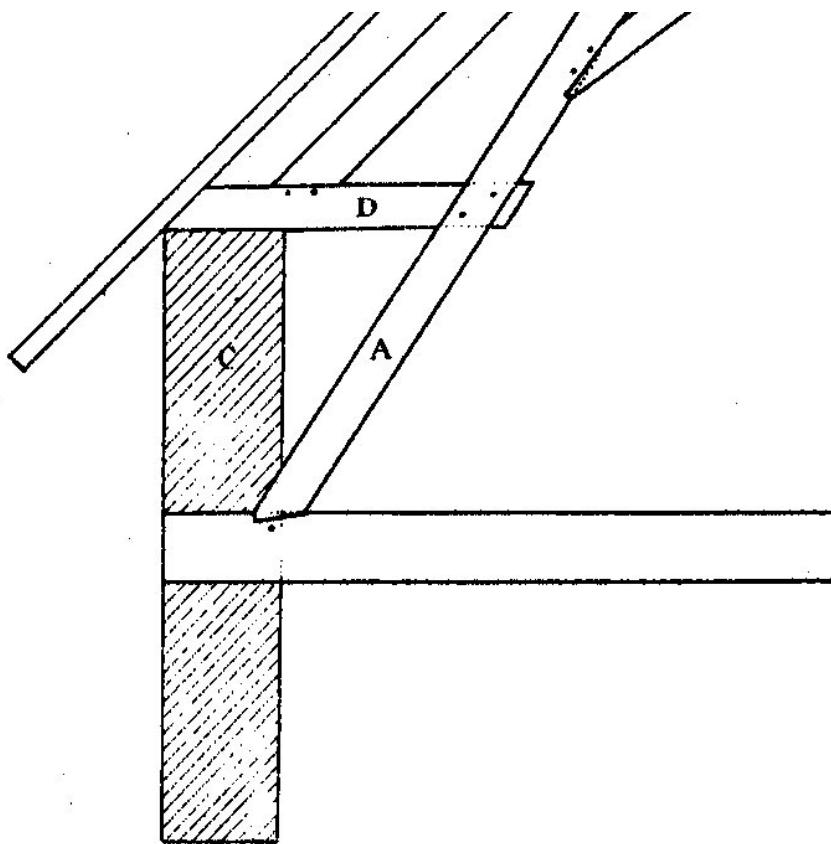
Epi de toiture



Dégradation du faux-entrait



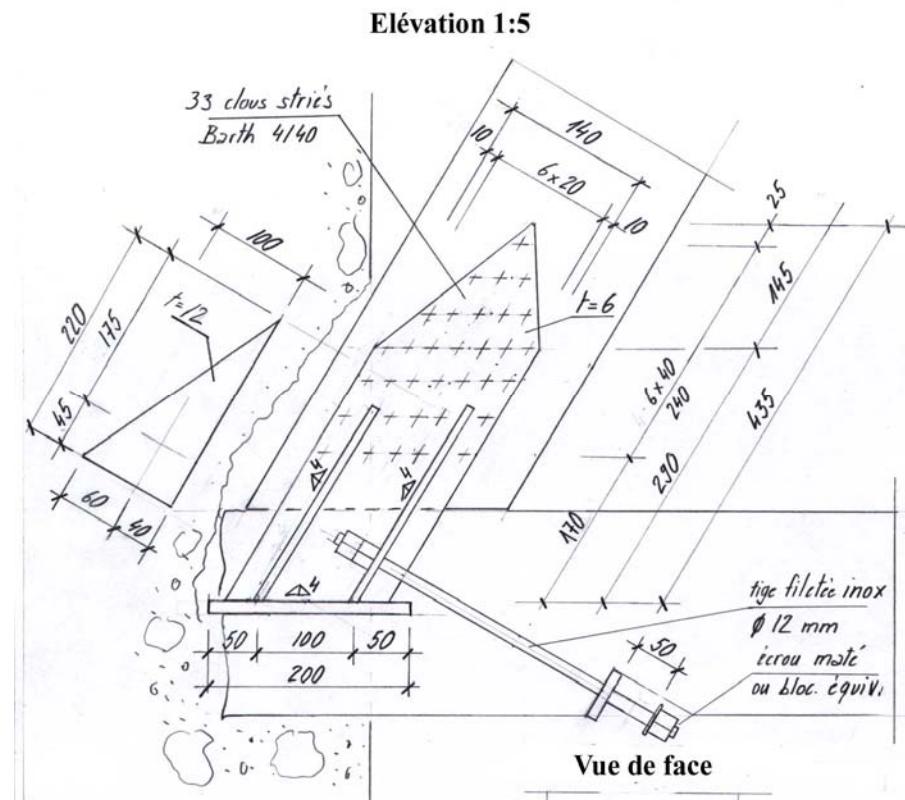
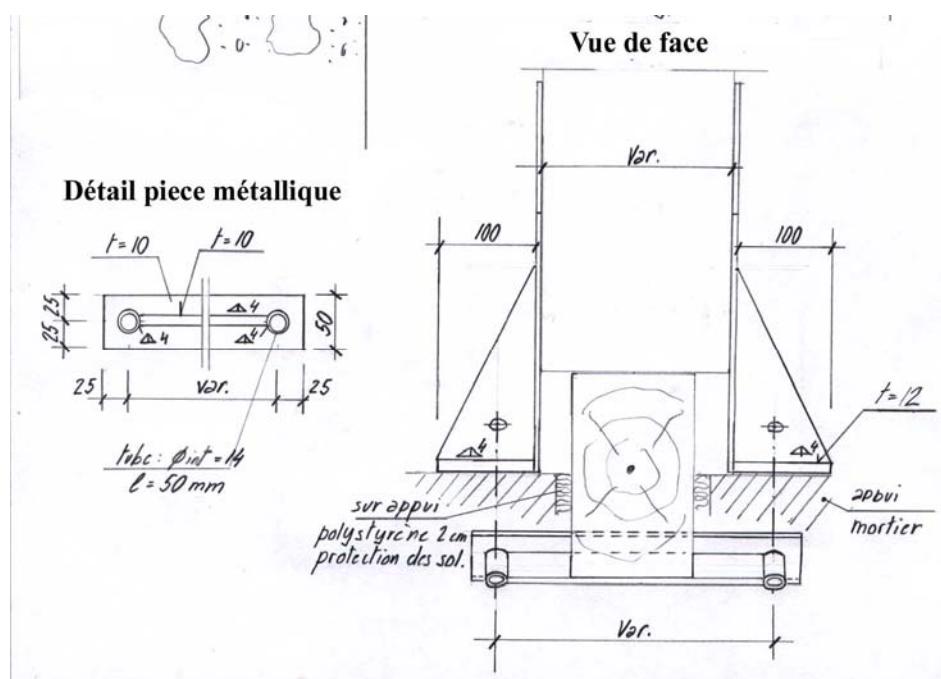
Pied d'arblétrier - entrait



Remplacement du pied de l'arbalétrier



Remplacement du pied de l'arbalétrier



Avant-bois de l'entrait



Remplacement de l'arbalétrier



Remplacement du pied d'arbalétrier



Degradation des têtes de solives





Remplacement des têtes de solive

Vue de dessous



vue de dessus



Situation



Diagnostique



Assainissement

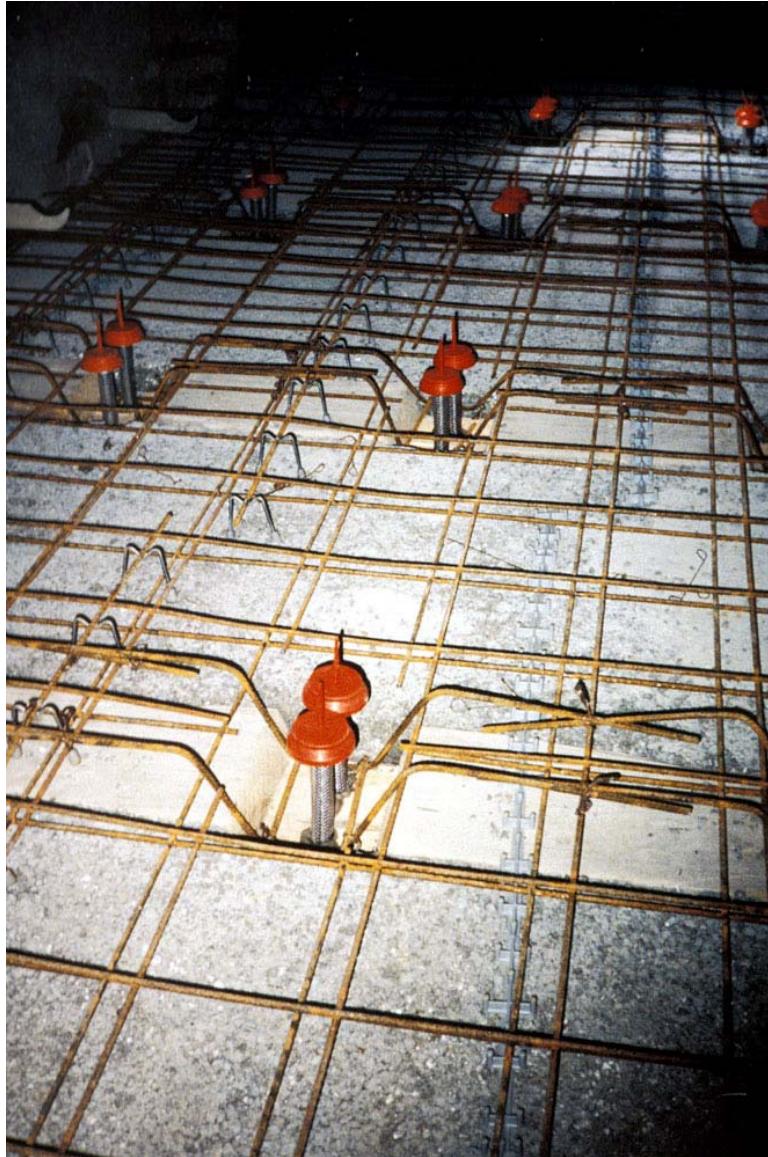


Déformations des solives

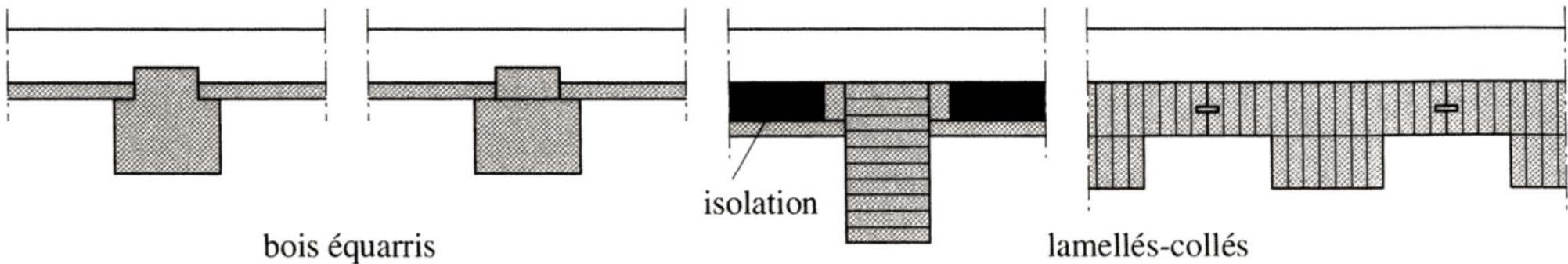


- > aptitude au service
- > nouvelle situation de charge
- > nouvelle situation acoustique

Renforcement de solivage



Bois béton mixte



(b) Poutres en té.

Renforcement de solivage



Renforcement des solives

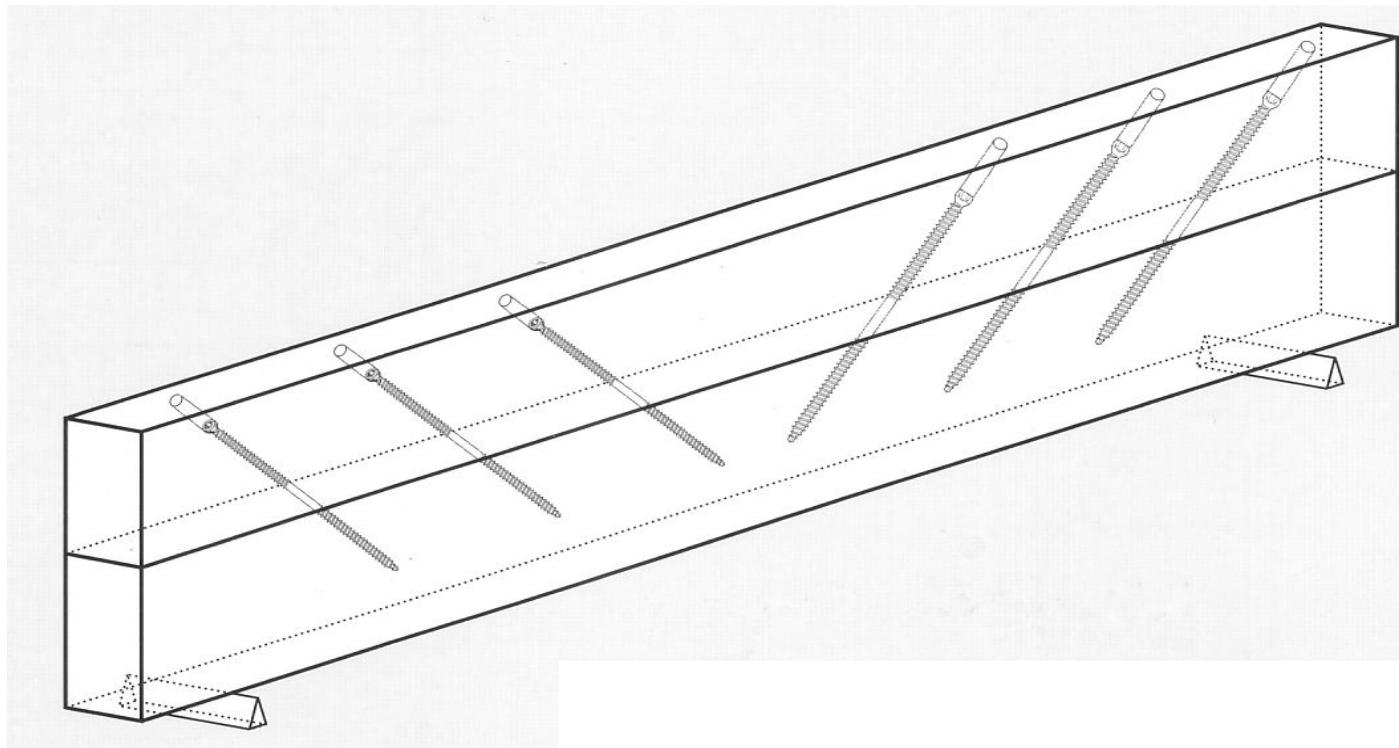
Trägeraufdopplung

The diagram illustrates the 'Trägeraufdopplung' (double header) reinforcement technique for joists. It shows two joists with a height of 80 and a width of 40. Reinforcement bars are attached from both the top and bottom. The software screenshot shows the calculation for 'WURTH plus VGS 8.8 x 120' with various parameters listed.

Schematische Darstellung der Einschraubmaße.
Die Verstärkung kann von oben oder von unten
angebracht werden.

Sollte die Verstärkung von unten ausgeführt werden, können
die Schrauben versenkt und verdeckt werden.

Renforcement des solives

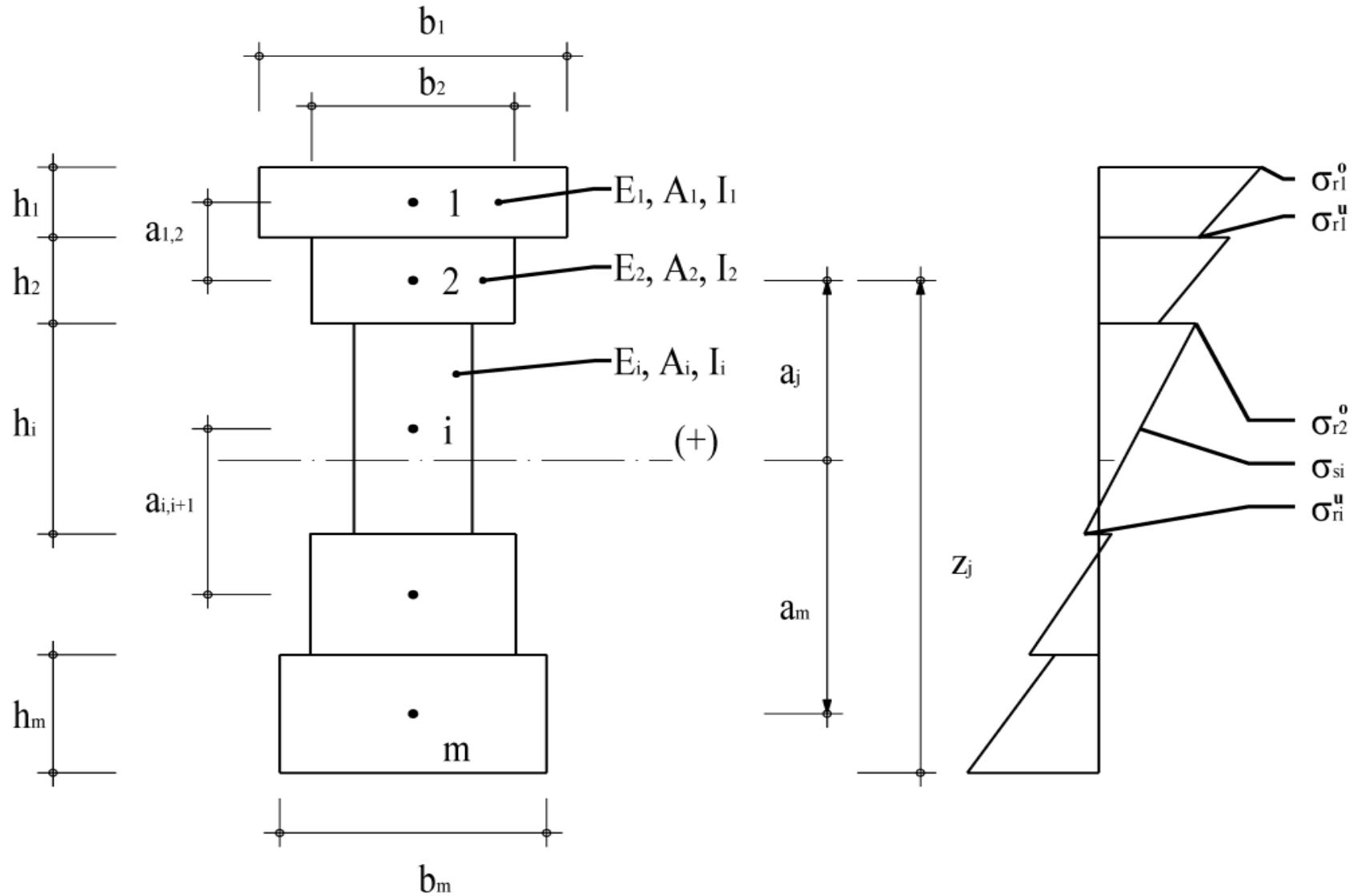


Section composée

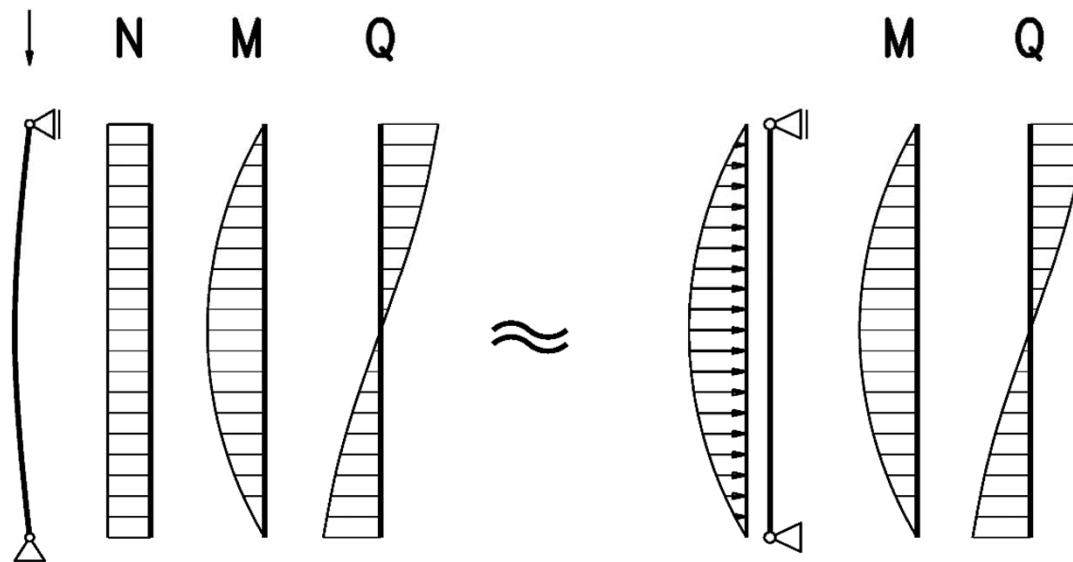
Tableau 14: Poutres chevillées, coefficients de réduction du moment de résistance et du moment d'inertie

Composition de la section	Moment de résistance	Moment d'inertie
2 profils superposés	$\beta = 0,85$	$\eta = 0,65$
3 profils superposés	$\beta = 0,60$	$\eta = 0,33$

Méthode - γ



Méthode - γ



$$I_{eq} = \underbrace{\sum_{i=1}^m I_i}_{rigidité propre} + \underbrace{\sum_{i=1}^m \gamma_i \cdot \bar{A}_i \cdot a_i^2}_{rigidité de translation}$$

Méthode – γ

- Exemple du bi-couches

$$k = \frac{\pi^2 \cdot E_b \cdot A_b}{l^2 \cdot \bar{C}}$$

$$\gamma = \frac{1}{1 + k}$$

C : rigidité de la connexion exprimée en (N/mm)

$\bar{C} = C/e$: rigidité de la connexion exprimée en (N/mm²)

e : distance entre les connecteurs (mm)

Méthode - γ

Les contraintes

- Contrainte à l'axe de la section i

$$\sigma_{si} = \frac{M}{I_{eq}} \cdot \gamma_i \cdot a_i$$

- Contrainte de bord

$$\sigma_{ri} = \frac{M}{I_{eq}} \cdot \left(\gamma_i \cdot a_i \pm \frac{h_i}{2} \right)$$

Méthode - γ

Les contraintes

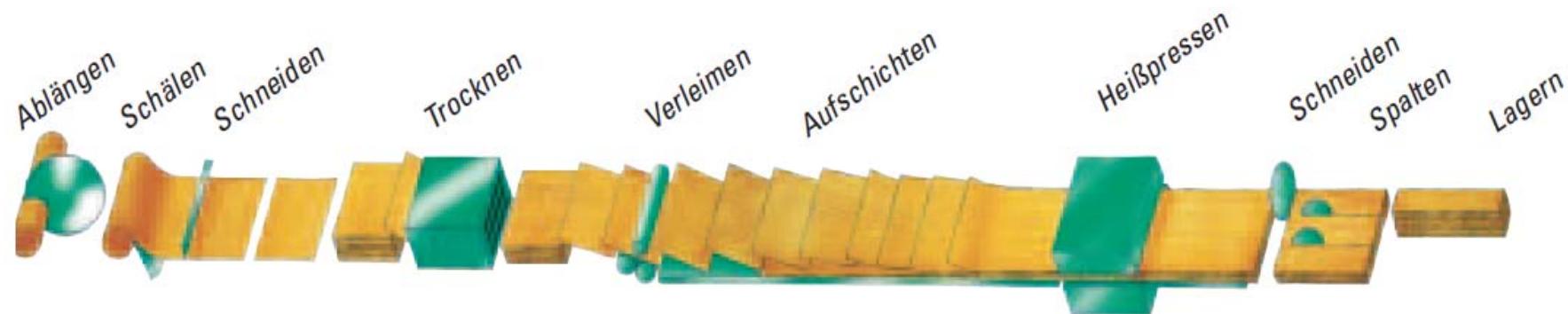
- Le flux de cisaillement entre la couche i et $i+1$ (N/mm)

$$t_{i,i+1} = \frac{Q}{I_{eq}} \cdot S_{i,i+1}$$

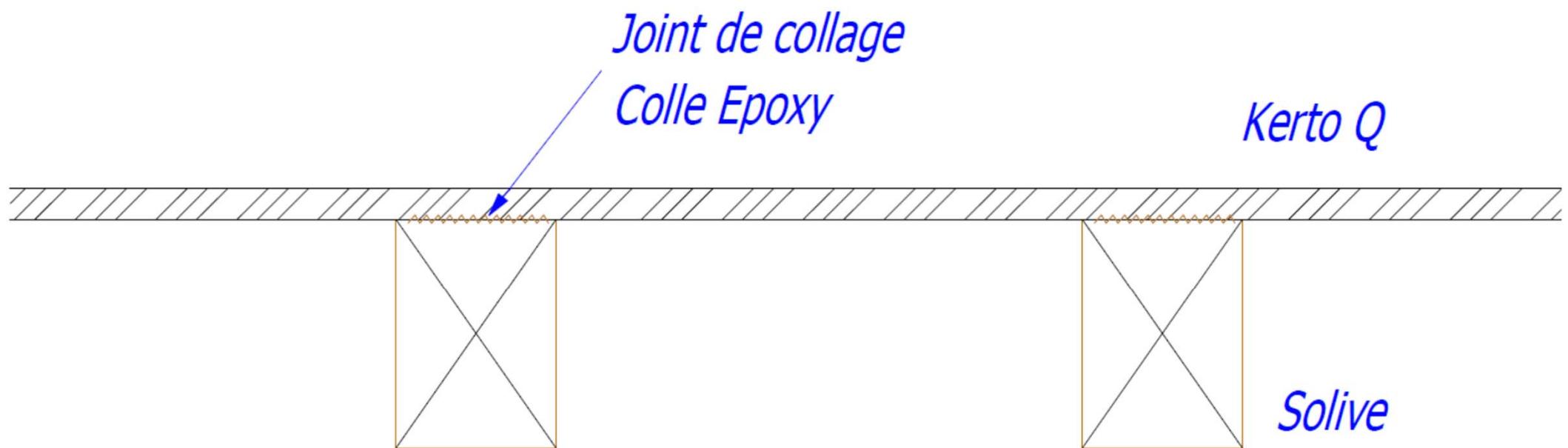
- Avec

$$S_{i,i+1} = \sum_{j=1}^i \gamma_j \cdot \bar{A}_j \cdot a_j$$

Kerto



Renforcement des solives



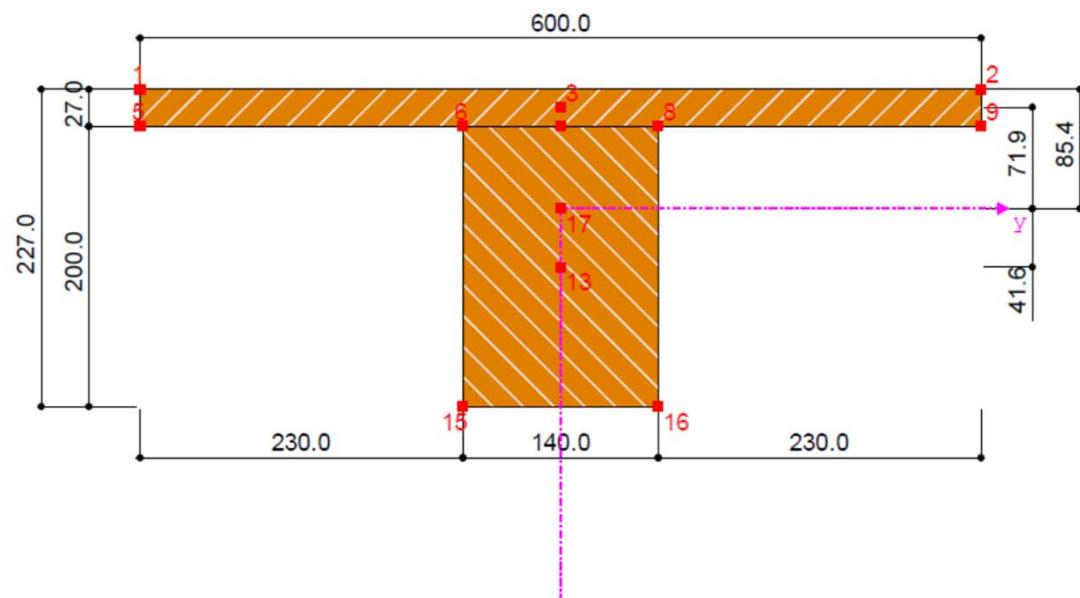
Renforcement des solives

- Section 14/20 $e=11'000 \text{ N/mm}^2$

$$I = 93.3 \cdot 10^6 \text{ mm}^4$$

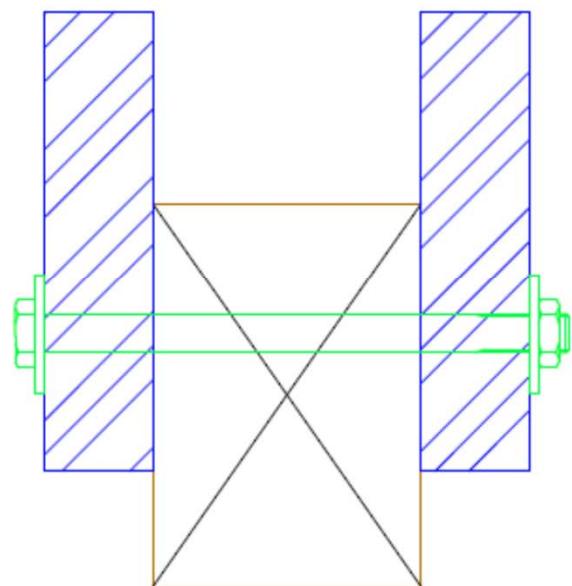
- Avec renfort Kerto Q; $t = 27\text{mm}$; $E = 10'500 \text{ N/mm}^2$

$$I = 247.5 \cdot 10^6 \text{ mm}^4$$



Renforcement des solives

Kerto S



Boullonage

Solive

Kerto S

Charakteristische Festigkeitswerte und E-Moduln für Kerto-S in N/mm² (für DIN 1052: 2004)

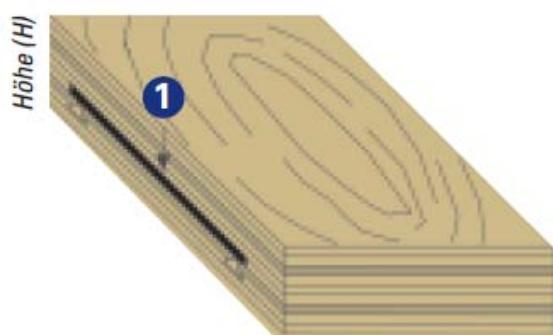
1 Plattenbeanspruchung

Biegung II zur Faser ¹⁾	$f_{m,0,k}$	50
Biegung \perp zur Faser	$f_{m,90,k}$	–
Druck \perp zur Faser	$f_{c,90,k}$	2,0
Schub	$f_{v,k}$	2,3
Elastizitätsmodul	$E_{0,mean}$	13 800
	$E_{90,mean}$	300
Schubmodul	G_{mean}	500

2 Scheibenbeanspruchung

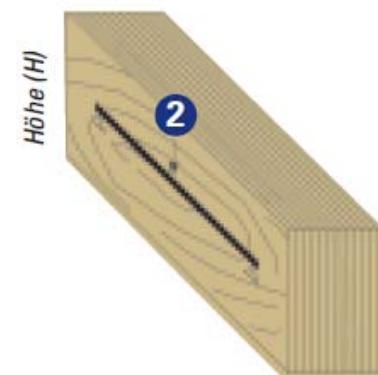
Biegung ¹⁾	$f_{m,k}$	48
Zug II zur Faser	$f_{t,0,k}$	38
Zug \perp zur Faser	$f_{t,90,k}$	0,8
Druck II zur Faser	$f_{c,0,k}$	38
Druck \perp zur Faser	$f_{c,90,k}$	6,0
Schub	$f_{v,k}$	4,4
Ausklinkung	k_n	6,0
Elastizitätsmodul	$E_{0,mean}$	13 800
Schubmodul	G_{mean}	500

1) Die Werte gelten für $H \leq 300$ mm. Für $H > 300$ mm sind die Werte mit dem Beiwert $k_H = \left(\frac{300}{H}\right)^{0,12}$ zu multiplizieren.



Schwind- und Quellmaß q in % pro % Änderung
der relativen Holzfeuchte

- | | |
|--------------------------|---------------------------------|
| in Plattenebene | II zur Faserrichtung 0,01% |
| | \perp zur Faserrichtung 0,32% |
| \perp zur Plattenebene | 0,24% |



Merci de votre attention