Liimitud puitkonstruktsioonid

Alar Just

Thorn Engineering

TAL TECH

Puumarket 7.11.2019

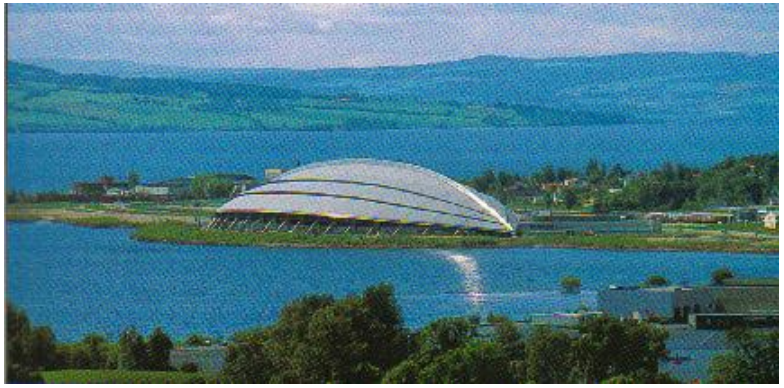
Ruhnu kirik, 1644

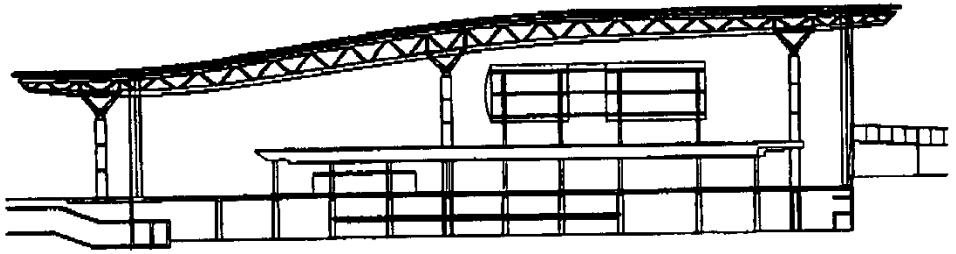

Tondiraba jäähall

Lillehammer OM 1994

Vikingskipet, Hamar

Håkon's hall, Lillehammer



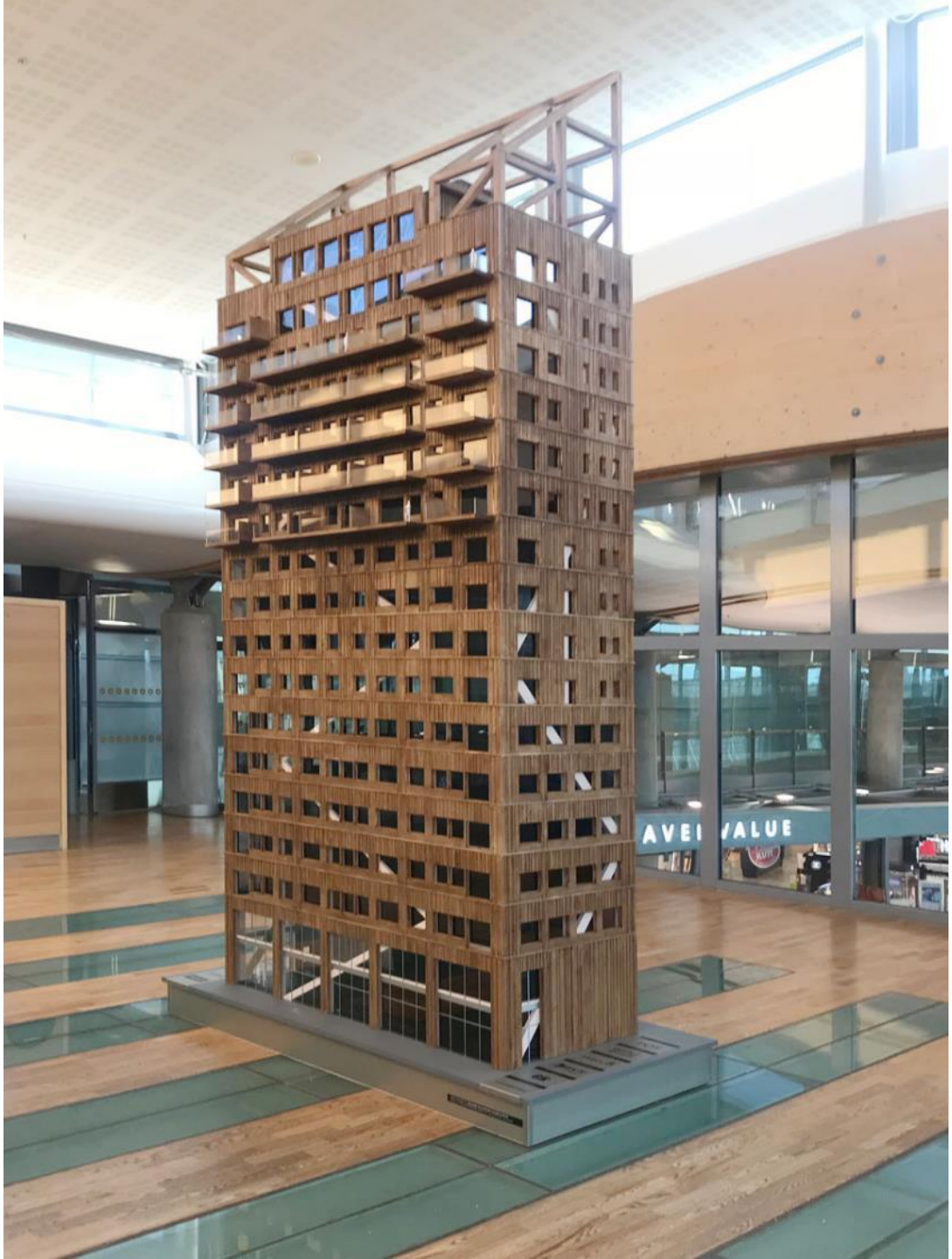


Gardermoen’i lennujaam
Oslo, Norra

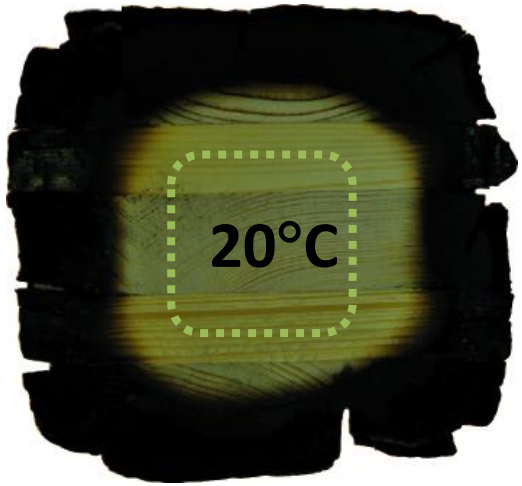

Estonian Golf &
Country Club
Jõelähtme

HoHo | RLP Rüdiger Lainer + Partner, Architects
Vienna, Austria


Mjøstårnet
Brumunddal
Norra

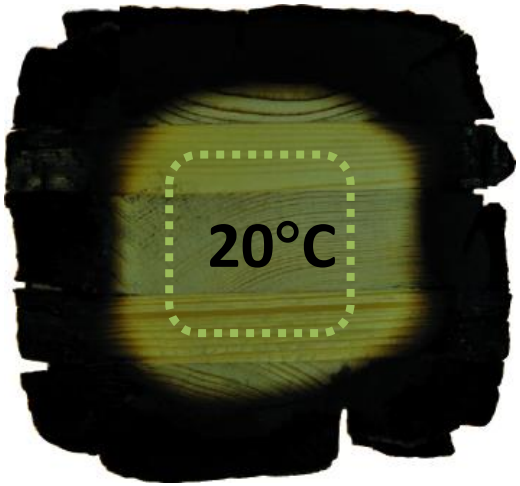

VALUE

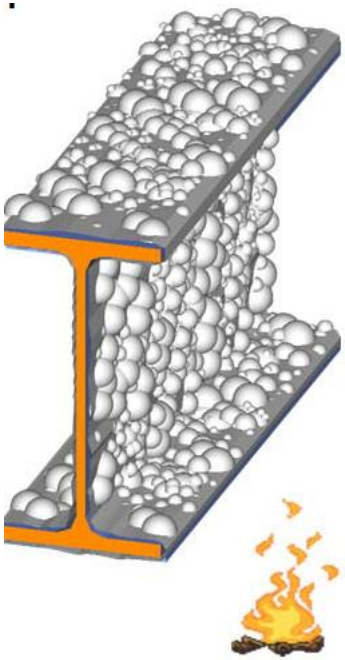
Puit tules



Söestumiskiirus
0,65 mm/min

Puit tules





Söestumiskiirus
0,65 mm/min

Puidu põlemine

- **Puit on hea isolaator**
  ($\lambda_{puit,20} \cong 0.2$, $\lambda_{betoon,20} \cong 2.0$, $\lambda_{teras,20} \cong 40$ W/mK)
- **Puusöe soojusjuhtivus on ainult 1/6 puidu soojusjuhtivusest**
- Suurte ristlõigete puhul tugevus ei vähene
- Mõõdud ja kandevõime vähenevad


Vaida jalgteesild

Christchurch 22.veebruar 2011

	Quake epicentre
Date	22 February 2011, 12:51 pm NZDT
Magnitude	6.3 M_L[1]
Depth	5 km (3.1 mi)
Epicenter	43.5834°S 172.7012°E near Lyttelton, Canterbury, New Zealand
Countries or regions	New Zealand
Max. intensity	MM IX - Violent[2]
Peak acceleration	1.88*g* (city); 2.2*g* (epicentre)[3]
Tsunami	3.5 m (11 ft) tsunami waves in Tasman Lake, following quake-triggered glacier calving from Tasman Glacier[4][5]


WARD
SEARCH ROUTE
City Centre
Welcome to Christchurch
City Centre Map
Due to earthquake damage, parts of the Central City remain cordoned off from public access. These cordoned areas will reopen in stages as remedial work is completed.
To help you find your way around our city scan the QR code below (or check out www.christchurch.org.nz/map) or pick up a free mini-map from the i-SITE Visitor Centre, Rolleston Avenue (beside Canterbury Museum).
Open 8.30am – 5pm daily.
Free phone 0800 4 237 83
or (03) 379 9629.
Landmark
Hospital/Medical Centre
NZ Post
Money Machine
Carpark
Public Toilet
Supermarket
Red Zone
City Council


LEIGHS
CONSTRUCTION
LEIGHS
CONSTRUCTION
www.leighsconstruction.com
FAHEY

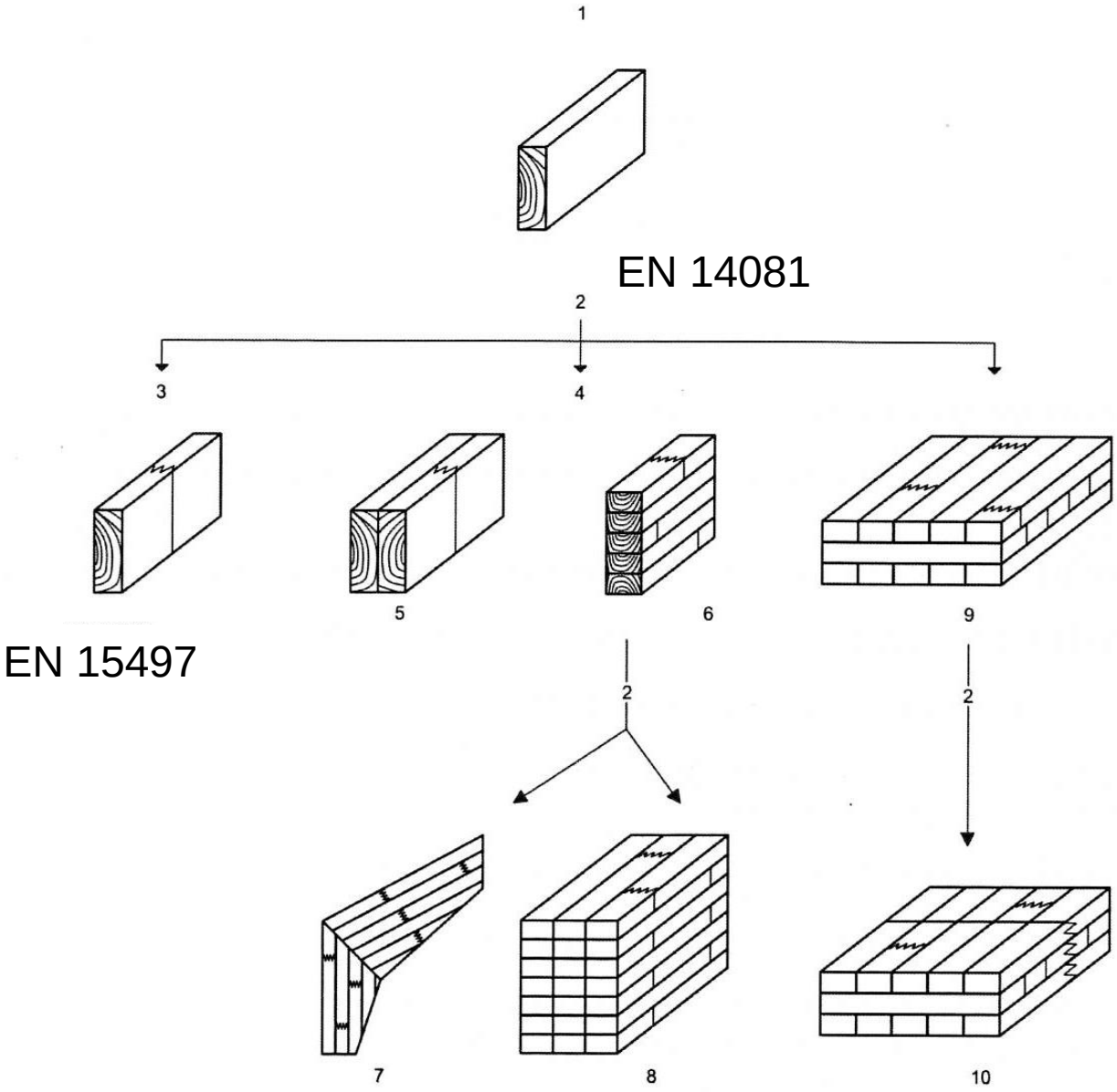
Testmaja

Canterbury Ülikool

Christchurch


DANGER KEEP OUT
LIFT UP (543887)

Liimitud puitmaterjalid


1
EN 14081
2
3
4
5
6
9
EN 15497
2
2
7
8
10
EN 14080
EN 16351

- **EVS-EN 14081-1:2016**
- **Puitkonstruktsioonid. Nelinurkse ristlõikega tugevussorditud ehituspuit. Osa 1: Üldnõuded**
- **EVS-EN 14081-2:2010+A1:2012**
- **Osa 2: Masinsortimine. Täiendavad nõuded esmasteks tüübikatsetusteks**
- **EVS-EN 14081-3:2012**
- **Osa 3: Masinsortimine. Täiendavad nõuded tootmisohjele ettevõttes**
- **EVS-EN 14081-4:2009**
- **Part 4: Machine grading - Grading machine settings for machine controlled systems**

- **EVS-EN 14080:2013**
- **Puitkonstruktsioonid. Lamell-liimpuit ja plankliimpuit. Nõuded.**

- **EVS-EN 15497:2014**
- **Sõrmjätkatud ehituslik täispuit. Teostusnõuded ja tootmisele esitatavad miinimumnõuded**

- **EVS-EN 16351:2015**
- **Puitkonstruktsioonid. Ristkihtpuit. Nõuded.**

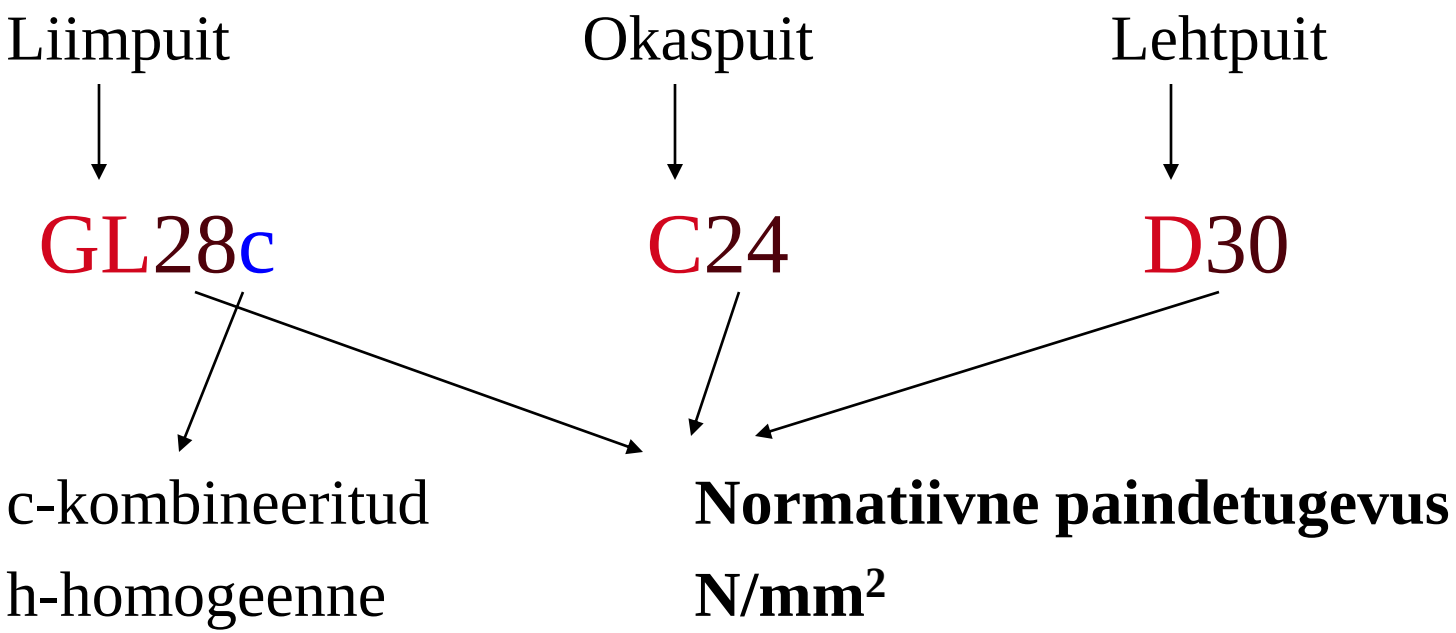
Puitkarkass

- **Karkassipuit peab olema kuivatatud ja tugevussorteeritud puit!**

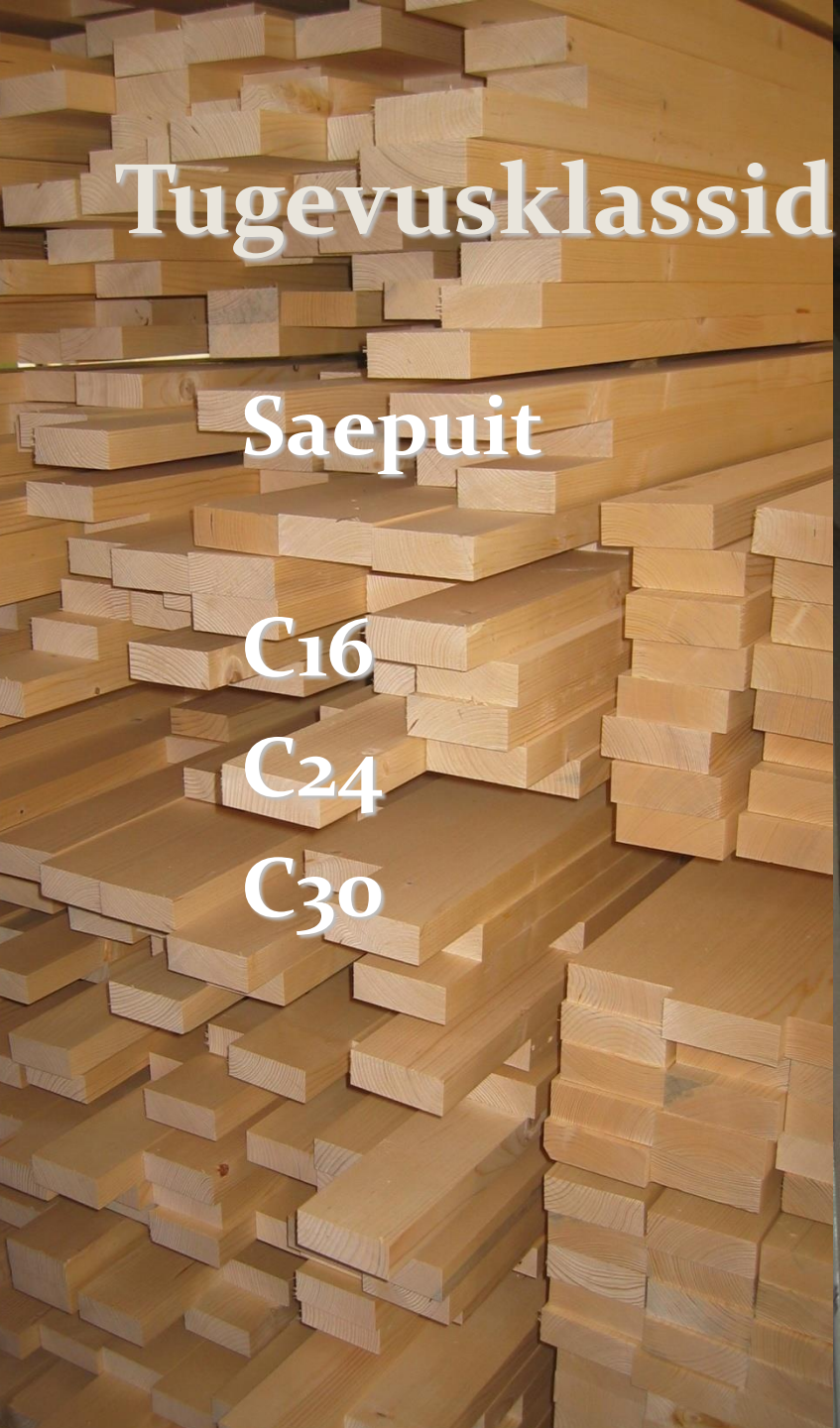
Puidu tugevus

Puidu arvutustugevus sõltub:

- koormuse iseloomust
- kasutuskohast (kliimast)



Tugevusklassid



Saepuit

C16

C24

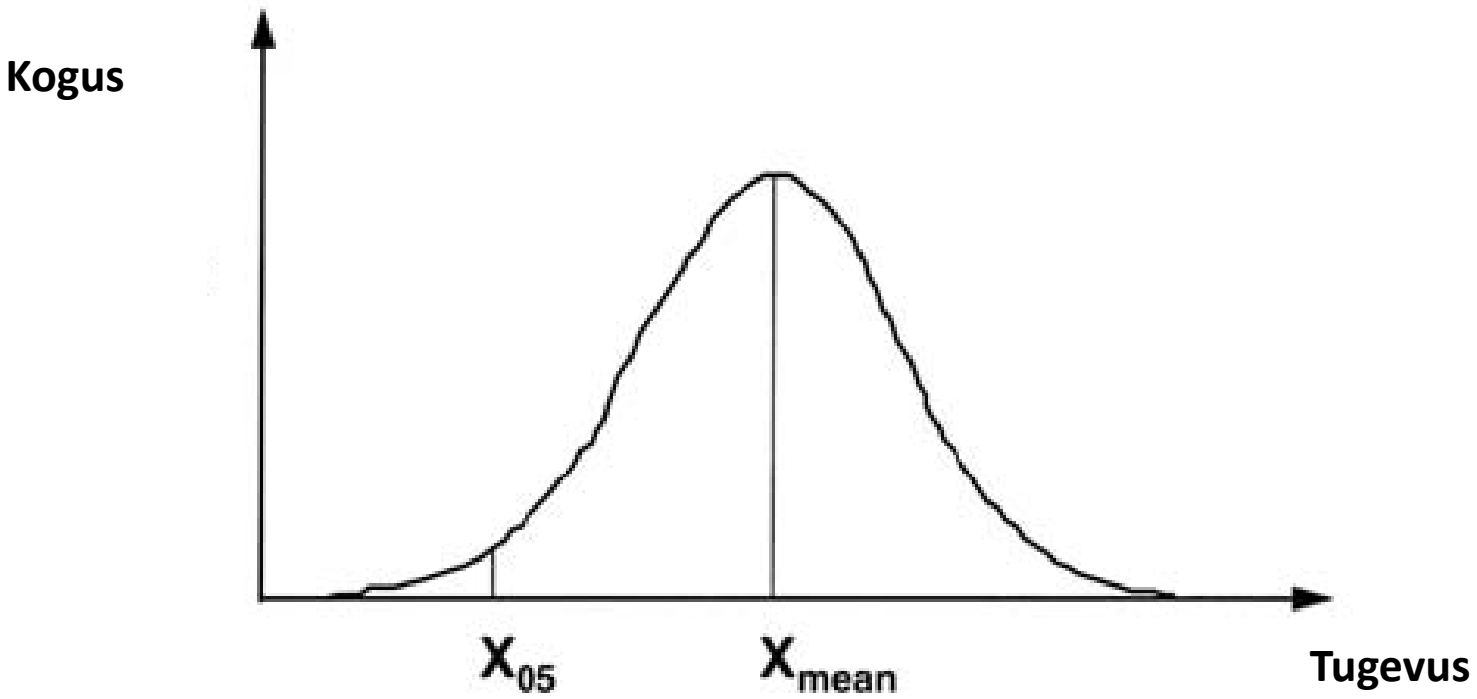
C30

Liimpuit

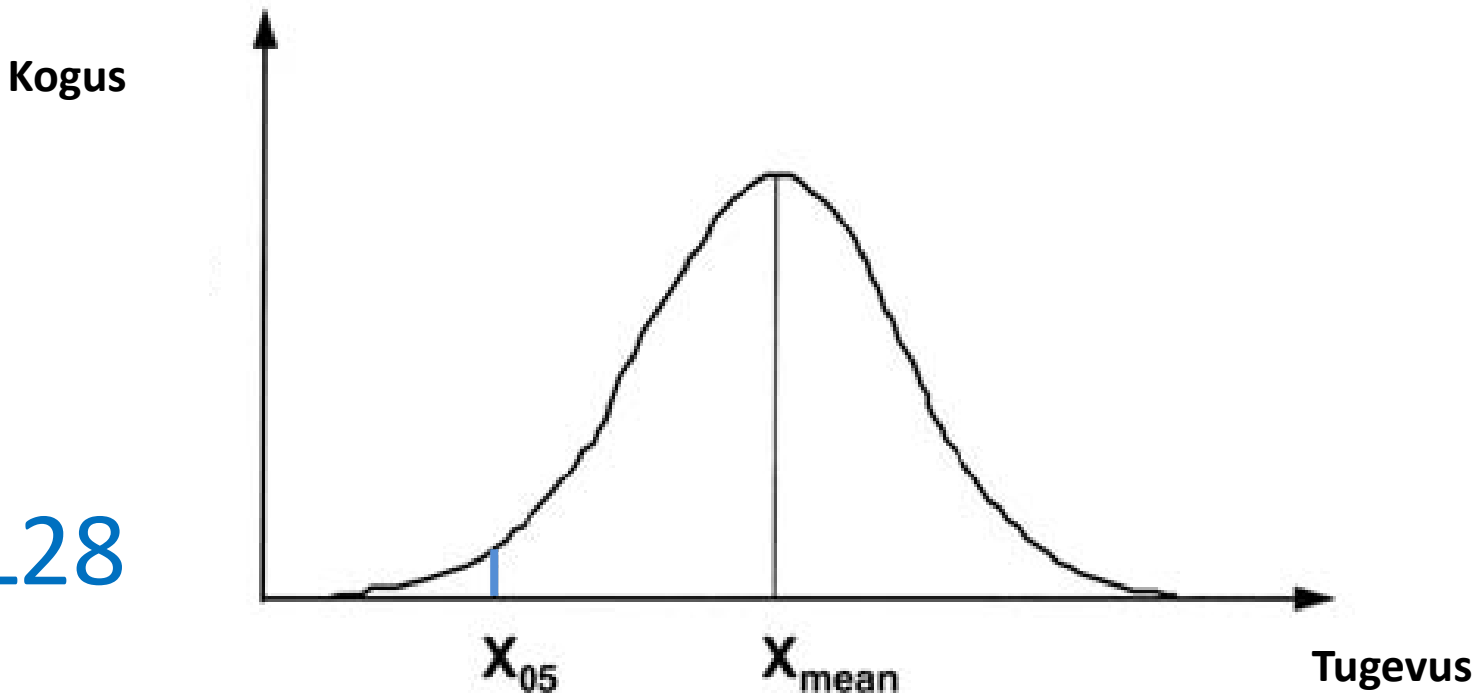
GL28c, GL28h

Tugevusklassid

Puidu normtugevus



Puidu normtugevus

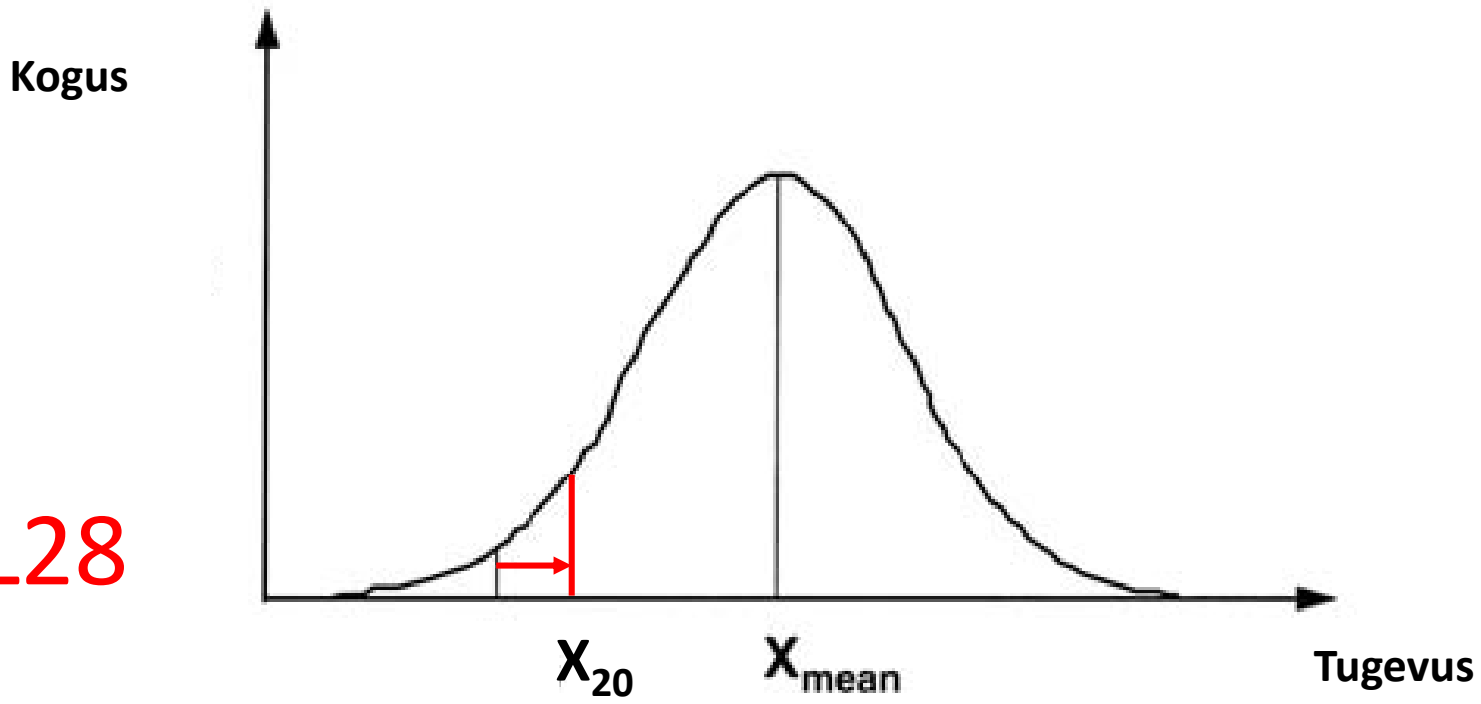


GL28

28 N/mm²

Puidu normtugevus tules

GL28



32 N/mm²

Puidu arvutustugevus

Tugevuse arvutusväärtus:

$$f_d = k_{mod} f_k / \gamma_M$$

k_{mod} modifikatsioonitegur

f_k tugevuse normväärtus

γ_M materjali osavarutegur

Materjali omaduste osavarutegurid

	γ_M
Põhikombinatsioonid:	
Saepuit	**1,3**
Lamell-liimpuit	**1,25**
Spoonliimpuit, vineer, OSB	**1,2**
Puitlaastplaat, puitkiudplaat	**1,3**
Avariikombinatsioonid:	**1,0**

Tugevuse arvutusväärtus:

$$f_d = k_{mod} f_k / \gamma_M$$

Kasutusklassid

Kasutusklass 1

Iseloomustatakse materjali niiskusesisaldusega, mis vastab temperatuurile 20°C ja õhu suhtelisele niiskusele 65%, ning mida ületatakse vaid mõnel nädalal aastas.

Okaspuidu
niiskusesisaldus
alla 12%.

Kasutusklassid

Kasutusklass 2

Iseloomustatakse materjali niiskusesisaldusega, mis vastab temperatuurile 20°C ja õhu suhtelisele niiskusele kuni 85%, ning mida ületatakse vaid mõnel nädalal aastas.

Okaspuidu
niiskusesisaldus
alla 20%.

Kasutusklassid

Kasutusklass 3

Iseloomustatakse kõrgema niiskusesisaldusega, kui kasutusklass 2.

Koormuse kestusklassid

	KESTUS	NÄIDE
Alaline	üle 10 a	omakaal
Pikaajaline	6 k – 10 a	laokoormus
Keskkestev	1 näd – 6 k	kasuskoormus
Lühiajaline	alla 1 nädala	lumi, tuul
Hetkeline		avariikoormus

k_{mod}

Tavaliselt vahelagede puhu

	1	2	3
Alaline	0,6	0,6	0,5
Pikaajaline	0,7	0,7	0,55
Keskkestev	0,8	0,8	0,65
Lühiajaline	0,9	0,9	0,7
Hetkeline	1,1	1,1	0,9

Tavaliselt katusetalade puhul

Tugevuse arvutusväärtus:

$$f_d = k_{mod}\, f_k / \gamma_M$$

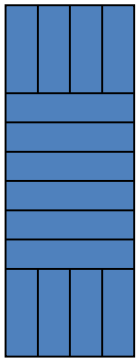
Puit- ja puidupõhjaliste materjalide näited

Üldiselt inseneri(konstruktsiooni)puit oleks

Ümarpalk

Saematerjal

Multilamell-liimpuit



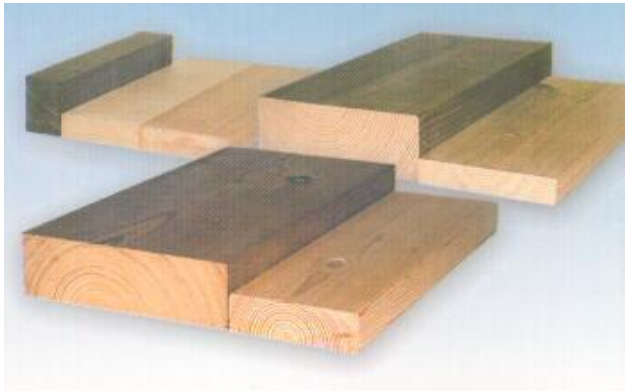
Rist-kihtpuit-plaat

Comwood

Kertopuu

Parallam

Kuum(termo)töödeldud puit

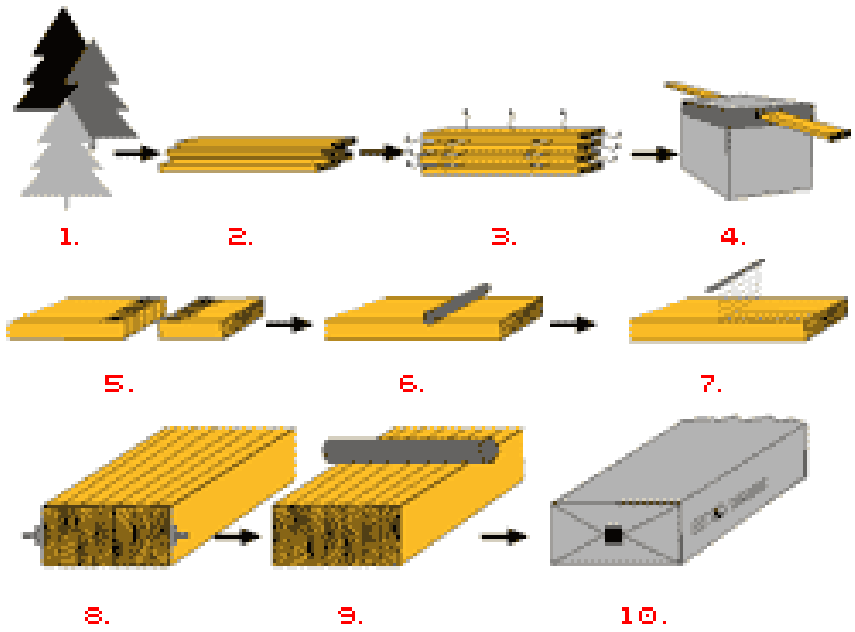


Intrallam 2,44 x 10,6 m

t = 32...89 mm


ABUS

Tootmine



1 – kuusepuu

2 – kuusepuit

3 – kuivatamine

4 – sorteerimine

5 – hammasliite tegemine

6 – hööveldamine

7 – liimi pealekandmine

8 – pressimine

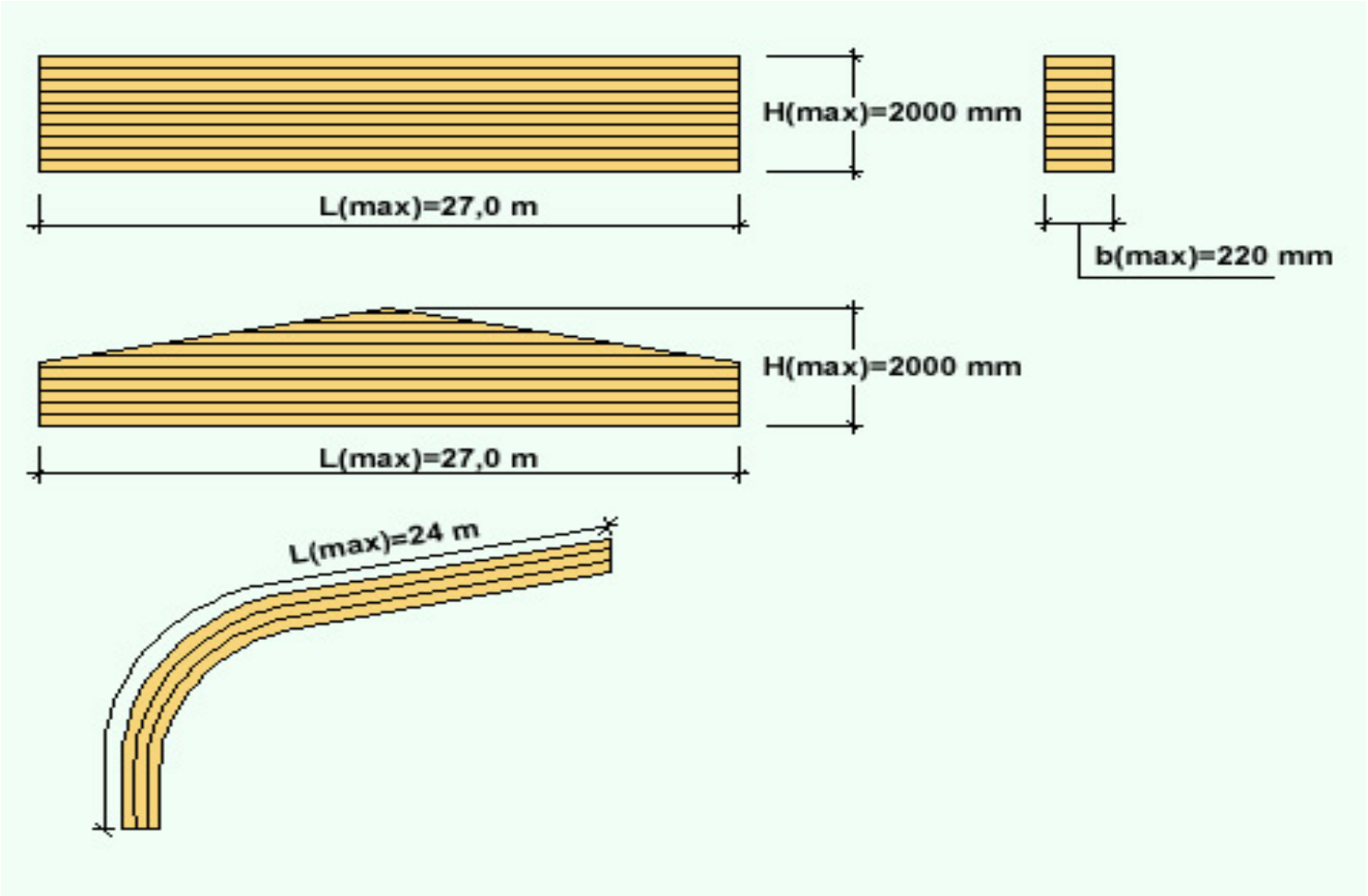
9 – hööveldamine

10 - pakendamine

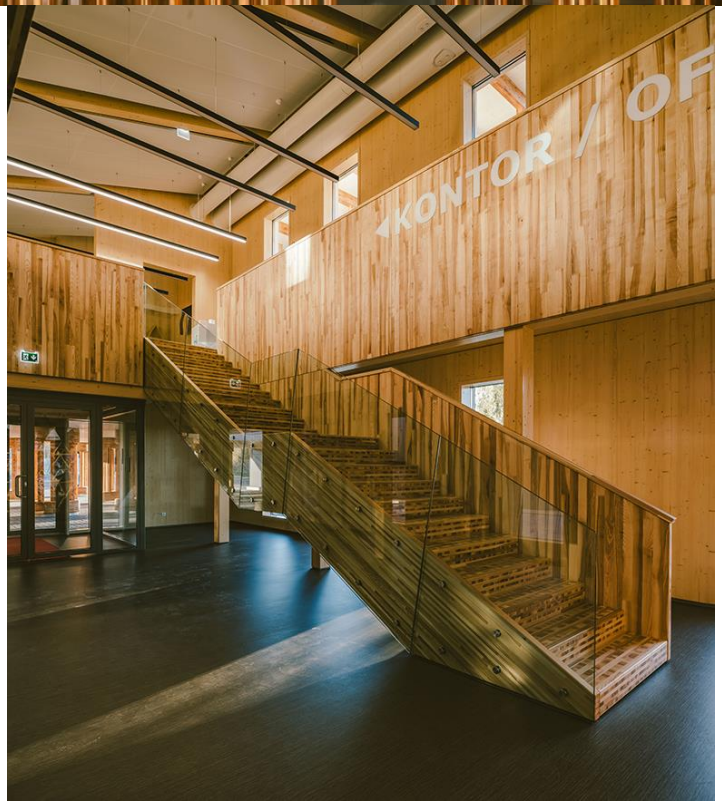
Hammasliited

- Hammasliited (*finger joints*) on üks vastutusrikkamaid kohti liimpuitelemendis ja nende kvaliteeti kontrollitakse põhjalikult
- Hammasliited valmistatakse standardi **EN 14080** järgi.

Liimpuit

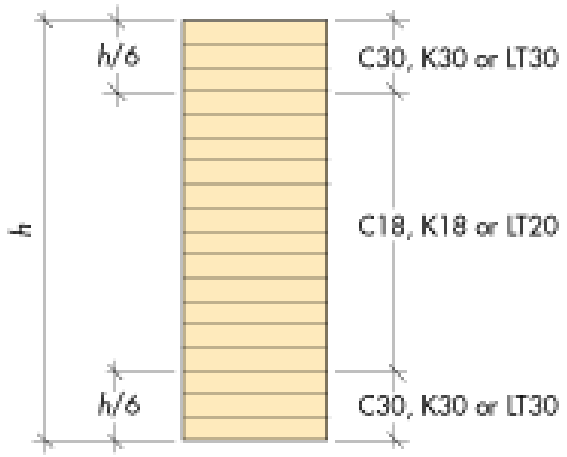

H(max)=2000 mm
L(max)=27,0 m
b(max)=220 mm
H(max)=2000 mm
L(max)=27,0 m
L(max)=24 m


ARCWOOD


KONTOR / OF

Kombineeritud või homogeenne liimpuit

- Lamelli paksused tavaliselt 33, 40, 45 mm
  - Kaarte lamellide paksused võivad olla veelgi väiksemad
- Lamellid on tugevussorteeritud
- Lamellis on lauad jätkatud hammasliitega



Kombineeritud liimpuit

Kombineeritud liimpuit –

Välimised lamellid on h/6 ulatuses tugevamast puidust, sisemised nõrgemast

Homogeenne liimpuit –

Kõik lamellid ühe tugevusega puidust

EN 14080:2013

Table 4 — Characteristic strength and stiffness properties in N/mm² and densities in kg/m³ for combined glulam

Property[a]	Symbol	Glulam strength class						
		GL 20c	GL 22c	GL 24c	GL 26c	GL 28c	GL 30c	GL 32c
Bending strength	$f_{m,g,k}$	20	22	24	26	28	30	32
Tensile strength	$f_{t,0,g,k}$	15	16	17	19	19,5	19,5	19,5
	$f_{t,90,g,k}$	0,5						
Compression strength	$f_{c,0,g,k}$	18,5	20	21,5	23,5	24	24,5	24,5
	$f_{c,90,g,k}$	2,5						
Shear strength (shear and torsion)	$f_{v,g,k}$	3,5						
Rolling shear strength	$f_{r,g,k}$	1,2						
Modulus of elasticity	$E_{0,g,mean}$	10 400	10 400	11 000	12 000	12 500	13 000	13 500
	$E_{0,g,05}$	8 600	8 600	9 100	10 000	10 400	10 800	11 200
	$E_{90,g,mean}$	300						
	$E_{90,g,05}$	250						
Shear-modulus	$G_{g,mean}$	650						
	$G_{g,05}$	540						
Rolling shear modulus	$G_{r,g,mean}$	65						
	$G_{r,g,05}$	54						
Density[b]	$\rho_{g,k}$	355	355	365	385	390	390	400
	$\rho_{g,mean}$	390	390	400	420	420	430	440

[a] Properties given in this table have been calculated according to 5.1.5 on the basis of the layups given in Table 2. If different layups for a certain strength class lead to different characteristic values the lowest values are given here.

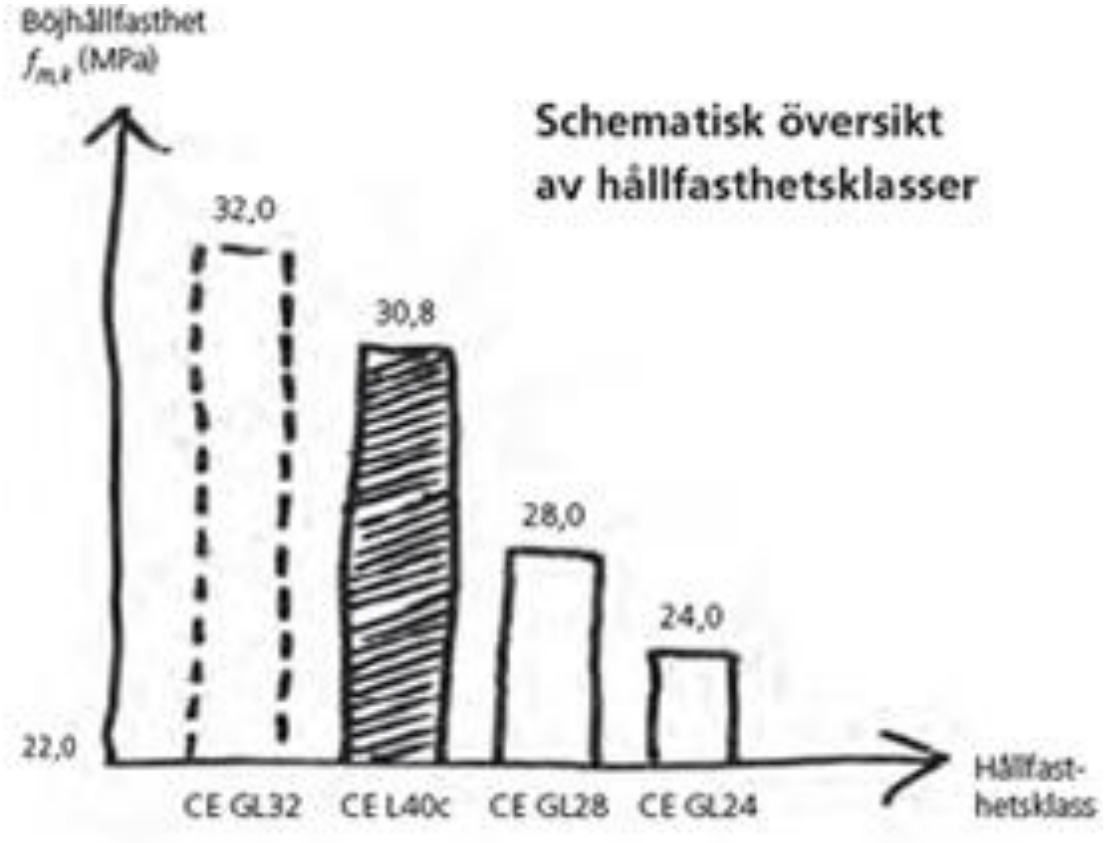
[b] Calculated as the weighted mean of the densities of the different lamination zones, see 5.1.5.3, 5th paragraph.

EN 14080:2013

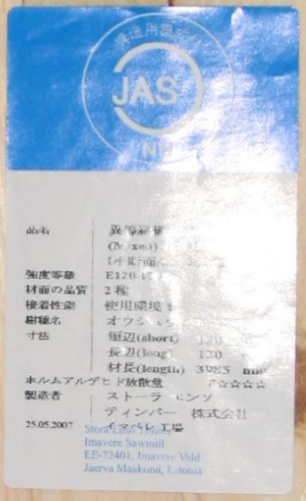
Table 5 — Characteristic strength and stiffness properties an N/mm² and densities in kg/m³ for homogeneous glulam

Property	Symbol	Glulam strength class						
		GL 20h	GL 22h	GL 24h	GL 26h	GL 28h	GL 30h	GL 32h
Bending strength	$f_{m,g,k}$	20	22	24	26	28	30	32
Tensile strength	$f_{t,0,g,k}$	16	17,6	19,2	20,8	22,3	24	25,6
	$f_{t,90,g,k}$	0,5						
Compression strength	$f_{c,0,g,k}$	20	22	24	26	28	30	32
	$f_{c,90,g,k}$	2,5						
Shear strength (shear and torsion)	$f_{v,g,k}$	3,5						
Rolling shear strength	$f_{r,g,k}$	1,2						
Modulus of elasticity	$E_{0,g,mean}$	8 400	10 500	11 500	12 100	12 600	13 600	14 200
	$E_{0,g,05}$	7 000	8 800	9 600	10 100	10 500	11 300	11 800
	$E_{90,g,mean}$	300						
	$E_{90,g,05}$	250						
Shear modulus	$G_{g,mean}$	650						
	$G_{g,05}$	540						
Rolling shear modulus	$G_{r,g,mean}$	65						
	$G_{r,g,05}$	54						
Density	$\rho_{g,k}$	340	370	385	405	425	430	440
	$\rho_{g,mean}$	370	410	420	445	460	480	490

L40 =
GL30..32


Böjhållfasthet
$f_{m,k}$ (MPa)
Schematisk översikt
av hållfasthetsklasser
32,0
30,8
28,0
24,0
22,0
CE GL32
CE L40c
CE GL28
CE GL24
Hållfast-
hetsklass


構造用集成材
JAS
NTI
品名 異等級構成構造用集成材
(Mixed) 対称構成 (sym)
〔小断面/S〕 桁：Keta
強度等級 E120-F330
材面の品質 2種
接着性能 使用環境1
樹種名 オウシュウアカマツ (Pine)
寸法 短辺(short) 120 mm
長辺(long) 120 mm
材長(length) 3985 mm
ホルムアルデヒド放散量 F☆☆☆☆
製造者 ストーラ エンソ
ティンバー 株式会社
25.05.2007
Stora Enso Timber
Imavere Sawmill
EE-72401, Imavere Vald
Jaerva Maakond, Estonia


JAS

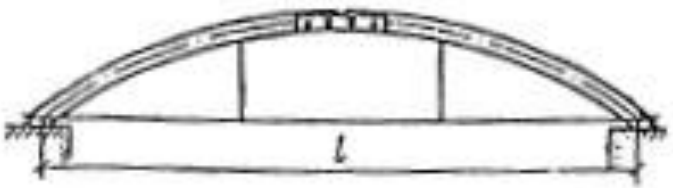

AS Rait tootmishoone

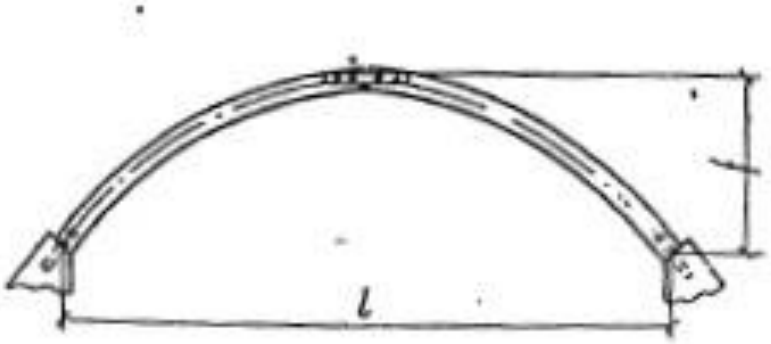

Tallinna spordihall


Coca-Cola

Kaared

- Horisontaalne toereaktsioon võetakse vastu tõmbi või kontraforsiga.

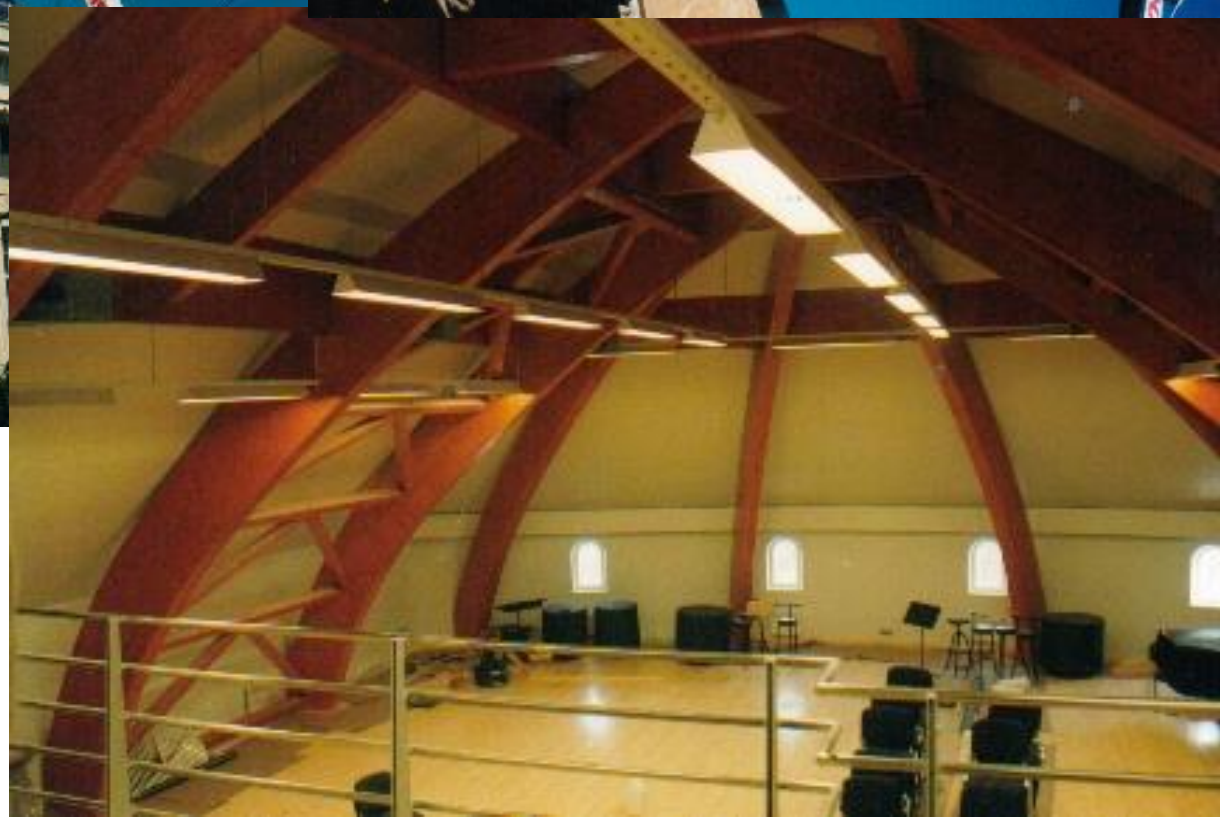




Lõunakeskuse jäähall


L=36 m

“Estonia” kuppelsaal




Lükati suusasild

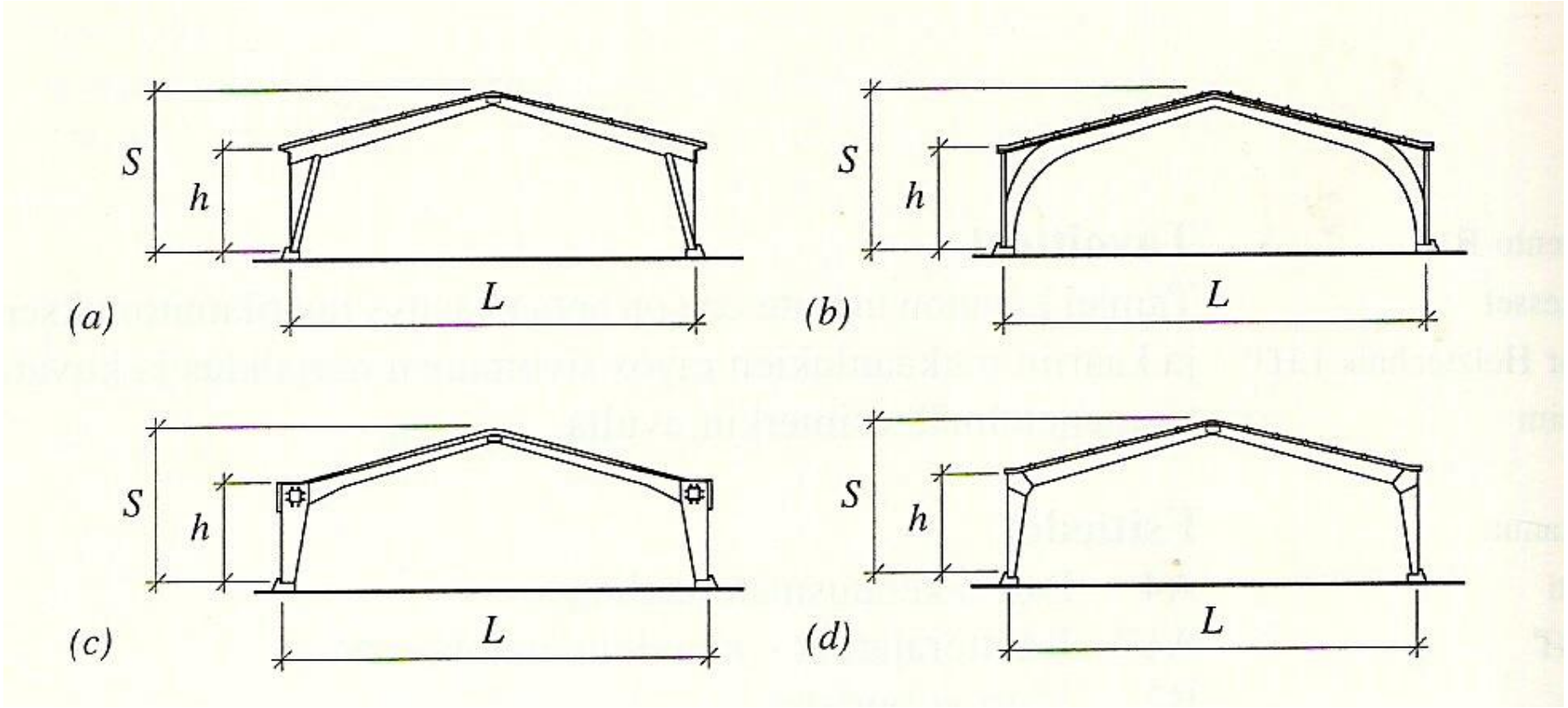

MERIRAHU SADAM

Merirahu jalgteesild


MERIRAHU SADAM

Kalvi Krass

Raamid




Ahja spordihall

Mesikäpa hall

Sõrestikud

- Väliskuju järgi:

a) kolmnurk-

b,c) trapets-

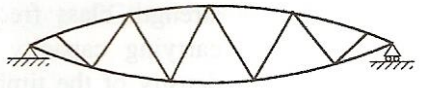
d) polügonaal-

e) segment-

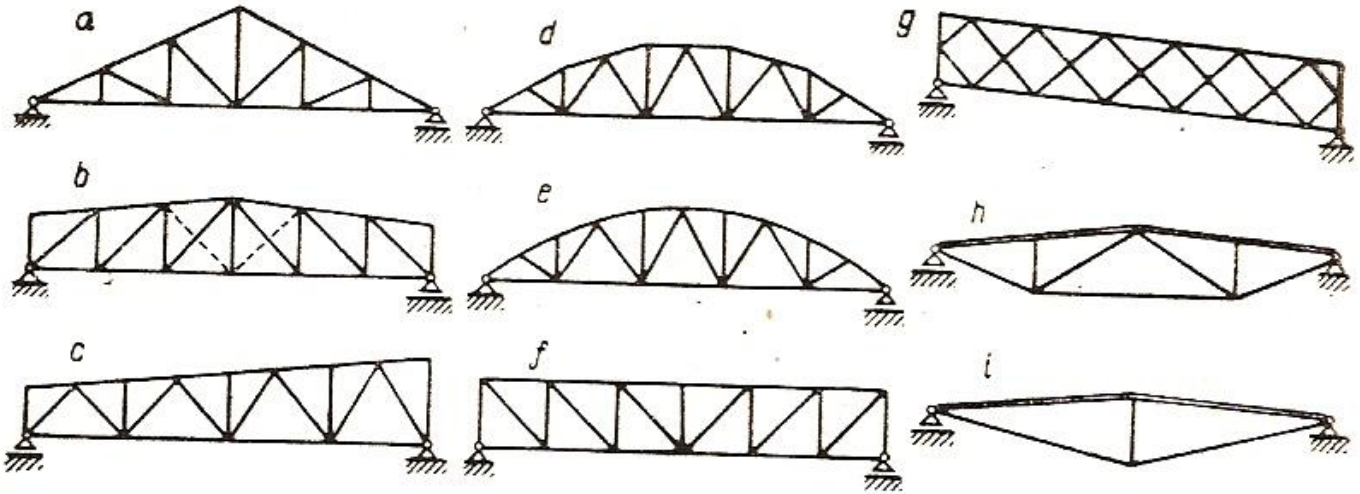
f,g) paralleelvöödega

h,i) sprengelsõrestik

j) läätsekujuline sõrestik



j



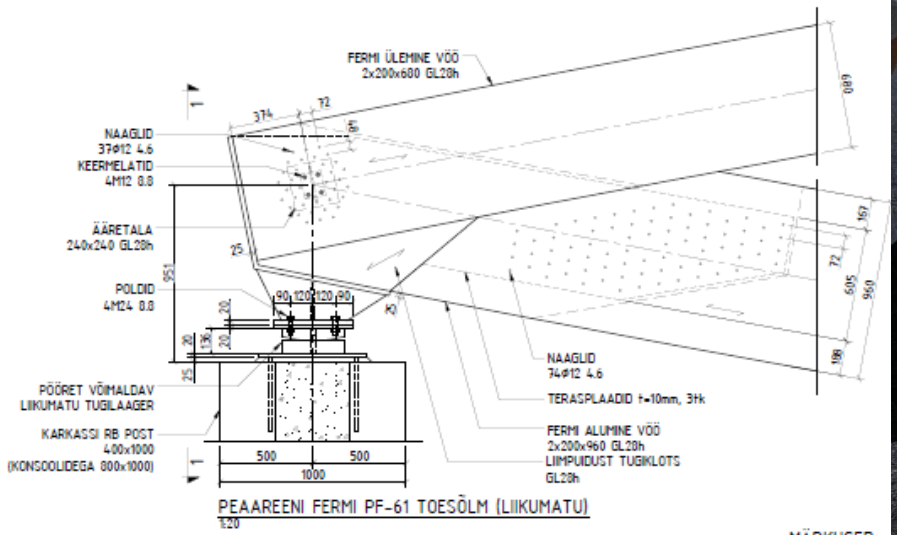
Palmako tootmishoone
Kavastus


www.kraana2.ee


www.kraana2.ee


Tondiraba jäähall

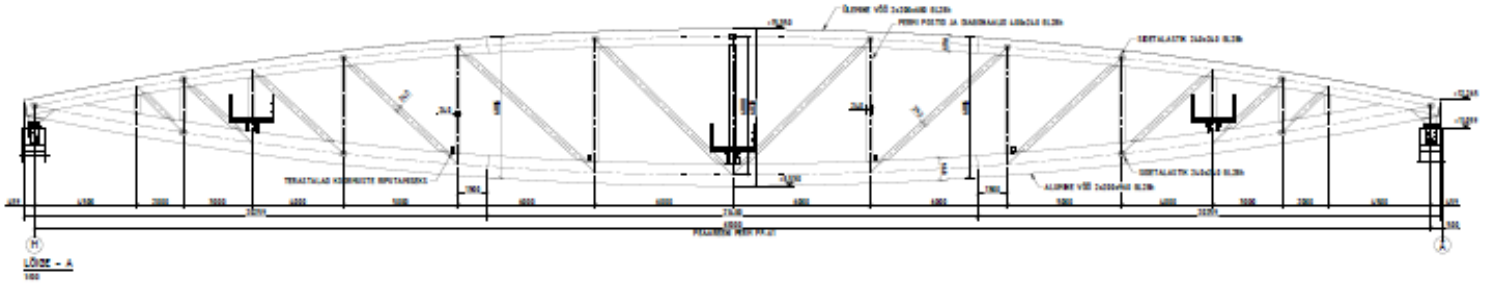

• Tondiraba jäähall
• L=61 m
Foto: Laur Lôvi



PEAAREENI FERMI PF-61 TOESÕLM (LIIKUMATU)

1:20

MÄRKUSED



Spoonliimpuit (LVL)

- Spoonliimpuitu ehk vineerpuitu saadakse 3 mm paksuse kuusespooni kokkuliimimisel plaadiks ilmastikukindla liimiga.

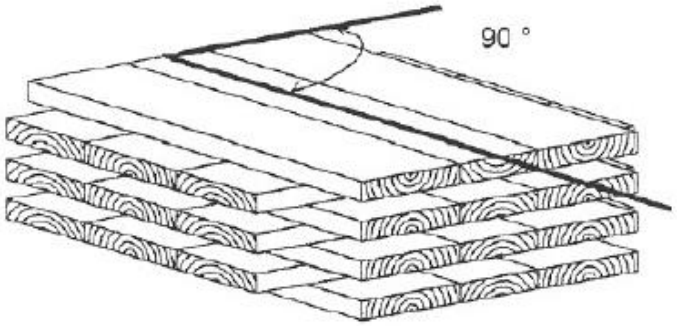
„Kertopuu“

Spoonliimpuit

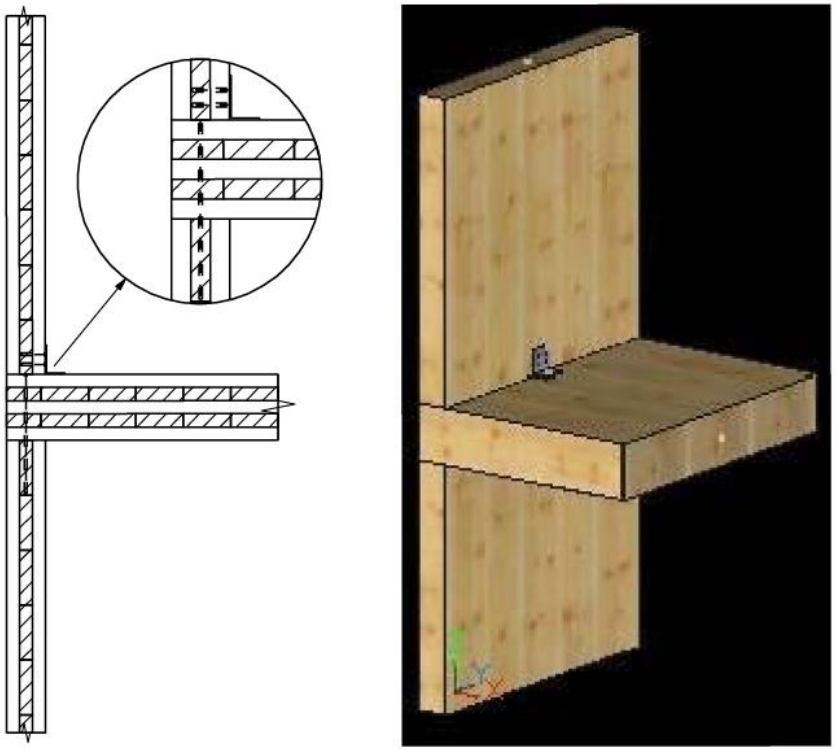
Metropol Parasol
Sevilla

Ristkihtpuit (CLT)

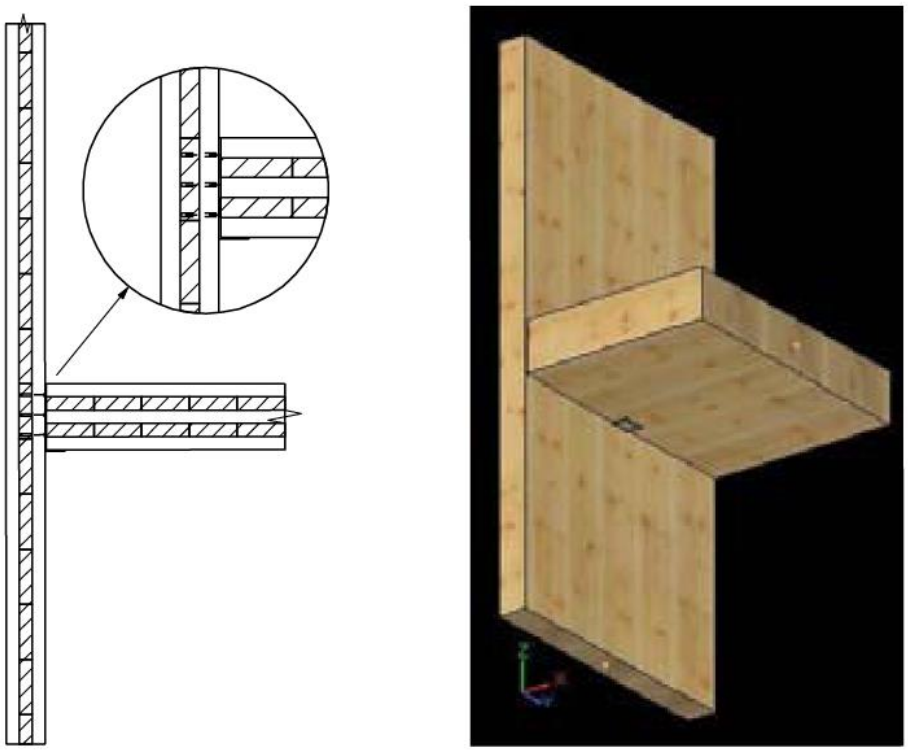
- CLT – *cross laminated timber*




Ristkihtpuit



Floor External Wall Joint



Floor External Wall Joint

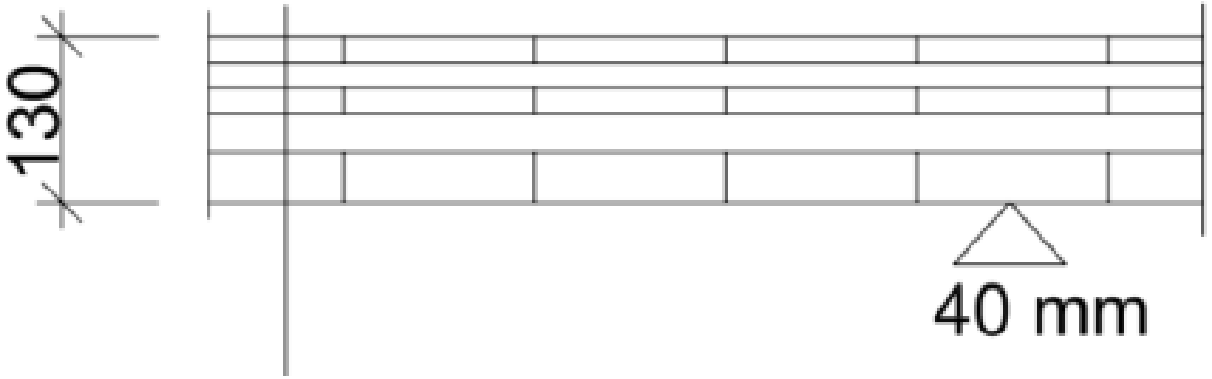
Allikas: Structurlam

UBC ühiselamu
Vancouver


NO SITE PARKING
DANGER
OPEN EXCAVATION
6088

Väike-Maarja tulekatse 1.11.2017

Ristkihtpuit



Tuli

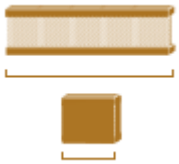

0:20


0:47


1:05


1:50

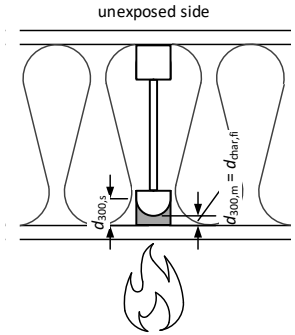
I-talad

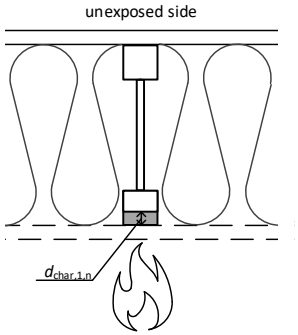


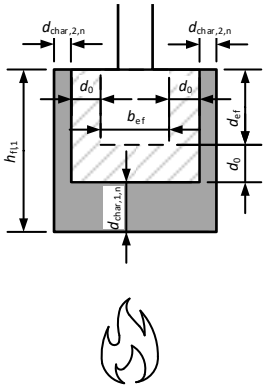
H=150..500 mm

- Materjali kokkuhoid
- Tundlikud tules

Hammasliide väga vastutusrikas!

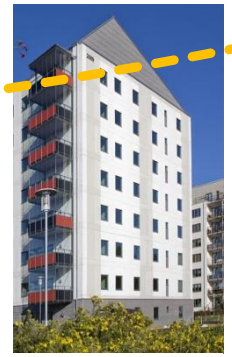

unexposed side
$d_{300,s}$
$d_{300,m} = d_{char,fi}$


unexposed side
$d_{char,1,n}$


$d_{char,2,n}$
$d_{char,2,n}$
d_0
d_0
b_{ef}
d_{ef}
d_0
h_{fi1}
$d_{char,1,n}$

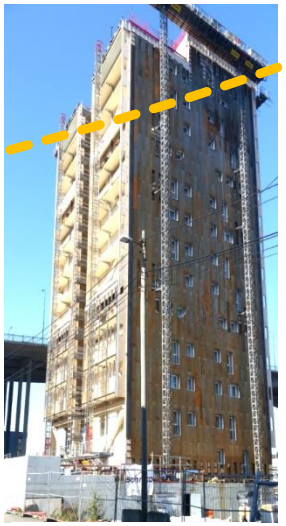
Areng alates1994

1996
5 korrust
Puitkarkass
Välludden,
Växjö

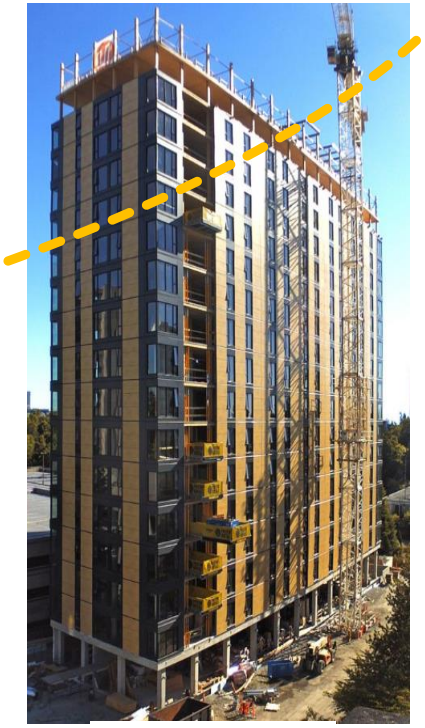


2009
8 k.
Massiivpuit
Portvakten,
Växjö

2012
10 k.
CLT
Forte, Melbourne



2015
14 k
Post-tala
TREET, Bergen
45 m



2017
18 k
CLT+betoon
Brock Commons,
Vancouver
53 m

2019
18 k.
Post-tala
Mjøstornet,
Brumunddal

TALTECH KONSTRUKTSIOONIDE LABOR


TalTechi teadus- ja õppehoone rekonstrueerimine
HEAVY CRANES
WWW.CRANE.EE
LIVE
Scroll for details
HD

Bergen 2014 – Treet (14 korrust)

- Kõrgeim puidust kortermaja!

Lôige


C
D
E
F
G
H
I
+44,65
Takplan
+41,70
13. Etasje
+38,75
12. Etasje
+35,80
11. Etasje
+32,55
10. Etasje
+29,35
9. Etasje
+26,40
8. Etasje
+23,45
7. Etasje
+20,50
6. Etasje
+17,25
5. Etasje
+14,05
4. Etasje
+11,10
3. Etasje
+8,15
2. Etasje
+5,20
1. Etasje
+2,20
Parkering
±0,00
kart