ARUNDA

EN

Jigs for dovetailed roof-frame assemblies

Instructions for use

English

Contents Page

Warning!
These Instructions for Use contain important indications concerning occupational safety when using ARUNDA jigs. Please read attentively!

Mode emploi complet EN - 14.10.08

1 Identification of the manufacturer

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1.1 International patent

The Arunda "Jigs for creating dovetailed assemblies" device is protected in Europe by patent EP1812213 B1. For all other countries the patent is currently pending (Patent Pending).

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2 Arunda material

2.1 Description of the jigs

Arunda jigs make it possible to create dovetailed roof-frame assemblies.

2.11 Types of jigs

Type of jig	For width of joist (with tail). mm	For height of joist. mm	Possible height of joint. mm	Depth of tail. mm	Depth of pins. mm
N° 60	60 to 80	90 to 260	90 to 200 (in steps of 10)	26	28
N° 80	80 to 120 (+ 20)	90 to 260 (+ 20)	90 to 200 (in steps of 10)	26	28
N° 100	100 to 140 (+ 20)	90 to 260 (+ 20)	90 to 200 (in steps of 10)	26	28
N° 120	120 to 160 (+ 20)	90 to 260 (+ 20)	90 to 200 (in steps of 10)	26	28
N° 160+	160 to 300	90 to 420	90 to 300 (in steps of 10)	26	28

Five jig sizes are available. The choice of a jig is defined by the current widths of the beams (e.g. joist or rafter) on which the tail (i.e. the male part) is cut. The model number is marked on each jig: 60, 80, 100, 120 and 160+. The greater the cross-section, the broader the tail, the larger the jig and greater the resistance of the assembly.
The use of Arunda jigs involves the use of other tools such as a router, an Arunda bit and accessories which we describe below**.**

Pair of Arunda jigs

2.2 Router

The router used to work with the Arunda system must meet the following design criteria:

Power	2600 Watts (absolute minimum 2200 W)
Fixing of the bit	Adapter or M 12 X 1 mm (AG) external-thread shank for screwed bit with internal (IG) M 12 X 1 mm screw pitch.
Ring	Possibility of mounting the Arunda guide ring perfectly centred on the spindle.
Safety:	1 position-blocking handle. 1 upper stop to prevent the router base-plate from lifting and 1 lower stop preventing the router base-plate from sinking.
Table	Possibility of fitting Arunda expansion plates in the four threaded holes envisaged for this purpose
Construction	Solid and robust.
Weight	Allowing for easy use in vertical and horizontal positions, < 7 kg.

Mafell LO65 EC router

2.21 Recommended machine

After conducting tests with many makes of machines and different power ratings, we recommend the use of one of the two following Mafell routers:
- MAFELL, model LO 65 EC., *230 V, 2600 W* or else LO 65 E, 230 V, 2200 W.

Many other machines were completely eliminated because they did not meet the power or job-safety requirements, had fixed blocking height, were difficult to handle and to fit Arunda accessories to or had other shortcomings.
The details of the machines are indicative and do not incur the liability of Arunda as a manufacturer.

Expansion plates

2.3 Expansion plate

It is necessary to add an Arunda expansion plate to ensure the good stability of the machine when used on the jigs.
Arunda envisages three specific plates adapted to the Mafell LO 65 EC and LO 65 E routers and the corresponding jigs.

2.4 Bits and blades

The Arunda bit is especially designed and adapted for use with the jigs. Its characteristics in every way meet the requirements and provide the compatibility required by the various Arunda equipment accessories (router, expansion plate, guide ring, etc). The Arunda bit has a spindle with an internal M12 x 1mm (IG) pitch screw thread.
The Arunda blades are reversible hard-metal plates.

Special Arunda cutter

2.41 Replacement of the blades

The electric cable of the machine must be unplugged when replacing the blades. Support the machine and block its spindle. Using the Allen key provided with the Arunda bit, loosen the small screws located on the blades. Turn the blades through 180° to use the as yet unused edge or replace the blades. Check that the blades are well seated in their respective housings and tighten the screws properly. If the bit is disassembled, reassembled or replaced, it will need recalibrating (cf. section *3.24 Calibrating the bit*).

Arunda blades

2.5 Guide ring

The Arunda guide ring (or copying ring) is used to guide the router on the jigs.

Arunda ring

2.6 Gauge

The Arunda gauge is designed to position the bit under the router. It is a reference and marking tool. The jig is 36 mm deep which corresponds to the thickness of the 26 mm dovetail and the 10 mm of the male jig plate. The interior height of the jig is not the right position for all cases of machining (cf. sections 3.24 and 6.2)

Arunda gauge

2.7 Clamps

To work with Arunda jigs, 2 or 3 clamps are needed. The clamps must open 30 cm (or more) and be 14 cm deep. The 30 cm throat makes it possible to clamp the jigs onto 29 cm high joists (+ 1 cm for the jig) and to 29 cm thick stringers (the height of the stringer not being important). It must be possible to fix the clamp to the "ears" of the female jig whatever the circumstances and heights of the pins. The 14 cm throat-depth of the clamp is essential.
We recommend fast all-steel lever clamps because of their robustness and the great clamping speed they permit (Arunda lever clamp).

Arunda lever clamp

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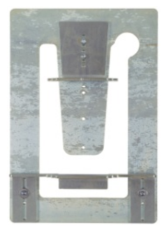
3 Preparation of the material

3.1 Jigs

3.11 Male jig

The male jig has two stops. One is fixed but it can, however, be positioned at various heights and the other is mobile and is intended to bed onto the timber



Male jig

3.12 Female jig

The female jig has a conical central opening. This jig includes a fixed stop which can also be positioned at various heights.

Female jig

3.2 Preparation of the router

3.21 Fitting the guide ring

Under the base of the Mafell LO65 EC router is a rectangular plate of brown synthetic material: this must be preserved! However the central part – with two concentric circles – must absolutely be removed.
CAREFULLY install the special Arunda Ø 30 mm guide ring in the housing under the router base-plate and firmly secure with two M5 x 15 mm screws.

Base-plate, ring and cutter

3.22 Fitting the expansion plate

It is essential that the router have a wide bearing surface when used on the jigs to guarantee stability and safety.
The Ø 190 mm plate is meant for jigs N°. 60, 80 and 100. The Ø 230 plate is meant for jig N°. 120 and the Ø 290 plate for jig N°. 160+.
Place the expansion plate under the router base-plate by centring the expansion-plate holes on the four threaded holes in the router base-plate and secure by means of four M5 x 15 mm screws.

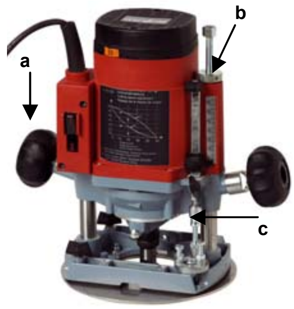
Positioning the bit

3.23 Fitting the bit

Move the router base-plate up close to the motor unit and screw the bit in, tightening it with a spanner while blocking the machine spindle.

3.24 Calibrating the bit

Using the Arunda jig, start by positioning the bit so that the blades rest on the interior of the "U" of the jig. The bit will thus stand 36 mm proud under the expansion plate. Firmly tighten the blocking handle of the machine.



Safety blocking

3.25 Safety blocking of the router

⚠ Block the upper and lower router stops to prevent them from rising or falling because of vibration or an accidental loosening of the main blocking handle. The bit should not come into contact with the guide ring.

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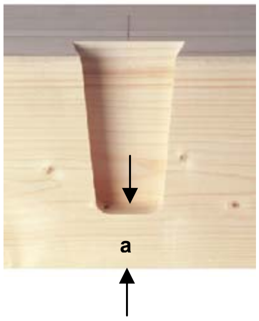
4 Dimensioning the assemblies

4.1 Height of the tail and pins

The Arunda jigs make it possible to cut dovetails and pins from 90 to 200 mm in height with jigs N°. 60, 80, 100 and 120 and up to 300 mm with jig N°. 160+, in 10 mm steps.



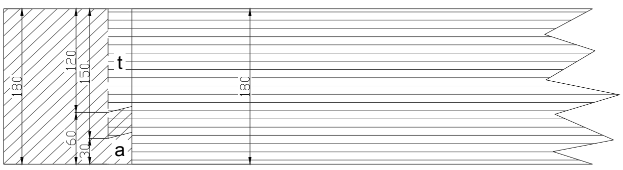
a = bed

4.2 Dimensioning tail and pins

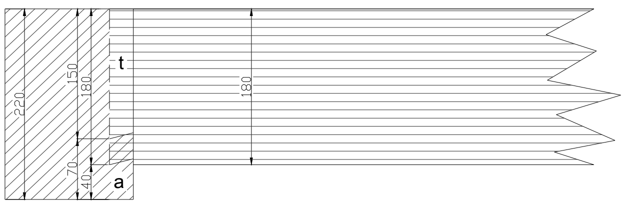
⚠ A dovetail assembly (tail and pins) is dimensioned in relation to the height of the timbers to be assembled, e.g. joist and stringer).
It is necessary to set **the bed of the pins at a minimum of between 1/6th and 2/6^{ths} of the height of the stringer**. The bed (a) being the part of the timber located between the angled interior base of the pin cutout and the lower edge of the timber.

As a matter of safety, the minimum bed (a) of 1/6th of the stringer must be respected; it cannot be less. The rule for checking is:
hsom min = 1.2 · tail H (minimum stringer height = 1.2 x height of tail).

Example 1
Joist/stringer height 180 mm
(Bed 1/6th to 2/6^{ths} height of stringer 180 mm)
Minimum Bed 1/6th: 30 mm = Tail 150 mm
Bed : 40 mm = Tail 140 mm
Bed : 50 mm = Tail 130 mm
Bed 2/6^{ths} : 60 mm = Tail 120 mm



Example 2
Joist height 180 mm / stringer 220 mm
(Bed 1/6th to 2/6^{ths} stringer height 220 mm)
Minimum Bed 1/6th *(36.6 mm) rounded up*
=: 40 mm = Tail 180 mm
Bed: 50 mm = Tail 170 mm
Bed: 60 mm = Tail 160 mm
Bed ~.2/6^{ths} : 70 mm = Tail 150 mm



a = height of bed / **t** = height of tail

Example 1: The calculation for 180 mm high joist/stringer gives the following heights:
- tail of 150 mm for a bed of 30 mm (or)
- tail of 140 mm for a bed of 40 mm (or)
- tail of 130 mm for a bed of 50 mm (or)
- tail of 120 mm for a bed of 60 mm

Example 2: The calculation for a 220 mm high joist/stringer assembly, defines a bed of between 36.6 (minimum 1/6th) and 73.2 mm (2/6ths). Given that the tails can be cut to every 10 mm between 90 and 200 mm, we shall, for this example, take a valid bed of between 40 mm and 70 mm (the minimum value of 36.6 mm being rounded up to 40 mm).
The value of the bed (40 to 70 mm) deduced from the stringer (220 mm) gives us the following heights:
- tail of 180 mm for a bed of (36.6) 40 mm (or)
- tail of 170 mm for a bed of 50 mm (or)
- tail of 160 mm for a bed of 60 mm (or)
- tail of 150 mm for a bed of 70 mm

A 90 mm tail (minimum height) can be cut in a joist as of 90 mm high. The joist may exceed the maximum height of the tail by 200 mm or 300 mm respectively provided that it complies with the dimensioning rule.
The stringer height determines the heights of the bed and the pin. This rule is valid for joists/stringers of similar or different heights. But it is the height of the joist that determines the maximum height of the tail.

4.3 Width of the dovetails

The table below gives the essential characteristics of the Arunda jigs.

A	B	C	D	E	F	G	H
Type of jig	For joist width mm	For joist height mm	Height of possible tail/pin mm	Tail width with height 130 mm	Tail width with height 200 *(300)* mm	Depth of tail	Depth of pins
N°. 60	60 to 80	90 to 260	90 to 200 (in steps of 10)	57 mm	67 mm	26 mm	28 mm
N°. 80	80 to 120 (+ 20)	90 to 260 (+ 20)	90 to 200 (in steps of 10)	80 mm	91 mm	26 mm	28 mm
N°. 100	100 to 140 (+ 20)	90 to 260 (+ 20)	90 to 200 (in steps of 10)	100 mm	111 mm	26 mm	28 mm
N°. 120	120 to 160 (+ 20)	90 to 260 (+ 20)	90 to 200 (in steps of 10)	120 mm	131 mm	26 mm	28 mm
N°. 160+	160 to 300	90 to 420	90 to 300 (in steps of 10)	140 mm	*(160 mm)*	26 mm	28 mm

It may be seen that, in column E *Tail width with height 130 mm*, the widths of 80, 100 and 120 mm (mentioned for jigs N°. 80, 100 and 120) are valid for a tail height of 130 mm.
Column F *Tail width with height 200 mm* gives values of 91, 111 and 131 mm (jigs N°. 80, 100 and 120) for a tail height of 200 mm.
Explanation: The height of the structural members usually increases according to the width. Thus, a beam 80 mm wide is usually 120, 140, 160, 180 mm high, but seldom from 200 to 280 mm. According to this theory, a tail cut with jig N°. 80 will be 80 mm wide for a height of 130 mm (a 130 mm tail is acceptable for a joist/stringer height of up to 160 mm). If it is necessary to cut a dovetail 180 mm high, it would then be 88 mm wide at the top, that is to say 4 mm more to the left and the right than the width of the joist. The consequence, being that the two upper corners of the tail will be slightly truncated, is not visible once the tail and the pins have been assembled and does not have any unfavourable consequence on the working load. If the upper corners of the tail of a dovetail joint are truncated, the back of the tail remains laterally gripped by the pins. So this will not affect the stability of the assembly.
Conversely, this situation results in a broader dovetail as soon as one deviates from the minimum of 80 mm (and of 100 and 120 mm respectively for the other jigs). Thus, for the same model of jig 80, the width of the tail is 91 mm – instead of 80 mm – for a height of 200 mm. The advantage is that the working load increases with the increase in width (and height) of the dovetail.

The mega-jig N°. 160+ makes it possible to produce tails and pins of up to 300 mm high.

4.4 Working loads

The following table indicates the valid working load by dimension of assembly.

Dimensioning the dovetail assembly

Vd1 : Dimensioning according to the shearing effort of the joist tail **Vd2: Dimensioning according to the bed on the stringer**		
Vd1 = 2/3 · Az · zulЂQ where: Az = ((b1+b2)/2·(he-12.5))+ π (12.5²)/4+((b2-25)·12.5) * zulЂQ = 0.9 N/mm2: tangential constraint due to the shearing action according to DIN 1052-1 table 5		
Vd2 = 0.09 ·a where: 0.09 (kN/mm)= empirical coeff., where = hsom he - He + b2/2 resisting " length" (mm) * 12.5 = 12.5mm geometrical value		
The values of Vd1 and Vd2 are indicative. They correspond to real loads, without coefficient. ***These indicative values do not incur the liability of the manufacturer.***		
Tail H: maximum tail height (mm)	**he**: tail height or cut-out against joist (mm)	**hsol max** ≤2 · He
hsol: joist height (mm)	**b**: joist width (mm)	**hsom min** = 1.2 · tail H
hsom min: total minimum stringer height (mm)	**b1**: maximum variable tail width (mm)	**b2**: variable minimal tail width (mm)

Minimum stringer width bs: bs = 80 mm if cut-out on one side bs = 120 mm if cut-out on both sides			Jig ***Arunda N °60*** *Joist width 60 to 80 mm x height 90 to 260*		Jig ***Arunda n° 80*** *Joist width 80 to 120 mm x height 90 to 260*		Jig ***Arunda n° 100*** *Joist width 100 to 140 mm x height 90 to 260*		Jig ***Arunda n° 120*** *Joist width 120 to 160 mm x height 90 to 260*		Jig ***Arunda 160+*** *Joist width 160 to 300 mm x height 90 to 420*	
			The lesser working load of Vd1 and Vd2 will be taken to calculate the loads **1 kN = 100 kg**									
Tail h (mm)	**hsol** (mm)	**hsom min** (mm)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)
300	**420**	**420**	-	-	-	-	-	-	-	-	*23.98*	**16.92**
300	**300-360**	**360**	-	-	-	-	-	-	-	-	*23.98*	**11.52**
290	**400**	**400**	-	-	-	-	-	-	-	-	*23.02*	**16.02**
290	**300-340**	**348**	-	-	-	-	-	-	-	-	*23.02*	**11.34**
280	**400**	**400**	-	-	-	-	-	-	-	-	*22.08*	**16.92**
280	**280-330**	**336**	-	-	-	-	-	-	-	-	*22.08*	**11.16**
270	**380**	**380**	-	-	-	-	-	-	-	-	*21.14*	**16.02**
270	**280-320**	**324**	-	-	-	-	-	-	-	-	*21.14*	**10.98**
260	**360**	**360**	-	-	-	-	-	-	-	-	*20.21*	**15.12**
260	**260-310**	**312**	-	-	-	-	-	-	-	-	*20.21*	**10.80**
250	**340**	**340**	-	-	-	-	-	-	-	-	*19.29*	**14.22**
250	**260-300**	**300**	-	-	-	-	-	-	-	-	*19.29*	**10.62**
240	**320**	**320**	-	-	-	-	-	-	-	-	*18.38*	**13.32**
240	**240-280**	**288**	-	-	-	-	-	-	-	-	*18.38*	**10.44**
230	**300**	**300**	-	-	-	-	-	-	-	-	*17.47*	**12.42**
230	**240-270**	**276**	-	-	-	-	-	-	-	-	*17.47*	**10.26**
220	**280**	**280**	-	-	-	-	-	-	-	-	*16.57*	**11.52**
220	**220-260**	**264**	-	-	-	-	-	-	-	-	*16.57*	**10.08**
210	**280**	**280**	-	-	-	-	-	-	-	-	*15.69*	**12.42**
210	**220-250**	**252**	-	-	-	-	-	-	-	-	*15.69*	**9.90**
200	**260**	**260**	*4.49*	**7.33**	*7.24*	**8.34**	*9.56*	**9.24**	*11.87*	**10.14**	*14.80*	**11.52**
200	**200-240**	**240**	*4.49*	**5.53**	*7.24*	**6.54**	*9.56*	**7.44**	*11.87*	**8.34**	*14.80*	**9.72**
190	**240**	**240**	*4.17*	**6.43**	*6.79*	**7.44**	*8.98*	**8.34**	*11.17*	**9.24**	*13.93*	**10.62**
190	**200-220**	**228**	*4.17*	**5.35**	*6.79*	**6.36**	*8.98*	**7.26**	*11.17*	**8.16**	*13.93*	**9.54**
180	**240**	**240**	*3.87*	**7.33**	*6.34*	**8.34**	*8.41*	**9.24**	*10.48*	**10.14**	*13.07*	**11.52**
180	**180-220**	**220**	*3.87*	**5.53**	*6.34*	**6.54**	*8.41*	**7.44**	*10.48*	**8.34**	*13.07*	**9.72**
170	**220**	**220**	*3.57*	**6.43**	*5.89*	**7.44**	*7.85*	**8.34**	*9.80*	**9.24**	*12.21*	**10.62**
170	**180-200**	**204**	*3.57*	**4.99**	*5.89*	**6.00**	*7.85*	**6.90**	*9.80*	**7.80**	*12.21*	**9.18**
160	**200**	**200**	*3.27*	**5.53**	*5.46*	**6.54**	*7.29*	**7.44**	*9.13*	**8.34**	*11.36*	**9.72**
160	**160-180**	**192**	*3.27*	**4.81**	*5.46*	**5.82**	*7.29*	**6.72**	*9.13*	**7.62**	*11.36*	**9.00**
150	**200**	**200**	*2.99*	**6.43**	*5.04*	**7.44**	*6.75*	**8.34**	*8.46*	**9.24**	*10.52*	**10.62**
150	**160-180**	**180**	*2.99*	**4.63**	*5.04*	**5.64**	*6.75*	**6.54**	*8.46*	**7.44**	*10.52*	**8.82**
140	**180**	**180**	*2.72*	**5.53**	*4.62*	**6.54**	*6.21*	**7.44**	*7.81*	**8.34**	*9.69*	**9.72**
140	**140-160**	**168**	*2.72*	**4.45**	*4.62*	**5.46**	*6.21*	**6.36**	*7.81*	**7.26**	*9.69*	**8.64**
130	**140-160**	**160**	*2.45*	**4.63**	*4.21*	**5.64**	*5.69*	**6.54**	*7.16*	**7.44**	*8.86*	**8.82**
120	**160**	**160**	*2.19*	**5.53**	*3.81*	**6.54**	*5.17*	**7.44**	*6.52*	**8.34**	*8.04*	**9.72**
120	**120-140**	**144**	*2.19*	**4.09**	*3.81*	**5.10**	*5.17*	**6.00**	*6.52*	**6.90**	*8.04*	**8.28**
110	**120-140**	**140**	*1.94*	**4.63**	*3.42*	**5.64**	*4.65*	**6.54**	*5.89*	**7.44**	*7.23*	**8.82**
100	**100-120**	**120**	*1.70*	**3.73**	*3.04*	**4.74**	*4.15*	**5.64**	*5.27*	**6.54**	*6.43*	**7.92**
90	**100**	**108**	*1.47*	**3.55**	*2.66*	**4.56**	*3.66*	**5.46**	*4.65*	**6.36**	*5.64*	**7.74**

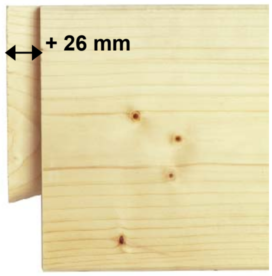
Once the height of the tail has been calculated, refer to the table to find the working load.
Explanations relating to the first three columns:
- *Tail H (mm)*: indicates the tail height.
- *hsol (mm)*: indicates the joist height.
- *hsom* *min (mm)*: indicate the minimum stringer height.

The following columns give the working loads *Vd1* and *Vd2* for jig models 60, 80, 100, 120 and 160+.
- *Vd1*: indicates dimensioning according to the shearing effort of the joist tail.
- *Vd2*: indicates dimensioning according to the dovetail bed on the stringer.
The weakest working load is used for calculating the loads.

Important: Values *VD1* and *VD2* are indicative values. They correspond to real loads without coefficient.
These indicative values do not incur the liability of the Arunda manufacturer.
Example: A 180 mm tail cut on 220 mm high joists/stringers with jig model 100 will give the following values (from left to right in the table) :

			Arunda **Jig *N°. 60***		***Arunda*** **Jig *N°. 80***		***Arunda*** **Jig *N°. 100***		***Arunda*** **Jig *N°. 120***		***Arunda*** **Jig *N°. 160+***	
Tail h (mm)	**hsol** (mm)	**hsom min** (mm)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)
180	**180-220**	**220**	*3.87*	**5.53**	*6.34*	**6.54**	*8.41*	**7.44**	*10.48*	**8.34**	*10.48*	**8.34**

The working load is 7.44 kN (744 kg) per assembly. If a joisting comprises 5 beams and hence 10 joints, we will have a working load of 7440 kg on the surface. To know the working load per m2 this value is divided by the number of m2.
Arunda makes a table available to Arunda users to help determine the dimensions of the timbers in relation to the weakening of the tail cut-outs. This compensation table of the weakening of the joists/stringers in relation to the tail cut-outs" is available on our Internet site www.arunda.ch under the heading "Download"..



Length of the tail = 26 mm

4.5 Sizing the timbers
The beams in which the tails (e.g. the joists) are cut must be sized + 26 mm per assembly. A joist with a dovetail at each end will thus have an additional length of 52 mm; e.g. a joist with 4000 mm distance between stringers (shoulder-to-shoulder) will be sized to 4052 mm

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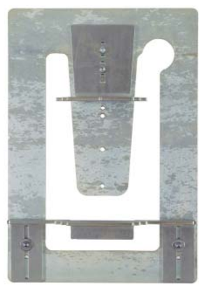
5 Preparation and machining

5.1 Safety
CAUTION: It is essential to wear ear protectors and safety goggles!

5.2 Prerun test – checks
Always run a complete assembly test before machining a set of timbers in order to check 3 important criteria:
- the correct height of the tail and…
- that of the pins, similar and corresponding to the calculation and…
- an adequate gripping force of the assembly (tail in pins).


Stops on male jig

5.3 Adjusting the stops on the jigs

5.31 Fixed stops
The fixed stops on the jigs have to be adjusted according to the selected height of the tail/pins.
For example, if the desired height of the tail is 180 mm, the fixed stop of the male jig is set to 180 and the fixed stop of the female jig to 180. The fixed stops must be firmly tightened.

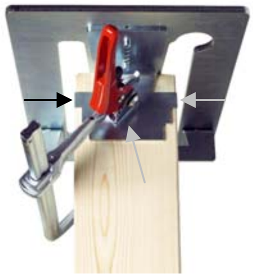

Stop on female jig

5.32 Sliding stop
Just remember that the lower stop of the male jig must remain mobile and not be blocked so that it can adapt to the beam and its variations in dimension.

5.4 Positioning the male jig

5.41 Clamping the male jig

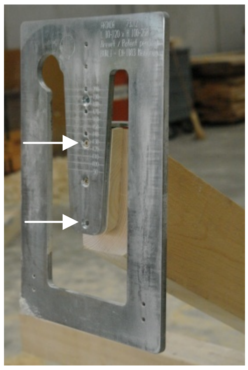
Place the male jig vertically on the end of the beam that is to take the dovetail (the joist) and press the fixed positioning stop onto the upper face of the beam.
Slide the mobile stop up under the beam.
Centre the upper fixed stop across the width of the beam using the "stepped" cut-outs corresponding to the usual timber widths (no need to mark the widths).
Then, with a clamp, sandwich the beam tightly between the two stops. This now firmly holds the whole male jig frame on the beam head so that it cannot bend under the pressure of the router.
Make sure that the jig is perfectly bedded onto the beam head.
Again ensure that the upper fixed jig stop is well centred across the width of the beam.



Fixing the male jig

5.42 Screwing the male jig

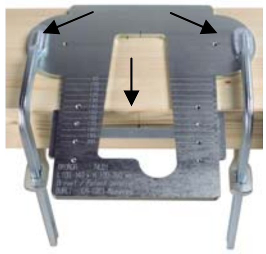
An alternative consists in screwing the male jig to the beam head. This solution is intended only for machining on rafters (skewed vertical cut) which does not allow the stops to bed down at 90° on and under the rafter. The screwing of the male jig is necessary in cases of rafters on a ridge purlin or rafters on a sole plate.
In this case, it is necessary to note that when the router is pushed against the screwed jig, it can cause a slight inflection of the lower part of the jig frame. It is thus necessary when machining, to support the router only on the central part of the male jig.



Screw-on male jig

5.5 Positioning the female jig

The centre line of the joists is firstly to be marked on the upper faces of the stringers (or on the front face as appropriate).
The female jig is positioned on the face of the stringer by aligning the "V" notch of the stop on the centre line.
The jig is held by two clamps placed <u>at the end</u> of the two "ears" of the jig.



Fixing the female jig

5.6 Cutting the dovetail

Lay on some pieces of wood to make a test assembly before cutting the run.
Respect the direction of rotation of the bit (indicated on the jig).
Present the router – **turned off** – by placing the bit in the hole provided in the male jig (top left).
Cut the tail in a single pass or in two passes according to the width of the timber and the desired cleanliness of the cut.
Do not change the position of the bit in the router between the cutting of the tail and that of the pins. Indeed, the jigs are so designed that they automatically produce a difference in cutting depth of 2 mm between the tail (26 mm) and the pins (28 mm).

5.61 Cutting the tail in one pass

When cutting in a single pass, follow the central and interior part of the jig (the dovetail shape) by resting the machine ring against it.
Start machining from the top left, go down and finish up at the top right.
Hold the guide ring tightly up against the jig.
Stop the machine and lift the bit out at the bottom in the large part of the cut-out in the jig.
Cf. following drawing *Router path*.

5.62 Cutting the tail in two passes

When cutting in two passes, make the first cut (levelling) on the outside of the beam in order to decrease by approximately half the width of the shoulder.
Then, with the router, make a first cut following the outside of the central part of the jig resting the router ring on it. Return to the starting point, taking great care to follow the same path outside the timber, otherwise you risk causing damage when you come to machine in the other direction.
On the second pass, machine by following <u>the interior central</u> part of the jig starting from the top left, go down and finish at the top right.
Stop the machine and remove the bit by sliding it down to the big cut-out in the jig.
Remove the clamp and then the jig.
Cf. drawing below showing *Router path*.

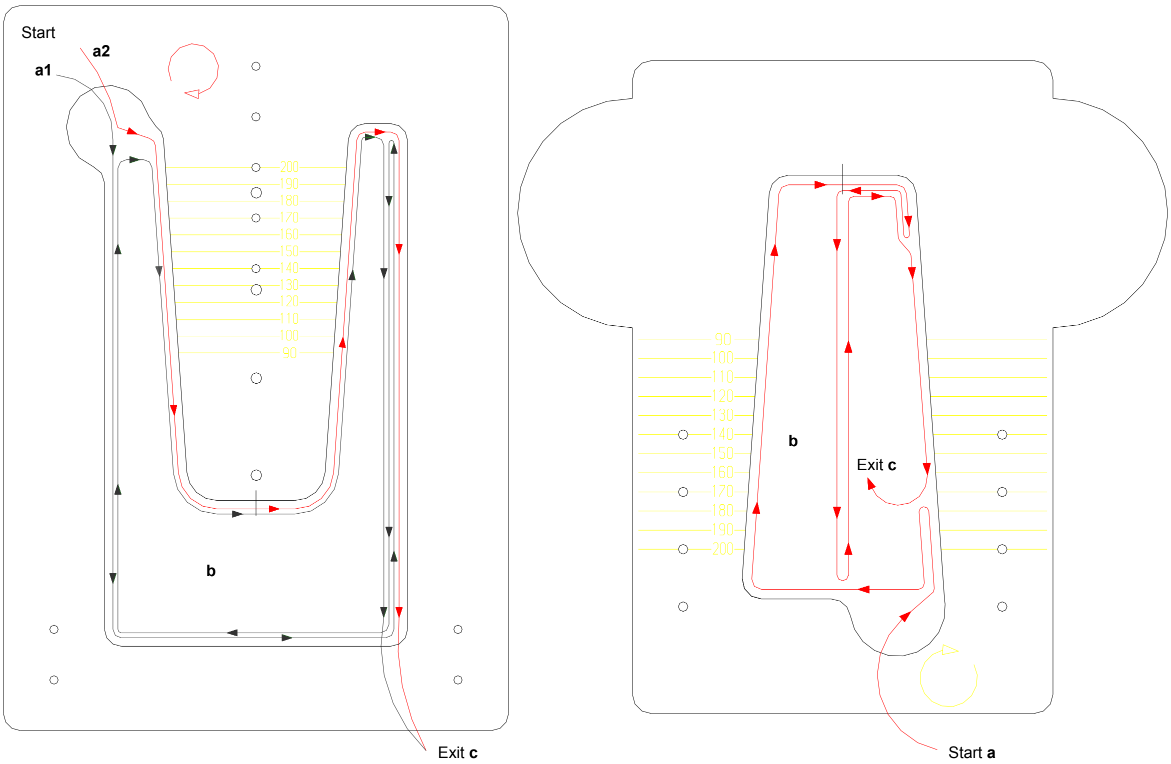
5.63 Cutting with a screwed male jig

In certain cases, it is necessary to screw the male jig to the beam head (cf. section *7.4 Assembly of rafters*). In this case, you should be aware that passing the router over the lower part of the screwed jig can cause a slight inflection of the jig frame due to the pressure. It is thus essential to support the router only on the central part of the male jig when machining.

5.7 Cutting the pins

Lay on some pieces of wood to make a test assembly before cutting the run.
Respect the direction of rotation of the bit (indicated on the jig).
Place the router – **turned off** - in the circular cut-out in the female jig.
Turn on the machine.

Start machining by drilling into the edge of the wood close to the circular housing (start point) and moving down 2-3 cm in order to avoid splintering out on the return stroke and then go back to the start.
Move the machine to the other side (opposite the starting point) and machine by following the cut-out in the jig.
Go back to the bottom of the cut-out and machine the remainder.
Stop the machine and remove the bit at the bottom in the large cut-out in the jig.
Remove the screw clamps and then the jig.
Cf. drawing below showing *Router path*.



Machining the tail: in 1 pass **a2** (or)
in 2 passes **a1** + **a2**
a1 - **a2**: Bit starting point
b: Bit path
c: Bit removal point

Machining the pins

a: Bit starting point
b: Bit path
c: Bit removal point

Router path

---

6 Result of machining and modification

6.1 Result of machining

Slide the tail into the pins. The tail should fit easily into the pins but must be forced for the last 3 to 10 millimetres (according to the timber sections). A dovetail assembly should have no play. Use a tool (a mallet) to force the last millimetres of the tail into the pins.

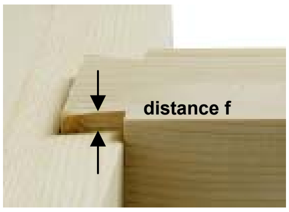
6.2 Adjustment of the gripping force

You must unplug the electric cable before doing any work on the bit.
The gripping force of the timber assembly is adjustable.
If the assembly is too loose, draw the bit some tenths (up to ~1.5 maximum) of a

mm out of the router with the help of the upper and lower machine stops. Check this adjustment by comparing with the standard height of the jig which is 36 mm. The increase in machining depth will result in a reduction of the gap between the pins and an increase in the width of the tail because of the bit cone. Any change in the depth of the bit will cause a roughly quadruple effect on the gripping force.
If the assembly is too tight, do the opposite and push the bit some tenths of a mm below the base plate. Check this change by comparing with the standard height of the jig which is 36 mm.
Block all the tightening handles and machine stops after adjusting the bit.
Any change in the position of the router bit must be made for the machining of both the tail and the pins and not between the machining of the tail and that of the pins.

6.3 Gripping force according to material

It is necessary to take account of the quality of the material to be assembled and its water content to appreciate the gripping force of the assembly. The following cases require a weak to average gripping force: narrow cross-sectioned timbers / reduced-height dovetails / seasoned timbers / glued-laminate timbers. Conversely, the following cases require an average to strong gripping force: average to large cross-sectioned timbers / average to excessive-height dovetails / damp to wet timbers / heavy timbers.
When the tail is manually and gradually introduced into the pins, there comes a moment when one feels an increase in the gripping force. At that point, you will note that the tail, which is not yet at the bottom of the pins, stands a few mm proud of the top of the pins. We choose to call this extra part of the tail, not yet inserted into the pins, **f** (gripping force).



Distance f in the assembly

Our experience has taught us the following based on:
- the type of timber
- the water content of the timber
- the lesser or greater height of the assembly (from 90 to 200 mm)
- the lesser or greater width of the assembly (from 57 to 131 mm according to the jig used and the height of the tail).

Type of timber	**f: tail standing proud of the pin** before forcing
Glued laminate timbers (spruce/fir) 12-14% moisture content	~2 to ~5 mm
Two or three-ply timbers (timbers made up of 2 or 3 plies, spruce/fir) 12-14% moisture content	~4 to ~7 mm
Heavy timber (spruce/fir) 15 to > 30 % moisture content	~6 to ~10 mm

The above data is purely empirical. They do not incur the manufacturer's liability and do not relieve the user of the jigs from conducting tests.

6.4 Gripping force of moist timber

The gripping force of an assembly involving green wood (with high moisture content) can be anticipated by increasing the value f mentioned above. When testing, it can prove to be difficult to fit the tail into the pins, considering the significant gripping force. Conversely, the gripping force will have decreased and will be correct after the timber has been stored for a few weeks and its moisture content has decreased before assembly on the building site.

6.5 Dry timber exposed to inclement weather

If structures are assembled using seasoned timber (glued laminates, two or three-ply seasoned timber beams, etc.), care must be taken to cover this material if it is stored outside or delivered during bad weather. Indeed, it can be difficult or even impossible to assemble joints in timber that has swollen under the effect of rain.

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7 Types of frame assemblies


Joist flush with stringer

7.1 Assembly of a 90° joist-stringer joint

7.11 Joist flush with stringer

Also header joist on rafter or staircase header joist.
In these cases, the assemblies are simple to realize. The jigs are easily positioned, the stops rest on the timber at 90°. The clamps are used to maintain the jigs. See sections *5.6 to 5.7*.

7.12 Offset joist on stringer

If the joist has to be offset above or below the stringer, the male and female jig stops are offset likewise; e.g. if the joists are to come 30 mm below the level of the stringer, the height of the pins will have, for example, to be 180 mm and the tail 150 mm.

Joist offset from stringer

7.2 Skewed joist-stringer assembly

7.21 Joist at 45° to stringer

Joist at 45° (or another angle) to the stringer.
Add 26 mm (per assembly) parallel to the skewed levelling line (on the upper face of the joist) corresponding to the distance between stringers.
The axis of the levelling line is drawn towards the interior of the beam.
The male jig is placed on the beam head, centring the "V" notch of the upper fixed stop on the centre line.
Depending on the width of the beam, the machining may require an additional operation because of the greater width resulting from the skew.
In that case, pencil in the outline of the dovetail jig on the beam head by way of reference mark.
Then move the jig towards the tip of the beam head.
Make a first pass to decrease the shoulder between the edge of the tip and the outline of the dovetail by half.
Recentre the jig on the centre line and cut the tail in one or two passes.

Joist skewed in relation to stringer

7.3 Assembly on a post

7.31 Stringer on a through post

The tail is machined on the head of the stringer just as it is on the end of a joist.
The height of the tail will be as great as possible in relation to the stringer (but not more than 200 mm, according to the characteristics of the jig).
Mark the real position of the stringer on the post.
Bore an additional milled hole to the left and right of the female jig near the central cut-out (careful how you move the bit through!).
Position the jig on the post and secure it with two screws in the holes just made.
Using a large-diameter bit, bore one or more holes so that you can insert the bit and start machining.
You will then have to cut down the top of the tail to decrease its height so that it can be easily slipped into the pins: the external width of the tail must be equal to or lower than the upper width between the pins.
A chisel blow to the right and left of the top of the pins (at the points) to somewhat decrease the cheek will make it easier to slip the tail into the pins.

Stringer on through post

7.32 Stringer on a stopped post

The tail is machined on the head of the stringer just as it is on the end of a joist.
The height of the tail will be as great as possible in relation to the stringer (but not more than 200 mm, according to the characteristics of the jig).
The post is machined the same way as for machining pins on a stringer, the only difference being that it is difficult to fix the female jig with the two clamps. Bore an additional hole to the left and right of the female jig near the central cut-out (careful how you move the bit through!).
Position the jig on the post and fix it with two screws in the holes just made. The pins are then machined normally.

Stringer on stopped post

7.4 Assembly of rafters

7.41 Rafter on squared ridge purlin.

<u>Alternative 1</u>
Add 26 mm parallel to the skewed levelling line on the side of the rafter.
Cut the rafters on the skew.
Also cut the end of the rafters to 90° to the right of the levelling line.
The male jig, without the lower sliding stop, is placed and centred on the beam head. It is held by two screws in the centre.
The tail is machined in one or two passes. The pins are machined normally.
<u>Alternative 2</u>
Alternative to cutting the end of the rafters at 90°.
To avoid this additional cut of the end of the rafter at 90° to the levelling line, screw a right-angled wooden triangle under the upper fixed stop of the male jig (after having bored two holes in it), the hypotenuse of which wooden triangle is angled to correspond to the angle of the rafter. The use of such a wooden triangle ensures that the jig beds down well on the head of the skewed beam.
It is, however, necessary to calculate the triangle so that, in the final assembly, the

Rafter on squared ridge purlin

rafter comes flush with the purlin.
The male jig, without the sliding stop, is placed and centred on the beam head. It is held by two screws in the centre.
The tail is machined in one or two passes.
The pins are also machined normally.

7.42 Rafter on chamfered ridge purlin

After having determined the height of the dovetail, start by machining the pins on the chamfered purlin. Then chamfer both sides of the purlin. Now take a small ruler and measure the height of the pins from the narrow bottom of the cut-out to the top, on the chamfered purlin (resting the ruler on the bottom of the pin cut-out). The measured reading is used to position the male jig on the rafter head. For example, if the measured height is 175 mm, the (point of) the male jig can be positioned 175 mm from the rafter. The male jig is screwed in this position. The upper stop is screwed against the jig at the point nearest to the rafter. Prepare a wooden block at an angle that corresponds to the angle of the rafter. Then screw the wooden block under the upper stop after drilling two holes in it. The stop, with its wooden block, thus bears firmly on the rafter and it can now be used to machine all the other rafters in the same position.

Rafter on chamfered ridge purlin

7.43 Rafter stopped on top plate

Lay on some pieces of wood to make a test assembly before cutting the run.
This is the same situation as that described in section 7.*41 Rafter on squared ridge purlin*.
Screw a right-angled wooden triangle under the upper fixed stop of the male jig (after having bored two holes in it), the hypotenuse of which wooden triangle is angled to correspond to the angle of the rafter.
It is, however, necessary to calculate the triangle so that, in the final assembly, the rafter comes flush with the purlin.

Rafter on valley rafter

7.5 Assembly of a valley rafter

7.51 Assembly of a valley rafter with a hip rafter

This assembly is more difficult to produce. Indeed, the positioning of the jigs is complex and difficult to transfer from one part to another (valley and hip rafter). However, if the positioning is correctly done, the machining will be as simple as for any other assembly. Do not hesitate to bore some additional holes in the female jig plate to fix it to the hip (or valley) rafter. Some tests will be essential.

7.6 Other assemblies and specialities

Many other assemblies are possible with Arunda jigs. Only the most current techniques have here been described. However, the specific case of the frame of a tower produced by a craftsman is worth a mention. The frame included, at its base, a curved external stringer of glued laminated timbers (in two parts) and a second interior stringer, also of curved glued laminated timbers (in two parts). The joists were laid out star fashion and dovetailed assemblies connected the external stringer to the interior stringer. The craftsman ran some tests before obtaining a splendid and technically perfect result.

8 Possible problems

Problem	Cause	Solution
The tail floats in the pins	The gripping force of the assembly is insufficient	Increase the projection of the bit beneath the router base plate (cf. section *6 Result and final adjustment*)
The tail is too tight in the pins	The gripping force of the assembly is too great	Decrease the projection of the bit beneath the router base plate (cf. section 6 Result *and final adjustment*)
	It is difficult to slip the tail into the pins and it seems to butt up against the pins. The tail and/or the pins have projections on the machining surfaces.	Support the router ring correctly against the jigs. Carefully follow the shapes of the jig. (cf. sections *5.6 to 5.7 Machining…)*
The tail does not lie sufficiently flush with the pins	The jig stops did not bed correctly on the timber to be machined.	Pay great attention to the support of the stops, in particular that of the female jig when tightening the clamp.
The bit is considered to project too far beyond the jig (> ~1.5mm) even if the assembly has been completed	The guide ring is damaged: it must have been knocked thus forming a flat on the ring. The ring is no longer completely round.	Replace the guide ring, calibrate the bit and carry out a test.

Also consult the "Question and answer" section – which has lots of information – of our Internet site www.arunda.ch, available in several languages.

9 Table of the working loads

Table of working loads – Dimensioning of dovetail assembly

Vd1 : Dimensioning according to the shearing effort of the joist tail **Vd2: Dimensioning according to the bed on the stringer**		
Vd1 = 2/3 · Az · zulЂQ where: Az = ((b1+b2)/2·(he-12.5))+ π (12.5^2)/4+((b2-25)·12.5) * zulЂQ = 0.9 N/mm2: tangential constraint due to the shearing action according to DIN 1052-1 table 5		
Vd2 = 0.09 ·a where: 0.09 (kN/mm)= empirical coeff., where = hsom he - He + b2/2 resisting " length" (mm) * 12.5 = 12.5mm geometrical value		
The values of Vd1 and Vd2 are indicative. They correspond to real loads, without coefficient. ***These indicative values do not incur the liability of the manufacturer*.**		
Tail H: maximum tail height (mm)	**he**: tail height or cut-out against joist (mm)	**hsol max** ≤2 · He
hsol: joist height (mm)	**b**: joist width (mm)	**hsom min** = 1.2 · tail H
hsom min: total minimum stringer height (mm)	**b1**: maximum variable tail width (mm)	**b2**: variable minimal tail width (mm)

Minimum stringer width bs: bs = 80 mm if cut-out on one side bs = 120 mm if cut-out on both sides			Jig ***Arunda N °60*** *Joist width 60 to 80 mm x height 90 to 260*		Jig ***Arunda n° 80*** *Joist width 80 to 120 mm x height 90 to 260*		Jig ***Arunda n° 100*** *Joist width 100 to 140 mm x height 90 to 260*		Jig ***Arunda n° 120*** *Joist width 120 to 160 mm x height 90 to 260*		Jig ***Arunda 160+*** *Joist width 160 to 300 mm x height 90 to 420*	
			The lesser working load of Vd1 and Vd2 will be taken to calculate the loads **1 kN = 100 kg**									
Tail h (mm)	**hsol** (mm)	**hsom min** (mm)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)	***Vd1*** *(kN)*	**Vd2** (kN)
300	**420**	**420**	-	-	-	-	-	-	-	-	*23.98*	**16.92**
300	**300-360**	**360**	-	-	-	-	-	-	-	-	*23.98*	**11.52**
290	**400**	**400**	-	-	-	-	-	-	-	-	*23.02*	**16.02**
290	**300-340**	**348**	-	-	-	-	-	-	-	-	*23.02*	**11.34**
280	**400**	**400**	-	-	-	-	-	-	-	-	*22.08*	**16.92**
280	**280-330**	**336**	-	-	-	-	-	-	-	-	*22.08*	**11.16**
270	**380**	**380**	-	-	-	-	-	-	-	-	*21.14*	**16.02**
270	**280-320**	**324**	-	-	-	-	-	-	-	-	*21.14*	**10.98**
260	**360**	**360**	-	-	-	-	-	-	-	-	*20.21*	**15.12**
260	**260-310**	**312**	-	-	-	-	-	-	-	-	*20.21*	**10.80**
250	**340**	**340**	-	-	-	-	-	-	-	-	*19.29*	**14.22**
250	**260-300**	**300**	-	-	-	-	-	-	-	-	*19.29*	**10.62**
240	**320**	**320**	-	-	-	-	-	-	-	-	*18.38*	**13.32**
240	**240-280**	**288**	-	-	-	-	-	-	-	-	*18.38*	**10.44**
230	**300**	**300**	-	-	-	-	-	-	-	-	*17.47*	**12.42**
230	**240-270**	**276**	-	-	-	-	-	-	-	-	*17.47*	**10.26**
220	**280**	**280**	-	-	-	-	-	-	-	-	*16.57*	**11.52**
220	**220-260**	**264**	-	-	-	-	-	-	-	-	*16.57*	**10.08**
210	**280**	**280**	-	-	-	-	-	-	-	-	*15.69*	**12.42**
210	**220-250**	**252**	-	-	-	-	-	-	-	-	*15.69*	**9.90**
200	**260**	**260**	*4.49*	**7.33**	*7.24*	**8.34**	*9.56*	**9.24**	*11.87*	**10.14**	*14.80*	**11.52**
200	**200-240**	**240**	*4.49*	**5.53**	*7.24*	**6.54**	*9.56*	**7.44**	*11.87*	**8.34**	*14.80*	**9.72**
190	**240**	**240**	*4.17*	**6.43**	*6.79*	**7.44**	*8.98*	**8.34**	*11.17*	**9.24**	*13.93*	**10.62**
190	**200-220**	**228**	*4.17*	**5.35**	*6.79*	**6.36**	*8.98*	**7.26**	*11.17*	**8.16**	*13.93*	**9.54**
180	**240**	**240**	*3.87*	**7.33**	*6.34*	**8.34**	*8.41*	**9.24**	*10.48*	**10.14**	*13.07*	**11.52**
180	**180-220**	**220**	*3.87*	**5.53**	*6.34*	**6.54**	*8.41*	**7.44**	*10.48*	**8.34**	*13.07*	**9.72**
170	**220**	**220**	*3.57*	**6.43**	*5.89*	**7.44**	*7.85*	**8.34**	*9.80*	**9.24**	*12.21*	**10.62**
170	**180-200**	**204**	*3.57*	**4.99**	*5.89*	**6.00**	*7.85*	**6.90**	*9.80*	**7.80**	*12.21*	**9.18**
160	**200**	**200**	*3.27*	**5.53**	*5.46*	**6.54**	*7.29*	**7.44**	*9.13*	**8.34**	*11.36*	**9.72**
160	**160-180**	**192**	*3.27*	**4.81**	*5.46*	**5.82**	*7.29*	**6.72**	*9.13*	**7.62**	*11.36*	**9.00**
150	**200**	**200**	*2.99*	**6.43**	*5.04*	**7.44**	*6.75*	**8.34**	*8.46*	**9.24**	*10.52*	**10.62**
150	**160-180**	**180**	*2.99*	**4.63**	*5.04*	**5.64**	*6.75*	**6.54**	*8.46*	**7.44**	*10.52*	**8.82**
140	**180**	**180**	*2.72*	**5.53**	*4.62*	**6.54**	*6.21*	**7.44**	*7.81*	**8.34**	*9.69*	**9.72**
140	**140-160**	**168**	*2.72*	**4.45**	*4.62*	**5.46**	*6.21*	**6.36**	*7.81*	**7.26**	*9.69*	**8.64**
130	**140-160**	**160**	*2.45*	**4.63**	*4.21*	**5.64**	*5.69*	**6.54**	*7.16*	**7.44**	*8.86*	**8.82**
120	**160**	**160**	*2.19*	**5.53**	*3.81*	**6.54**	*5.17*	**7.44**	*6.52*	**8.34**	*8.04*	**9.72**
120	**120-140**	**144**	*2.19*	**4.09**	*3.81*	**5.10**	*5.17*	**6.00**	*6.52*	**6.90**	*8.04*	**8.28**
110	**120-140**	**140**	*1.94*	**4.63**	*3.42*	**5.64**	*4.65*	**6.54**	*5.89*	**7.44**	*7.23*	**8.82**
100	**100-120**	**120**	*1.70*	**3.73**	*3.04*	**4.74**	*4.15*	**5.64**	*5.27*	**6.54**	*6.43*	**7.92**
90	**100**	**108**	*1.47*	**3.55**	*2.66*	**4.56**	*3.66*	**5.46**	*4.65*	**6.36**	*5.64*	**7.74**

1 kN = 100 kg

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