Yurt / Ger Notes

written by Rene K. Mueller, Copyright (c) 2005, 2006, 2008, last updated Mon, April 7, 2008

How to Calc

The height **h** is 140-180cm, or even 200cm, smaller yurts (e.g. 3-4m) are lower, e.g. 6m often is 1.60 or more. The height is so low because the resulting room is better to heat, but for reason of comfort you may choose to have it your head height high.

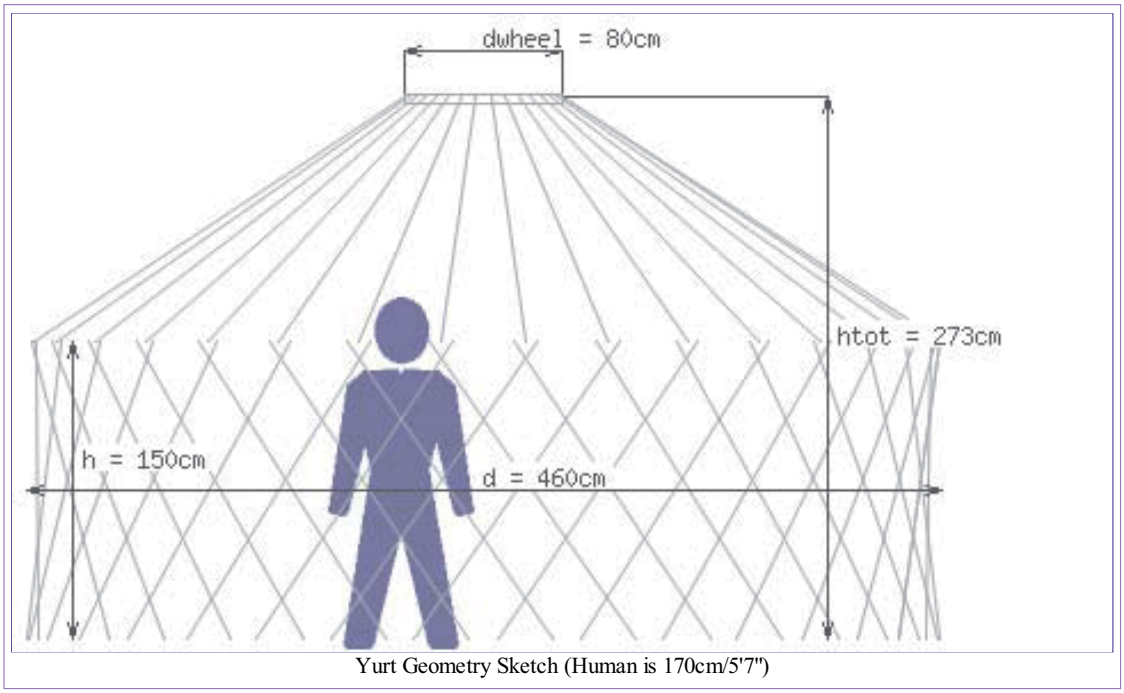
Traditional yurt development comes from a given **w** khana-spacing and length of a khana-section, and then the amount of poles is calculated, e.g. 2-3 khana sections, or 4-6 khana sections for large yurt, then the poles are counted. I have prefered to define the yurt from the amount of poles for reasons of angle measurement and symmetry (e.g. multiple of 4 poles), to increase or decrease n_{poles} in order to make and see how large the spacing of **w** gets. The resulting **w** should be between 20-35cm in order to create a stable wall / *khana*, good stable laths may allow larger spacings of **w**.

Usually the roof poles lie on each lath junctions, which is arranged as crossed lattice. Modern yurts disregard this approach and lie the roof poles on the rope which holds the wall / *khana* together, this way one is very flexible to build with given parts (e.g. wall / *khana*, crown-wheel / *toono* etc) multiple sized yurts, but you sacrifice some of the stability of the lattice wall.

Traditionally and also for stability the wall lattice is spread so the crossing laths relate in 90° (α_{khana}) angle, but you may have a shorter angle like 60-80° and have with shorter laths a higher wall.

The diameter of the crown-wheel / *toono* is traditionally 20% of the yurt diameter, but this is just a reference nothing more.

Yurt Calculator



Yurt Geometry Sketch (Human is 170cm/5'7")

Edit the numbers in the yellow fields, and then press "calculate" button.

d = 460 cm, h = 150 cm, n_{poles} = 34, d_{wheel} = 80 cm

height defined by ○ h_{tot} = 273.36 cm, or via ◉ α_{roof} = 33°, (0..50°)

calculate reset

Hint: The larger the **d** diameter, the more poles you need, try a multiple of 4 for the roof pools ($\mathbf{n_{poles}}$). The resulting **w** should be between 20-35cm as mentioned to get a stable khana (e.g. diameter cm / 10 = poles gives **w** = 31cm).

Also, $\mathbf{w_{wheel}}$ shouldn't be too small in order to assemble the roof poles on the roof/crown wheel, increase the roof/crown wheel diameter $\mathbf{d_{wheel}}$ if necessary. Also, $\boldsymbol{\alpha_{khana}}$ you can alter, and increase **h** by a given $\mathbf{l_{khana}}$ (e.g. 2m l_{khana} with 90° gives h ~ 142cm, but with 83° you reach h ~ 150cm).

Metric vs English System

As wood and other material is in the US still in feet and inches measured, may this small calculator assist you.

100 cm = 3.280 ft

Enter your number, and hit ENTER or TAB

1 yard = 91.44cm, 1' or feet = 30.48cm, 1" or inch = 2.54cm. 1cm = 0.01m, 100cm = 1m

General:

total circumference c = 14.45m,

floor area A_{floor} = 16.62m^2

total volume V_{total} = 31.76m^3

Wall / *Khana*:

spacing of roof poles & khana w = 42.5cm,

length of khana lath l_{khana} = 183.1cm,

spacing between holes $w_{khana\text{-}holes}$ = 37.05cm,

total 5 holes (extra 35cm left), with α_{khana} = 70° angle

(if you change it, calculate again)

total of apprx. n_{laths} = 79 khana laths required,

gives $n_{khana\text{-}sections}$ = 3 khana-sections, when $l_{khana\ section}$ = 5m

(if you change it, calculate again).

Roof Poles / *Uni*:

Roof pole length l_{pole} = 226.53cm,
(add additional length for entering the crown-wheel / *toono* 3-4cm and the other end with cord 2-3cm, total e.g. 6cm)
angle between each pole α_{poles} = 10.59°,
space between poles at the roof/crown wheel w_{wheel} = 7.39cm

Canvas

The canvas has two main pieces: the roof, and the wall.

Roof Canvas

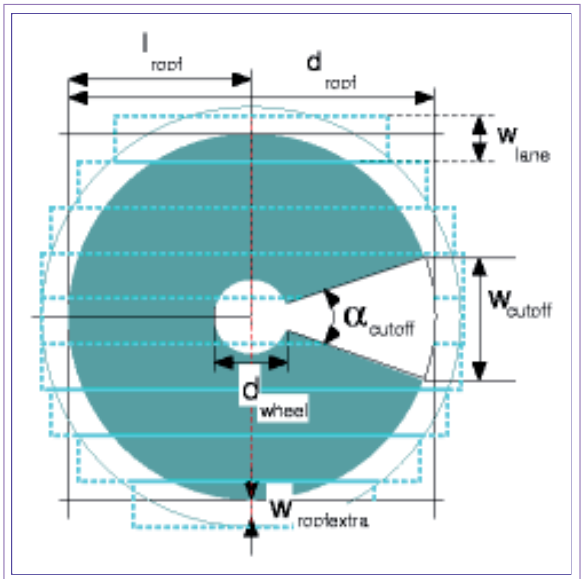
In order to calculate the angle α_{cutoff} I simply calculate both circumferences, based on d_{roof} and **d**, and then substract the later from the first, this is the length which is left and needs to be cut away:

$\alpha_{cutoff} = (d_{roof} * \pi - d * \pi) * 360 / (d_{roof} * \pi)$

$w_{cutoff} = \sin(\alpha_{cutoff}/2) * l_{roof} * 2$

Therefore

l_{roof} = 274.22cm,
d_{roof} = 548.44cm,
α_{cutoff} = 58.05 °,
w_{cutoff} = 266.05cm



Roof Canvas, Lanewise

A_{roof} = 23.62m^2 e.g. square canvas of 5.48 x 5.48m, apprx. 6.46m^2 left over.

Lanewise

Use multiple lanes (common way to get canvas) as indicated to compose the shape:

$n_{roof\ lanes} = d_{roof} / w_{lane}$ (and round up)

$l_{tot\ lanes} = d_{roof} * n_{roof\ lanes}$

You can calculate more exact (approximate the circle without tilt cutoff α_{cutoff}):

w_{lane} 150cm, $w_{roofextra}$ 15cm, calculate lanes

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Lane #1 = 5.07 x 1.5 m
Lane #2 = 5.78 x 1.5 m
Lane #3 = 5.78 x 1.5 m
Lane #4 = 4.81 x 1.5 m
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whereas last lane has 4.81 x 0.22m left over.

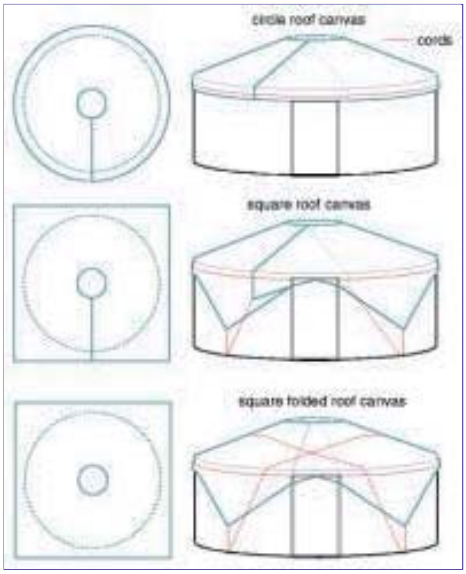
Total length as one lane: 21.44 x 1.5m

Often canvas comes 1m - 2m (e.g. 1.60m) width, but can be hundreds of meter long. I recommend for the height of the yurt **h** not to go over the common 1.60m, e.g. I choose 1.50m so I have 2 times 5cm left top and bottom for the seam.

Note: You need to add extra length as you have to sew the roof canvas (enter 5-10cm less than the actual lane width for w_{lane}), and also fold its seam two or four times, additionally, bought canvas usually shrinks 5-7%, so buy preshrinked canvas or shrink it (means wash it) **before** you cut.

Sewing: Either mark the middle line of each cut canvas lane (in the illustration the red line), and then align the lanes along this middle line or calculate the offset of each next layer to the previous; maybe also use needles to attach the next lane to sew, avoid wrinkles, with some practice with a sewing-machine you might do it without needles.

When working from top to bottom, next lane over previous lane, until you reach the center, then next lane under previous lane. For the rain cover you might use one big piece of canvas, instead to lay lanes to each other and leave a lot of seams where water can leak through.



Canvas Layout

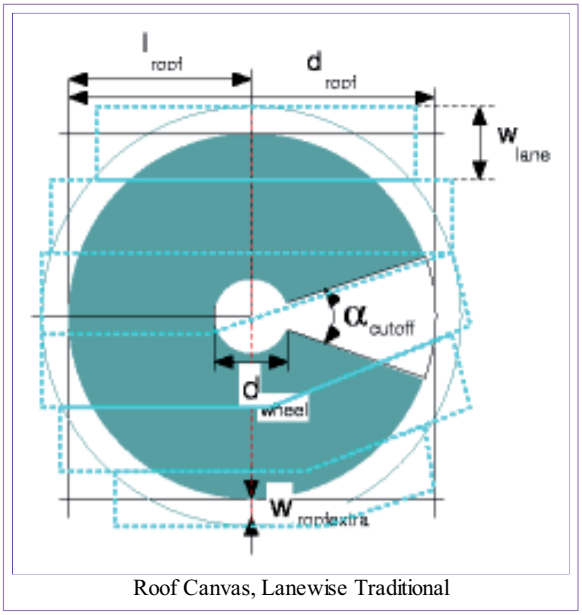
In the real world application, you might **not** cut α_{cutoff} away but just make a line cut, and let the two laps overlap each other, in this case you need an additional layer of cover, or bind it with a cord.

For the rain insulation I use a square blanket of synthetic and leave it in that shape and make **no cut** at all but fold it for the tilt and tie it with 4 or 6 cords to the bottom of the yurt.

The cotton interior roof canvas I compose with multiple canvas lanes, and for a roof angle α_{roof} of 25° I let the canvas leave without cut or folding the spare, the canvas did hang a bit between each roof pole. For larger roof angles you may consider to truncate the canvas to fit it more closely.

Traditional Lanewise

Traditional roof canvas is sewed lane wise, e.g. you attach various lanes until you reach the center, that part of the canvas is laid unto the yurt skeleton, and the next lanes are individually matched to that form and step by step added. It's a time consuming procedure, and the roof canvas fits closely but becomes more inflexible. As I mentioned before, for 25° roof angle a flat circle formed canvas is sufficient, the extra canvas (vs cone) is distributed evenly among all the roof and hangs a bit (1-2cm) down between the roof poles.



Roof Canvas, Lanewise Traditional

Pieslice-wise

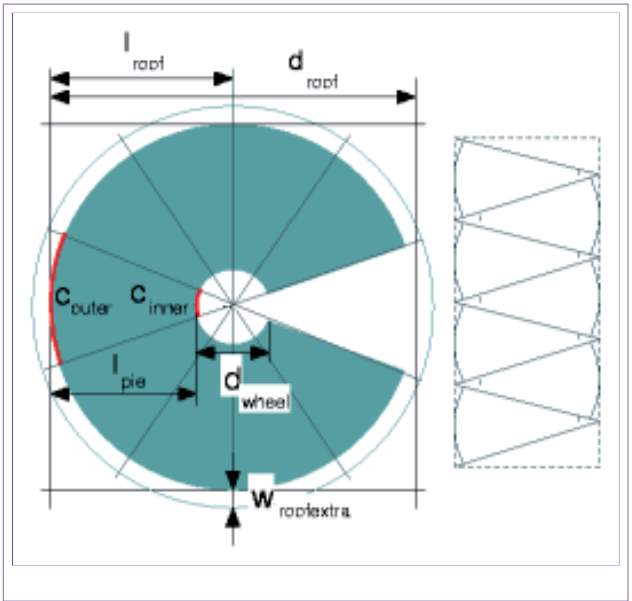
If the roof is small enough and match the width of the canvas, or the canvas available makes it more suitable, you can also make it pieslice-wise and arrange the pieces so it fits the lane nicely, with little leftover.

slices 12 recalculate

c_{outer} = 120.4 cm

c_{inner} = 20.94 cm

$l_{pole} = l_{pie}$ = 226.53 cm, and add 10-15cm ($w_{roofextra}$) to have it overlap to the wall



The pieslice-wise approach can be used for inner but also outer rain canvas, yet in case a 100% leak-free seam is then required, and since the seams run top to bottom of the roof and not sidewise this is doable. I use the pieslice-wise approach for the thermal insulation layer.

As you see, for each individual layer (rain canvas, insulation, and interior) you can use the calculator. I use for

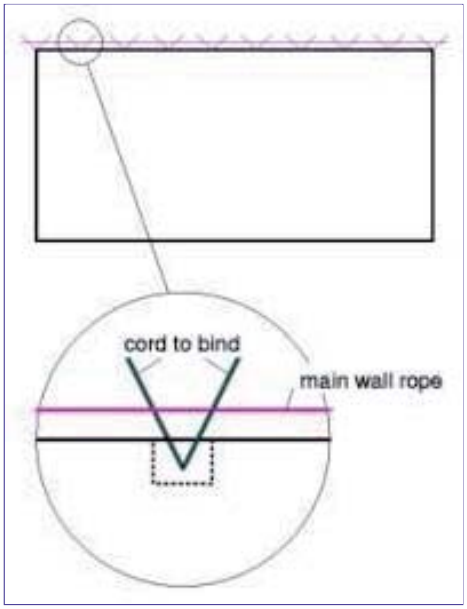
- rain cover: one piece of canvas of PE (d_{roof} x d_{roof}); roof: longlivity 12-18 months, wall: longlivity: 24-28 months
- thermal insulation: lanewise bubblewrap; roof: lasts 12 months max if exposed to UV by the sun
- thermal insulation: piewise, straw filled blankets
- interior cotton: lanewise

Wall Canvas

This is rather simple, it's rectangular, and **c** (circumference) times **h** of the lattice wall / *khana*. With your numbers, the wall canvas is 14.45 x 1.5m or A_{wall} = 21.67 m^2.

Best you choose $\mathbf{w_{lane}}$ the same as **h**, then you can use one lane for the entire wall canvas; otherwise you require to sew lot's of vertical lanes together to achieve **h**, with your $\mathbf{w_{lane}}$ you do one lane for the entire wall canvas.

You may substract the door width (discussed later in more detail), but I recommend you plan with extra length, it's easier to cut than add more canvas later. I used 10m long sections, attached short cords in order to bind it to the main rope, you can also bind to the roof-poles.



Wall Canvas Section with cords to bind

Total Canvas

Total canvas of apprx. 35.89 x 1.5m

Costs

You can get an approximate cost overview, choose your own currency (US$, €, CHF etc).

Cost per canvas meter:	25.00	total cost canvas:	897.25
Cost per roof pole:	0.00	total cost roof poles:	0
Cost per khana lath:	0.00	total cost khana:	0

calculate cost

Total Cost Canvas/Poles/Khana: 897.25

You still need:

- crown wheel aka *toono*
- door aka *khaalga*
- multiple layers (e.g. interior, insulation layer)
- floor

Often the canvas may the most expensive part of your yurt so it makes sense to really get a good and priceworthy source for the cotton, the same for the raincover.

My 6.4m diameter yurt with 64 poles did cost apprx. CHF 1000 or US$ 800 or € 670 (bamboo poles for roof & wall, PE as rain cover, wholesale cotton 1.5m wide etc), see details in my **yurt diary**.