Timber roof structure – queen truss

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1. ABSTRACT

English
This paper explains the pervasive use of timber for constructing roof structures. The task of the roof structure is to handle and transmit load to the load-bearing structure. When building timber roof structures it is of utmost importance to firmly bind structural elements. Roof structures are made of high-quality lumber (spruce) which is highly abundant in the local territory. Depending on the range of the structure builders often apply queen truss style which is detailed in this paper.The use of timber roof structures has a long tradition in civil engineering and the basic types of timber roof structures are still used today in building single family houses.

Bosanski
U radu je prikazana velika upotreba i značaj drveta za izradu krovne konstrukcije čija je uloga preuzeti i prenijeti opterećenje na nosive konstruktivne elemente. Najbitnije pravilo kod izrade drvene krovne konstrukcije je međusobno čvrsto povezivanje nosivih elemenata konstrukcije. Krovna konstrukcija se radi od kvalitetne drvene građe (smreka) koja je jako zastupljena na našem teritoriju.Ovisno o rasponu konstrukcije, često upotrebljavani sistem drvene krovne konstrukcije je sistem stolice, a u radu je detaljno opisan sistem dvostruke stojeće stolice sa nadzitkom. Primjena drvenih krovnih konstrukcija ima najdužu tradiciju u građevinarstvu a osnovni tipovi drvenih krovnih konstrukcija i danas su dominantni na stambenim individualnim objektima.

2. INTRODUCTION – ROOF STRUCTURE

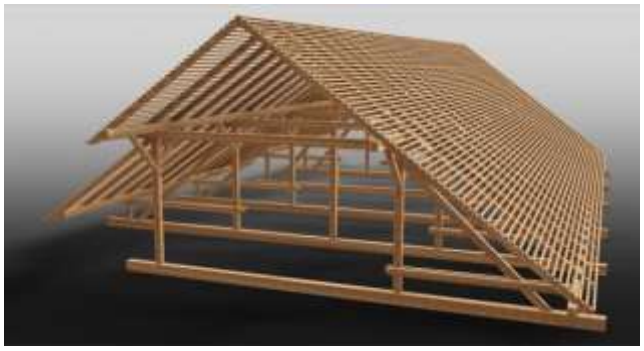
Roof is the top and final part of a building containing one or several leaning sides. Roof contains roof structure and roofing, and combined with the top floor ceiling it encloses the loft.
Roof structure transmits the load of roofing and dynamic loads across the load-bearing structures. Roof shields the building from the impact of rain, snow, wind, sun, fire and noise and thus its durability is significantly improved.
We can differentiate two types of roof structures:

a) Traditional roof structures
b) Engineered roof structures

Traditional roof structures have the dimensions of structural elements determined empirically meaning they are based on the previous experience.
Engineered roof structures, on the other hand, determine the dimensions of structural elements by applying static analysis which allows more efficient use of the construction materials.
There are two types of traditional roof structures:

1) Rafter
2) Purlin

Rafter roof can be of two types: roof without collar beam and roof with collar beam.
Purlin roof also comes in two varieties: hanger which transmits the load to outer walls, and truss which transmits the load to the ceiling or walls in the range of roof.



The gradient of roof sides depends on the type of roofing and climate.
There can be three types of roof depending on the gradient of roof sides:

1) Flat roof, gradient is <5°
2) Moderate roof slope, gradient is 5-25°
3) Steep roof slope, gradient is >25°

Depending on the number of roof planes/catchment areas and type of roof there can be: single-sloped roof, gable roof, three-sloped roof and hip roof. There is also complex or multi-pitched roof.
Roof consists of one or more roof planes which intersect at the ridge, hip and valley. The starting horizontal plane of roof is called eaves.
For construction of roof structures builders can use: beams, boards, billets, battens, complex nailed or glued (laminated) profiles.
It is highly important that all structural elements get tightly secured in both transversal and longitudinal direction, firmly secured to walls with minimal wear to the timber

3. ROOF STRUCTURES MADE OF LAMINATED WOOD; STEEL BOLTS

The stability of roof structure is ensured by securing the timber structures with steel bolts which have been designed for the particular load.

WOOD
Wood is natural, organic, inhomogeneous, and anisotropic material which has its advantages and disadvantages dictated by its physiological and biological factors. The most suitable type of timber for making roof structures is soft sawn or hewn timber – fir and spruce.



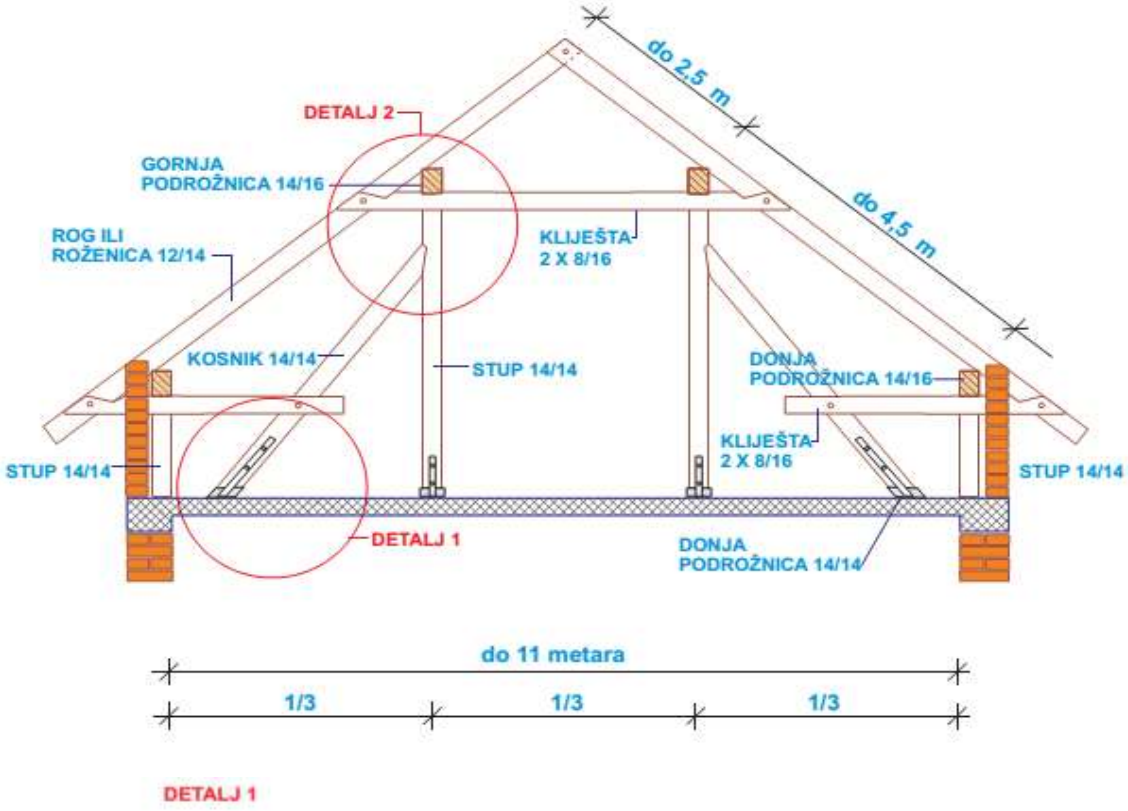
Raw spruce treated spruce/fir

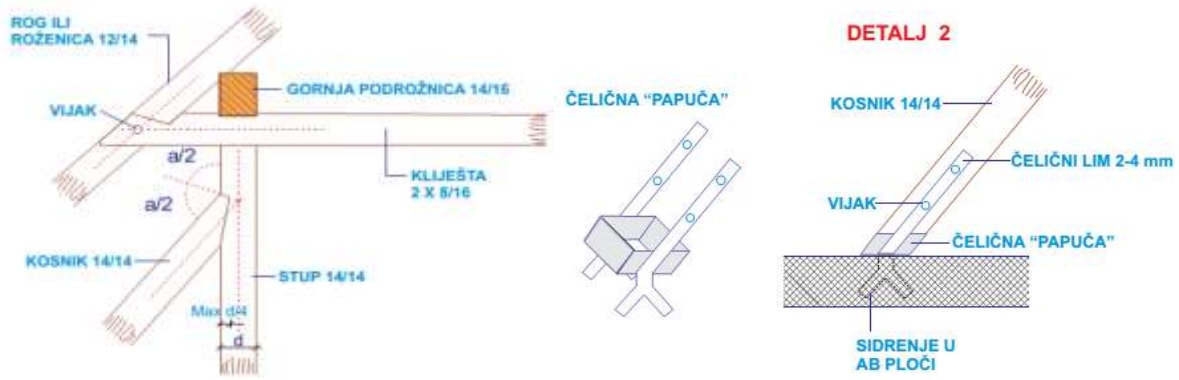
After the technological process of making laminated timber which includes drying, adhesives, pressure, planing, etc.) the final product is far stronger that natural wood. Research conducted in last decade shows that laminated girders are less susceptible to fire and have insulating properties, while other types of materials which are more susceptible to fire quickly lose strength while burning.
Water resistance is ensured by having high quality construction process and by selecting the most appropriate type of timber. Axial range of girder is 4-10m.
In our area there are several types of roof structures made of laminated timber: beam girder, truss girder, cantilever, two-hinged and three-hinged frame, two-hinged and three-hinged arch, and rough girder.

STEEL BOLTS
Steel is a processed product of iron ores like magnetite and hematite. The production of steel begins in tall ovens in which are inserted iron ore, coke and limestone and they are then heated to high temperatures. Steel used in civil engineering can be soft, medium hard, hard and extra hard.
Bolts are cylindrical steel connectors which have its head, neck, thread, washer, and nut. Bolts bigger than 5mm in diameter are always inserted into previously made holes, no matter what the type of timber is used.
Bolts are often used when dealing with timber. Bolts for timber are used only for single-cut joints made of different materials: timber-timber, timber-plywood, and timber-steel. Bolts can be made from stainless steel. Brass bolts cannot be used in timber structures.
Anticorrosive protection is achieved by zinc coating.

4. QUEEN TRUSS

Queen truss is a type of gable roof where tie beam leans only on tension and can be susceptible to bending from its own weight and the weight of ceiling. Rafters are supported by pillar leaning on the load-bearing walls. Rafters are combined with a beam and snick.
There are knee braces that can be plugged into pillars and they are interconnected by a horizontal beam which handles the compressive force. In that case snicks, plugs and steel joints are used. Sometimes junctions can be used and they support horizontal beam.





Queen truss can have a range between 7-12m. The minimal gradient is 25°-30° and maximal length of rafter is 7-7.5m.

There are several types of queen truss:

- Girder without upper wall but with tongs and truss (rafters are leaning directly on the tie beams)
- Girder with upper wall and tongs, truss without knee brace
- Girder with upper wall and half tongs, truss without knee brace
- Girder with upper wall and tongs, truss with knee brace

Girder with upper wall and tongs, truss with knee brace contains two medium sized purlins which are located approximately at 1/3 the distance to the outer bearing walls.

The load coming from roof is transmitted through rafters, purlins, pillars and tie beams to the bearing walls. Medium-sized purlins shorten the range of rafters and transmits the load from the rafters to the pillars while tongs bind the truss and serve as transverse bracing.

5. THE IMPLEMENTATION OF TIMBER ROOF STRUCTURES

Timber roof structures are heavily used in modern civil engineering not only becauseof its efficiency, ease of assembly or its bearing capacity but also because of its aesthetics. Many residential buildings convert their loft and thus create a very pleasant living area.

Research shows that timber roof structures will continue to be used even though technology is being rapidly developed and new types of materials get introduced in civil engineering. Most countries in Southeastern Europe are sometimes referred to as “green paradise on Earth”. According to the research conducted by the World Bank in 2012, Bosnia and Herzegovina has the most of its area under forest in the region. Total of 43% of the territory of Bosnia and Herzegovina is under forest. However, forest are harvested irrationally and unsystematically. In many parts of Bosnia and Herzegovina rules illegal tree felling and at this rate forests will be degraded. Forest degradation leads to fewer natural springs and increased number of insects so it is necessary to afforest the land.

CONCLUSION

Many innovations in civil engineering stem from the use of information technology, calculating the bearing strength and stability, using computers to shape and manufacture timber, applying European norms and using new types of materials and structures. Timber roof structures are still often used in civil engineering.

LITERATURE

[1] Peulić, Đ., Konstruktivni elementi zgrada, CROATIAKNJIGA, Zagreb 2002.

[2] Pamučina, T., Građevinske konstrukcije, NIGRO „Glas“, Banja Luka

[3] Lončarić, D., Drvene konstrukcije 1, Građevinski fakultetet, Sarajevo 2007.

[4] Lončarić, D., Metalne konstrukcije, Građevinski fakultetet, Sarajevo 2007.

[5] http://www.grad.hr/~druzak/ruzak.net-webdoc/konstrukcije/drva2_klasicnadrvenakrovista.pdf

[6] http://www.gfos.unios.hr/portal/images/stories/studij/sveucilisni-preddiplomski/elementi-visokogradnje-ii/EV2-skripta.pdf