SYSTEM OF LIGHTWEIGHT ROOF GIRDERS WITH PARALLEL CHORDS AND THEIR APPLICATION

Žikica Tekić [1]
Ljiljana Kozarić [2]
Martina Vojnić Purčar [3]

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Summary: *The paper presents wooden trusses with parallel chords designed in the System of lightweight roof girders - LKV system, and their application in the construction of buildings. The basic static systems of these girders, their characteristics, as well as numerous examples of constructed wooden structures are presented. In the structure of the wooden constructions, these girders can play the role of bearing elements for receiving gravity loading, as well as the role of lateral bracing frame.*

Keywords: *LKV system, metal connectors, roof, girder, bracing.*

1. INTRODUCTION

System of lightweight roof girders is a pre-assembled, industrialized system that is the most commonly used in the prefabricated construction of wooden roof structures. These girders are functional elements, formed of two components: one-piece rectangular cross-section elements and fasteners for forming joint connections and extension of chords. All the elements of girder (chords and web members) have the same width of the cross section, while the height of the cross section is determined by the size and the sign of the internal force in the element [1]. The construction of joint connections and extension of elements is performed using metal connectors, which represent a modern mechanical coupling in wooden structures. They are positioned in pairs and pressed into all the elements which form the joint or the extension of the elements using a hydraulic press machines [2]. In addition to metal connectors, it is possible to use metal sheets and veneer panels, with hand-wrought or machine-mounted nails and clamps, using pneumatic guns.
The shapes of wooden trusses can be varied and they depend on the projected roof shape. The paper presents wooden trusses with parallel chords designed in the System of lightweight roof girders, and their application in the construction of buildings. The basic static systems of these girders, their characteristics, as well as numerous examples of constructed wooden structures are presented. In the structure of the wooden construction,

[1] Žikica Tekić, dipl. inž. arh., University of Belgrade, Faculty of Architecture, Bulevar kralja Aleksandra 73/II, 11120 Belgrade, Serbia, tel: +381 11 3225 254, e-mail: ztekic@arh.bg.ac.rs
[2] Ljiljana Kozarić, dipl. inž. građ., University of Novi Sad, Faculty of Civil Engineering Subotica, Kozaračka 2a, Subotica, Serbia, tel: +381 24 554 300, e-mail: kozaricljiljana@gmail.com
[3] Martina Vojnić Purčar, dipl. inž. građ., University of Novi Sad, Faculty of Civil Engineering Subotica, Kozaračka 2a, Subotica, Serbia, tel: +381 24 554 300, e-mail: vojnicmartina@gmail.com

these girders can play the role of bearing elements for receiving gravity loading, as well as the role of lateral bracing frame.

2. CHARACTERISTICS AND APPLICATION OF THE GIRDERS

System of lightweight roof girders with parallel chords are applied in several basic variants:

- lateral bracing frames (Figure 1, 2 i 3),
- girders that are parallel to the roof ridge line (Figure 4),
- girders where the supports are at the same or at different heights (Figure 5)

Lateral wind bracing represents transverse roof bracing (Figure 1). They are positioned in plane of the upper chords with the task of accepting the wind load that is perpendicular at the plane of the basic lightweight roof girders. Lateral bracing frame has the task of providing lateral supporting points for the chords of the basic lightweight roof girders that are loaded axially with force of pressure, and in that case the lateral wind bracing has the role of lateral bracing frame. In fields without roof bracing, the side supports of the upper chord are achieved by placing wooden battens that transmit the load to adjacent bracings (Figure 2 - left). Web members in which the permissible slenderness is exceeded for the reference width of the cross-section, must have lateral supporting points at half its length. This is done by setting up the lateral bracing in the plane of two web members, between the two basic lightweight roof girders (Figure 2 - right). A wooden batten, with the minimum dimensions of the cross-section 5/5 cm, is placed between them, and it connects the adjacent bracings and web members at half their length. The position of the lateral bracings for the single and double-deck roof has been shown in Figure 3 [3].

Figure 1. Lateral wind bracing

Figure 2. Lateral bracing frame

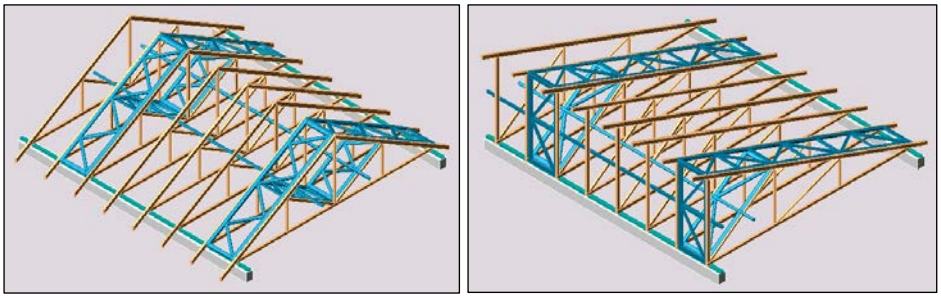

Figure 3. Position of bracings for single and double-deck roof

Girders that are parallel to the roof peak have been used in architectural solutions of single and double-deck roofs, when there are no bearing elements in the structure that are parallel to the line of roof peak (Figure 4). When the distance of the longitudinal bearing elements is too large for the use of a single or double-deck lightweight roof girder, a solution acceptable in that case is the organization of the roof structure by the use of girders parallel to the line of roof peak. The most frequent example of this is remediation of existing flat roofs. In comparison with traditional wooden structures, in their position in the structure of the roof, these girders have the role of a purlin.

The basic shape of the lightweight roof girder has a static system of a simply supported beam, it has parallel chords with varying length, depending on the position of the girder in relation to the roof peak. The buckling of the chords out of plane of the girder is prevented by placing the lateral bracings between the two lightweight roof girders in the sector of their supports. In areas without lateral bracings, the supports of the chords, along their longitudinal axis, are achieved by placing wooden battens that transmit the load to adjacent lateral bracings. The upper lateral bracing is parallel to the slope of the roof plane, since the lateral bracings are perpendicular to the basic lightweight roof girders.

The connection between the chords of the lightweight roof girders with the bearing structure, mostly reinforced concrete, is carried out using anchors and specially shaped

metal ties which have the function of stabilizing the connection, as well as accepting loads due to the uplifting effect of the wind. The roof cover, which is applied to the presented solutions, is a profiled trapezoidal sheet which lies on the upper chord of the lightweight roof girder. The connection is carried out using the standard coupling for profiled sheet with wooden construction. The derived connection has the ability to accept force due to the lateral buckling of the pressed upper chord of the lightweight roof girder. The buckling forces were taken over by the profiled sheet, which, in addition to the gravitational load, is further loaded on tension. Since the trapezoidal sheet does not lean with whole its surface on the upper chord of the lightweight roof girder, it is possible to specially shape the upper chord of the lightweight roof girder at the stage of their manufacture or to subsequently add the wooden elements on the upper surface of the upper chord of the lightweight roof girder to ensure an adequate laning of profiled sheet on the upper chord of the lightweight roof girder.

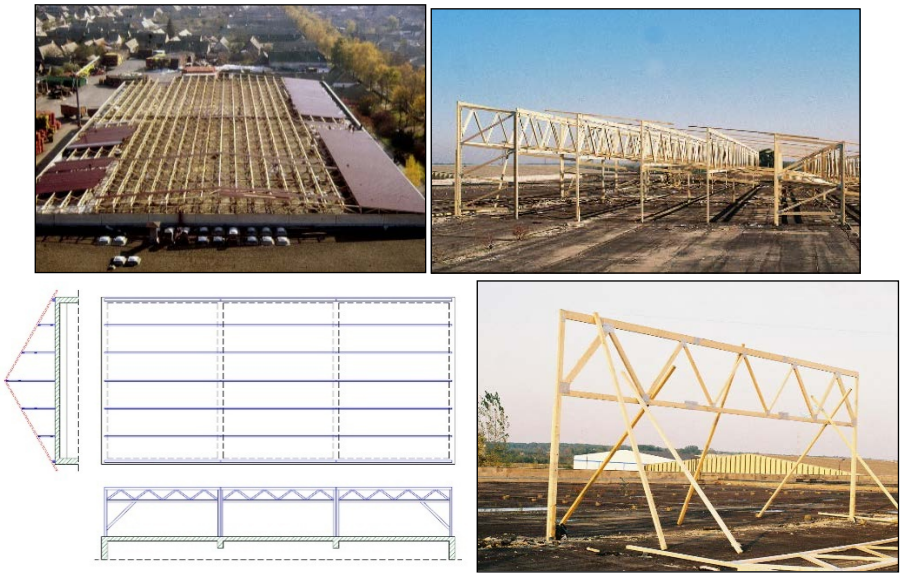

Figure 4. Girders parallel with the line of the roof peak

The girders where the supports are at the same or at different heights are usually the static system of simply supported beam. In Figure 5 - left, girders with supports at the same height and with static system of simply supported beam has been shown. The construction was made for the needs of the entertainment event and it was dismantled five days after the installation. In Figure 5 - right, the girders where the slope of roof was conditioned by the choice of the type of roof covering were presented. In both cases, the upper and lower chord are parallel.

Figure 5. Girders with the supports on the same (left) and at different heights (right)

3. CONCLUSIONS

A lot of variants with the application of lightweight roof girders with parallel chords have been presented, but a special place in the realization of wooden structures in the System of lightweight roof girders belongs to the lateral bracings frames. Practically, there is no wooden truss structure without bracings as constituent elements of the structure, in order to ensure its spatial stability. The installation of these girders is simple and it is performed using nails, by which the elements of lateral bracings are connected to chords of the lightweight roof girders, ie for the web members, in the case of preventing the buckling of the pressed web memebrs of the lightweight roof girders.

Girders that are parallel to the line of roof peak are economically very rational, since the wood consumption per unit roof surface is approximately twice as low as compared to some other forms of lightweight roof girders that are perpendicular on the line of roof peak and are generally set at a distance of between 80 and 90 cm. The use of these girders eliminates the need for secondary construction (for roof covering), if the cover is a profiled trapezoidal sheet. The distance of these girders is often greater than 200 cm, and is dictated by the height of the ribs of the profiled trapezoidal sheet which is used to cover the roof.

Girders where the supports are at the same height can find their application at floor constructions, while the girders where the supports at different heights are used in sloping roofs, when the higher hight of the ceiling is required in sector of the the highest point of the roof, and therefore the lower chord of the girder follows the slope of the roof level.

Regardless of which group of girders it is about, the common characteristic of all girders with parallel chords is the unification of the web members, as well as the geometric typeization of the joint that form the girder, in order to ensure the efficiency and cost-effectiveness of the realization of the system [4]. By designing web members in the form

of a diagonal of the same lengths or diagonals in combination with verticals, shaping the ends of the elements and forming joints requires a minimum operation in the production stage of these girders.

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ЛКВ НОСАЧИ СА ПАРАЛЕЛНИМ ПОЈАСНИМ ШТАПОВИМА И ЊИХОВА ПРИМЕНА

Резиме: *У раду су приказани носачи са паралелним појасним штаповима пројектовани у Систему ЛКВ, и њихова примена у конструкцијама објеката високоградње. Приказани су основни статички системи ових носача, њихове карактеристике, као и бројни примери изведених дрвених конструкција применом ових облика носача. У структури дрвене конструкције, ови носачи могу имати улогу носивих елемената за пријем гравитационог оптерећења, као и улогу спрегова против ветра и спрегова за укрућење.*

Кључне речи: *Систем ЛКВ, метални конектер, кров, носач, спрег за укрућење.*