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PARTICULARITIES OF PLATFORM WOODEN FRAMING STRUCTURES

BY

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Abstract. Platform wooden framing structures were first used in the U.S.A. in the early decades of the XXth century, and due to the advantages that this type of structures imply, they rapidly spread all around Europe, Australia and Japan. So far, as a direct consequence of the lack of national specific technical norms, the platform wooden framing structures that were built in Romania, do not have an adequate technical approach.

This paper presents and describes the structural layout and the particularities of the platform wooden framing structures, consisting as a starting point in conceiving a set of national technical norms which will bring under regulation the design and construction of this type of structures.

Key words: platform wooden framing structures; structural walls; load-bearing walls; low-weight frames.

1. Introduction

Builders have always aimed to erect safe, low-weight, cheap, eco and thermal efficient constructions (Sathre, 2014), without being influenced by the

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weather conditions and with short execution periods thus, implying low consumption of labor (Ritter *et al*., 2011). Among the traditional construction materials, wood has one the highest capacities in fulfilling most of the before mentioned requirements (Kuzman & Groselj, 2011).

Some of the first wooden structures were made up of heavy logs, fixed one on top of another, or of wood elements assembled in horizontal and vertical position (creating simple structural frames) with ceramic masonry block infilled between them.

The milestone of the low-weight wood structures, dates in 1833 when, Augustin Taylor built St. Mary church in Fort Dearborn, Illinois. The dimensions of the church were 7.5 m × 10.5 m and the new structural system consisted of wood planks 50 mm thick and 100/200 mm width, fixed with nails. When compared to the existing wood structures (those made up of heavy logs and those with masonry infills) this new construction system was nicknamed "balloon frame", because of the threat that the church would be seriously damaged by the wind action. The erection of the low-weight wood structure of the church cost only 400 U.S. dollars (Armstrong, 2012).

The popularity of the "balloon frame" structures rapidly increased on all northern part of the American continent due to their low price and because this specific structural system enabled promoters a wide variety of architectural functionalities. The climax of these structures was reached in the 1st decade of the 20th century.

The "balloon frame" structures have started to lose their popularity since the San Francisco great fire (1906), when it was found that the large spaces between the vertical wood planks provided large volumes of air, that accelerate the fire action and the small dimensions of the structural elements made them burn rapidly. Also, the great depression that followed the end of the First World War diminished the resources of wood, making this construction system even less preferred.

In the decades that followed, the fire-proofing of the "balloon frame" structures was improved, triggering an increase of the overall cost, making this system to be still used nowadays, but on a small scale. After 1918, the "balloon frame" system was enhanced, and a new structural solution appeared, called "platform framing".

2. Description of the "Platform Framing" System

Based on the principles of the balloon frame system, the platform framing structures were first used in the U.S.A. (Crişan & Gogulescu, 2011). The general layout of this system is presented in Figure 1. This paper describes the platform framing structural elements (Götz *et al*., 2001) , together with the assembling and execution phases (notations from Fig. 1 are used):

a) horizontally ground mounting 2-3-4-5 and 2-6-4-7 assemblies; the mudsills 2, are made of pretreated wood planks; vertical elements 3 and 6 are also made of pretreated wood planks having cross-sectional dimensions of 50 × × 100 mm^2 if the clear distance between them is 400 mm and of 50 × 150 mm^2 if the clear distance is 600 mm; the height of elements 3 and 6 equals that of the ground story minus the thickness of the top-floor;

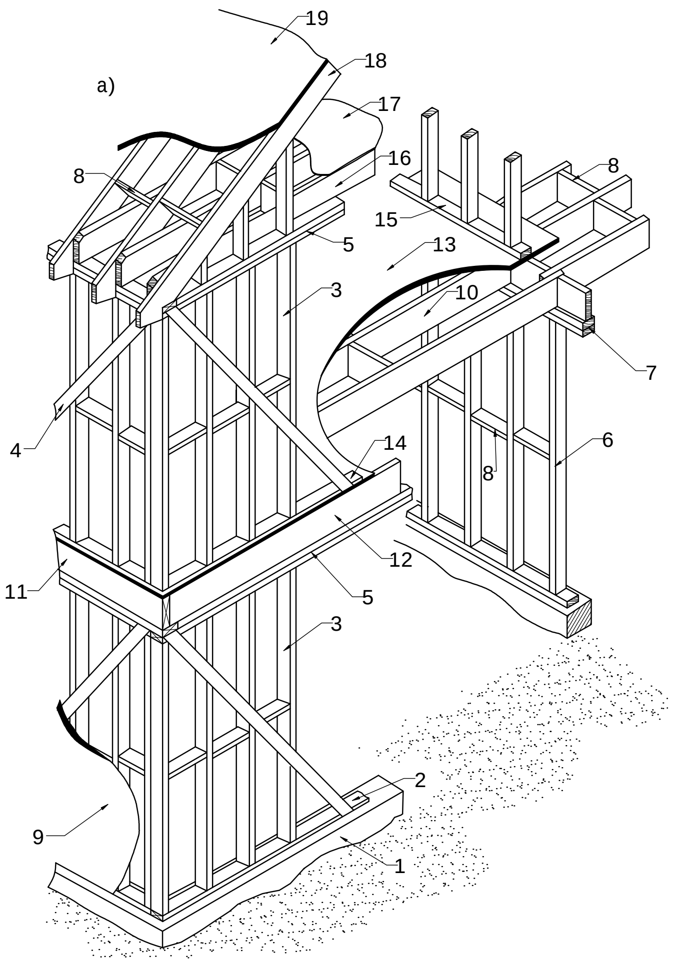

Fig. 1 – General layout of the "platform framing" structure (Thallon, 2008) 1 – rigid box; 2 – mudsills; 3 – stud walls; 4 – let-in braces; 5 – double plate (beam mounted on the upper part of the stud walls); 6 – light stud walls; 7 – double plate; 8 – blocking elements; 9 – structural panels; 10 – floor joists; 11 – rim elements; 12 – rim joists; 13 – subfloor; 14 – sole-plate (continuous element fixed on the perimeter of the subfloor); 15 – sole plate (continuous element fixed on the upper part of the subfloor); 16 – tie-elements; 17 – working floor; 18 – rafters; 19 – roof boarding.

b) swinging in vertical position the 2-3-4-5 and 2-6-4-7 assemblies and fixing them on the walls of the rigid box 1;

c) fixing the blocking elements 8 and partially boarding the 2-3-4-5 assembly with the structural panels 9;

d) fixing the joists of the top floor 10, the rim elements 11 and the rim joists 12; also, in this phase the blocking elements 8 and the subfloor are fixed; the joists of the top floor are usually made of wood planks, being fixed on the plates 5 or 7, bearing on the vertical elements 3 or 6;

e) horizontally joining the assemblies 14-3-4-5 and 15-6-4-7 and swinging them into vertical position to fit upon assemblies 2-3-4-5 and 2-6-4-7;

f) fixing the blocking elements 8 and partially boarding the 14-3-4-5 assembly with the structural panels 9;

g) fixing the tie-elements 16 and the working floor 17 necessary for the rafter mounting 18;

h) mounting the roof boarding 19;

i) fixing all structural panels 9.

3. Particularities of the Platform Wooden Framing Structures

Analyzing the general layout of the platform framing structure, the following particularities can be outlined:

a) the constitutive elements are made up of wood planks mounted at 400 mm or 600 mm clear distance between them; I-Joist elements can be also used, at the same clear distances;

b) the floor joists, the tie-elements and the rafters bear on the vertical studs through the double plates fixed on the top of the latter;

c) the floor over the ground level, assembly 10-11-12-8-13, is designed as a closed box (caisson);

d) the subfloor consists of surface elements (OSB or TEGO wood panels) arranged in such a way that continuous joins are avoided and each panel is fixed on its perimeter with nails or with blocking element;

e) based on the features presents on points c) and d), it can be outlined that the floor over the ground level has an infinite rigidity along his principal axes when compared to the displacement rigidity of the vertical elements;

f) the roofing system 19-18-16-8 (17 eventually) is designed to be undeformable, having a triangular shape;

g) the design of the roof boarding follows the same principles as in the case of the subfloor, having areas with high density of nails (where the blocking elements are fixed);

h) similar to the case of the floor over the first level, the roof has an infinite rigidity when compared to the displacement rigidity of the vertical elements;

i) during the execution phase, the structure is composed of simple and light frames (made of studs and double plates on their upper parts), stiffened by let-in braces, rigid floors and by the roof;

j) in the final stage, the structure consists of structural walls (carrying vertical and horizontal forces), bearing walls (carrying only vertical forces), light frames (also carrying only vertical forces) and of rigid floors and roof;

k) the structural walls are designed similar to the floors, but being composed of vertical caissons made of studs (doubled at the ends of the wall), blocking elements, structural panels and double plates at the top and bottom sides;

l) the structural walls are connected to the rigid box (which transfers all the loads to the foundations) using anchor bolts (undertaking shear forces) and anchor hold-downs (undertaking bending moments);

m) structural walls are fixed to the floor over the ground level using steel belts and ancor hold-downs;

n) the differences between the bearing walls (made of stud walls, non-structural panels, blocking elements and double plates) and the structural ones, consist of: lighter exterior panels with lower density of nails, connection to the rigid box only by anchor bolts and no steel belts used when fixed to the top floor (which makes them carry only vertical forces);

o) light frames (made of light stud walls and double plates at the top and bottom part) carry only vertical forces;

p) structural walls are usually placed out on the contour of the building and light frames are used in the inner construction area; it can be said that this structure is the opposite when compared to the one with central core;

q) the position of the structural walls can be shifted from one level to another, being a great advantage for the architects;

r) the way in which the floors and the roof transmit loads to the elements on which they bear, creates a particular loading state, where only some of the vertical elements undertake axial forces; a complementary assembling of the floor and roof is necessary for compensating this aspect;

s) the walls and the light frames have close vertical elements, insuring a safe transfer of the loads to the foundation system, similar to that of a rigid box.

4. Conclusions

By analyzing the particularities of the platform wooden framing structures the complexity and the rational layout of this system is being emphasized.

Understanding and disseminating these aspects is absolutely necessary in the process of conceiving a set of technical norms for the safe design and execution of this type of structures in Romania.

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PARTICULARITĂȚI ALE STRUCTURII "PLATFORM FRAMING" REALIZATE DIN LEMN

(Rezumat)

Structurile din lemn tip "platform framing" au apărut pe teritoriul U.S.A la începutul secolului al XX-lea şi, datorită avantajelor lor, s-au răspândit în America de Nord, Europa, Australia şi Japonia. În România utilizarea acestor structuri nu are, până în acest moment, o utilizare corectă din punct de vedere tehnic (alcătuirile sunt puțin cunoscute iar proiectarea nu are la bază norme tehnice româneşti).

Lucrarea prezintă alcătuirea acestui sistem şi principalele particularități de natură să evidențieze paşii necesari în vederea conceperii unor prescripții tehnice de calcul a acestor structuri pe teritoriul României.