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PLYWOOD USAGE IN PASSIVE HOUSE

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ABSTRACT
In the production of passive houses in the Europe, the wood based board has a very area for usage. Plywood from different types of wood are recommended in different types phase of this type of wood based passive houses. Mainly the characteristic of certain boards are important for certain parts of house construction from floor to roofs.
Keywords: passive house, plywood, wooden structure

1. INTRODUCTION
The construction of wooden houses began to build the foundations of the traditional way, by design. If it is a prefabricated wooden house, followed by construction of the foundation walls with factory pre-fabricated wall panel width of 120 cm, height 240-320 cm.
Wall panel element consists of a wooden frame thickness of 8 cm, which is clad on both sides Chipboard, OSB, plywood thickness from 1 to 2.2 cm. For external elements placed vapor barrier made of PVC foil and a layer of mineral wool thickness of 8 to 16 cm as thermal insulation.
In a separate layer of insulation inside the panels are installed flexible plastic piping installations (electricity, telephone, antenna), taking into special attention to prevent break vapor barrier. It is a common cause of wetting the insulation and its deterioration. Such engineered wall construction is coated with a fiber-gypsum board or similar board on the inside of wall and moisture resistant (combined) board and the corresponding facade layer on the outside wall.
This way of building walls are installed floor or roof structure. They consist of structural elements, which are usually of massive or laminated beams corresponding cross-sections. For them to jointed the board (usually plywood certain thickness) and sets the insulating layer.
The construction of wooden prefabricated houses used coated chipboard, OSB, plywood and HDF board as panel elements and massive or laminated beams as structural elements of the structure.
In order to achieve a certain insulation used thermal insulation material and moisture insulation material. They can also be applied non-wooden and other materials to achieve specific aesthetic, usable and similar applications.

2. PLYWOOD
The construction and arrangement of wooden houses plenty of used plywood. In these structures, they are subject to various conditions of use according to the type, intensity and direction of load, and different environmental conditions (humidity). In this structure are used for non-sanded , sanded and coated plywood with film-foil. Plywood differ in characteristics. In Tables 1 and 2 are shown data for the set–up and characteristic values of strength of birch and spruce plywood.

Table 1. Set-up, thickness, number of piece of veneer sheets in the set-up and characteristic values of bending strength, compressive strength, tension strength and mean modulus of elasticity of bending and tensile / compressive deformation parallel and perpendicular to the wood grain for birch plywood (density ρ = 680 [kg/m3]

birch plywood			The characteristic strength						The mean modulus of elasticity			
			bending [N/mm^2]		compressive [N/mm^2]		tension [N/mm^2]		bending [N/mm^2]		tension and compressive [N/mm^2]	
set–up	nominal thickness	number of sheets of veneer	$f_{m\parallel}$	$f_{m\perp}$	$f_{c\parallel}$	$f_{c\perp}$	$f_{t\parallel}$	$f_{t\perp}$	$E_{m\parallel}$	$E_{m\perp}$	$E_{t/c\parallel}$	$E_{t/c\perp}$
ǀ–ǀ	4	3	65,9	10,6	31,8	20,2	45,8	29,2	16471	1029	10694	6806
ǀ–ǀ–ǀ	6,5	5	50,9	29,0	29,3	22,8	42,2	32,8	12737	4763	9844	7656
ǀ–ǀ–ǀ–ǀ	9	7	45,6	32,1	28,3	23,7	40,8	34,2	11395	6105	9511	7989
ǀ–ǀ...ǀ –ǀ	12	9	42,9	33,2	27,7	24,3	40,0	35,0	10719	6781	9333	8167
ǀ–ǀ...ǀ –ǀ	15	11	41,3	33,8	27,4	24,6	39,5	35,5	10316	7184	9223	8277
ǀ–ǀ...ǀ –ǀ	18	13	40,2	34,1	27,2	24,8	39,2	35,8	10048	7452	9145	8352
ǀ–ǀ...ǀ –ǀ	21	15	39,4	34,3	27,0	25,0	39,0	36,0	9858	7642	9093	8407
ǀ–ǀ...ǀ –ǀ	24	17	38,9	34,4	26,9	25,1	38,8	36,2	9717	7783	9052	8448
ǀ–ǀ...ǀ –ǀ	27	19	38,4	34,5	26,8	25,2	38,7	36,3	9607	7893	9019	8481
ǀ–ǀ...ǀ –ǀ	30	21	38,1	34,6	26,7	25,3	38,5	36,5	9519	7981	8993	8507
ǀ–ǀ...ǀ –ǀ	35	25	37,6	34,7	26,6	25,4	38,4	36,6	9389	8111	8953	8547
ǀ–ǀ...ǀ –ǀ	40	29	37,2	34,7	26,5	25,5	38,3	36,8	9296	8204	8925	8575
ǀ–ǀ...ǀ –ǀ	45	32	37,0	34,7	26,5	25,5	38,2	36,8	9259	8241	8914	8586
ǀ–ǀ...ǀ –ǀ	50	35	36,8	34,8	26,4	25,6	38,1	36,9	9198	8302	8895	8605

Table 2. Set-up, thickness, number of piece of veneer sheets in the set-up and characteristic values of bending strength, compressive strength, tension strength and mean modulus of elasticity of bending and tensile / compressive deformation parallel and perpendicular to the wood grain for spruce plywood (density ρ = 520 [kg/m3]

spruce plywood thin veneers			The characteristic strength						The mean modulus of elasticity			
			bending [N/mm^2]		compressive [N/mm^2]		tension [N/mm^2]		bending [N/mm^2]		tension and compressive [N/mm^2]	
set–up	nominal thickness	number of sheets of veneer	$f_{m\parallel}$	$f_{m\perp}$	$f_{c\parallel}$	$f_{c\perp}$	$f_{t\parallel}$	$f_{t\perp}$	$E_{m\parallel}$	$E_{m\perp}$	$E_{t/c\parallel}$	$E_{t/c\perp}$
ǀ–ǀ	4	3	37,6	6,0	22,0	14,0	17,1	10,9	12235	765	7944	5056
ǀ–ǀ–ǀ	6,5	5	29,1	16,6	20,3	15,8	15,8	12,3	9462	3538	7313	5688
ǀ–ǀ–ǀ–ǀ	9	7	26,0	18,3	19,6	16,4	15,2	12,8	8465	4535	7065	5935
ǀ–ǀ...ǀ –ǀ	12	9	24,5	19,0	19,2	16,8	14,9	13,1	7963	5037	6933	6067
ǀ–ǀ...ǀ –ǀ	15	11	23,6	19,3	19,0	17,0	14,8	13,2	7663	5337	6851	6149
ǀ–ǀ...ǀ –ǀ	18	13	23,0	19,5	18,8	17,2	14,6	13,4	7464	5536	6795	6205
ǀ–ǀ...ǀ –ǀ	21	15	22,5	19,6	18,7	17,3	14,5	13,5	7323	5677	6755	6245
ǀ–ǀ...ǀ –ǀ	24	17	22,2	19,7	18,6	17,4	14,5	13,5	7218	5782	6724	6276
ǀ–ǀ...ǀ –ǀ	27	19	22,0	19,7	18,6	17,4	14,4	13,6	7137	5863	6700	6300
ǀ–ǀ...ǀ –ǀ	30	21	21,8	19,8	18,5	17,5	14,4	13,6	7072	5928	6681	6319

Construction of wooden houses plywood is used in floor construction, wall construction, roof construction, manufacture staircases and interior decorating. Required characteristics depend on the plywood applications. If used in floor construction, wall construction, roof construction plywood should be protected from moisture. Also, they should submit to (resist) a load of determined intensity without the deformation of plywood.
If the plywood used for flooring production base under the floor structure of its thickness of 6 or 8 mm to 18 mm, depending on the distance between the beams which are connected to the board. If plywood is used for the preparation of the substrate thickness from 12 to 19.5 mm for the distance of 400-600 mm, maximum up to 1000 mm. Plywood deflection that can occur due to the influence of load on it, depends on the value of the load and span between the beams which are fixed to plywood. Plywood is used in floor construction should be such that the mechanical properties in all conditions of use can handle continuous loads of up to 1.5 [kN/m2], or the maximum concentrated load of 2.7 [kN/m2].
In building wall constructions plywood are used as panels that are fastened to the supporting structure of the massive, mostly or laminated beams. Their characteristics (physical and mechanical) depend on whether the plywood used for exterior or interior walls (conditions of use requirements) and the expected load that will be exposed plywood. Minimum thickness of plywood used to build walls is 8 mm and the inner and outer walls are plywood commonly used thickness of 15 to 25 mm and thicker plates.
Plywood in roof constructions are used for panels that are fastened to the rafters of which are massive or laminated beams. Their thickness is from 15 mm or more, depending on the expected load range between the rafters.

3. PLYWOOD IN PASSIVE HOUSES

Passive house is a building in which no active heating or air conditioning system achieves a pleasant room temperature in winter and summer. In the passive house is provided with the comfort and convenience of living, while the housing needs for thermal energy does not exceed 15 [kWh / m²]. The realization of passive houses are placed high demands in quality applied building components. All external elements of buildings, except for glass surfaces should be insulated so well that the heat transfer coefficient U_K less than 0.15 [W/m2K]. Figure 1 shows a passive wooden house with characteristic recommendations in the construction of this house.

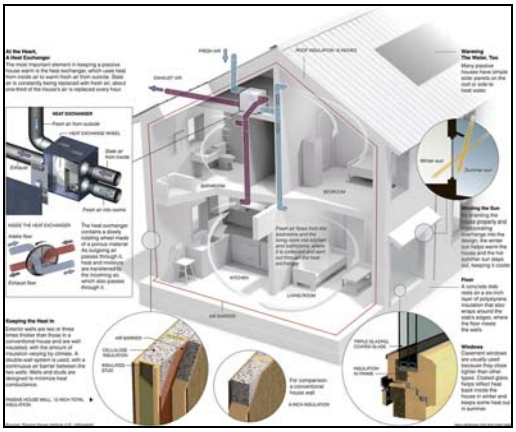

Figure 1. Passive wooden house

The construction of passive wooden houses using insulation layer is 25-40 cm thick and are fitted with triple glazing windows and doors that provide good retention of heat in the house. It is also necessary to incorporate a quality ventilation system.
To build a wooden passive house can be used several different types of wall construction, for example, exterior wall systems, "Mega", the outer wall of the Viking Double L core element.

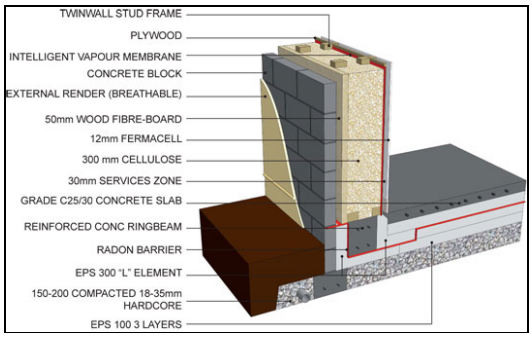

Figure 2. Viking Double L foundation element with a Timber Frame wall and a concrete block external leaf

In passive houses with wooden plywood can be applied in all areas of application as in any wooden house, ie floor, wall, roof structures with strict adherence to other requirements in the construction of passive houses in terms of facility site selection, orientation and shape of the house, thermal protection and thermal insulation of external walls, roof, ceiling, floor, energy efficiency of windows and external doors, use of heat-insulating material and an adequate system of ventilation air.
In passive wooden houses plywood can be applied in all areas of application as in any wooden house, ie in floor, wall, roof structures with strict adherence to other requirements in the construction of passive houses in terms of facility site selection, orientation and shape of the house, thermal protection and thermal insulation of external walls, roof, ceiling, floor, energy efficiency of windows and external doors, use of heat-insulating material and an adequate system of ventilation air.

4. CONCLUSION

Plywood is one of a group of board materials based on wood, that falls into the category of renewable building materials.
The outer wall of the timber structure can be 2 to 3 times thinner than the outer wall, constructed of typical building materials companies with identical thermal insulation coefficient. In this way increases the usable area of the building and up to 10%. Also materials for the construction of wooden houses are on average 10% cheaper than other building materials. Modern manufacturing ensures that the number of types of wooden prefabricated components that are installed in buildings, thus reducing the time required for construction.
Because of good physical and mechanical properties of plywood used in the floor structure, wall structure, roof structure as a lining in these structures, or as part of a panel prefabricated elements that are embedded in these structures.
Building wooden passive house provides all the advantages of building a passive object: comfort - the comfort of living increase in user space and providing pure air, economical construction, economical life in these buildings by reducing energy consumption and therefore reduce the cost of living, better protection of the environment (environmental aspect).

5. REFERENCES

[1] Borković Ž. i dr.: Vodič kroz energetski efikasnu gradnju, Ministarstvo zaštite okoliša, prostornog uređenja i graditeljstva, Zagreb, 2005
[2] Omer S.E., Ćehic M., Štrkonjić A.: PASSIVE WOODEN HOUSE, 14th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology" TMT 2010, Mediterranean Cruise, 11-18 September 2010
[3] Castagna, M.; Schmitt, Y.; Troi, A. : Analysis and optimization of a monitored passive house in Italy with dynamic simulation;, Proceedings 12th International Conference on Passive Houses , Nuremberg 11–12 April 2008, Germany, 2008
[4] www.forestindustries.fi/infokortit/handbookplywood/Documents/HandbookOfFinnishPlywood.pdf
[5] www.cochise.az.gov/uploadedFiles/Planning_and_Zoning/APA%20-%20Build%20Energy%20Efficient%20Walls.pdf