Low-rise house of plywood honeycomb panels

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Abstract. One of the current problems of the countries of the post-Soviet space is the low availability of housing. A rather large number of houses annually become obsolete, destroyed as a result of disasters. The global all-Russian modern trend of housing construction is its reorientation to the market of low-rise construction. Low-rise construction can be one way to increase the number of square meters per person. Russia is the largest producer of industrial wood and plywood in the world. Therefore, it is proposed to consider wooden house-building. There are different types of wood houses: traditional log construction; panel-house; frame house. The authors of the article suggest to consider a new type of the plywood honeycomb panel, which help to solve this problem. It has a patent. The main problem of panel houses is the connections between panels. The article is devoted to assessing, various nodes of the combination of panels. Advantages and disadvantages of the existing methods of connecting panels are considered. The report also suggested possible practical ways to constructing panel: ordinary panel-floor and ordinary panel-wall according to requirements of woodworking production. In conclusion, it is proposed an example of structural solution of linking of ordinary wall panels, floor covering panels and foundation for mass-market building.

1. Introduction.

Over the recent years various natural disasters (floods, hurricanes, etc.) and wars have taken place every year in numerous countries, which ruin thousands of square meters of residential space. Essential expenditures of time and funds are required for restoration of houses. Besides, in Russia and former Soviet republics outbreaks of economy class residential construction have been observed in the recent years [1]. Authors of the article suggest that a new type of low storey houses should be considered based on wooden panels made of non-standard plywood [2] for meeting the consumers’ demands.

Formerly, we considered issues of numeral calculations of this type of panels [3], where it was pointed out that some experimental studies were required for confirmation of theoretical prerequisites.

Let’s consider in detail structural solution for panels. A series is proposed to consist of several panels, as shown on Figure 1 and Figure 2.
A structural solution of wall panels and floor structures/covers is shown on Figure 3. This solution has been worked out by proceeding from requirements of materials cutting, manufacturing, as well as preliminary strength, rigidity and thermotechnical calculations of a panel.

Figure 1. A wall door panel for construction of low storey houses

Figure 2. A panel for construction of low storey houses

Figure 3. Structural solution of panels
2. Methods.

Apart from the issues related to the structural solution of panels, variants of panels interconnection should be considered for construction of the building frame.

For construction of new connecting units the previous experience should be studied, as well as most popular solutions used in the modern construction practice.

For example, in the Soviet period panel and shield houses were widely used for mass development of people’s garden plots. Many design institutes developed series of country houses: in Russia – Karelian institutes; in Belarus – “Belgosproject” (Figure 4), as well as some design institutes in Lithuania, Latvia and Ukraine [4,5,6,7,8].

![Figure 4. Facades of a wooden panel house – design 186-000-87. “Belgosproject”](image)

In the USA and Western Europe frame houses were actively gaining popularity in those years, which occupy leading positions in the construction industry at present. Also, houses based on wooden glued plywood panels of the full operational readiness may be pointed out. For example, the Belarusian plant for manufacturing of newsprint developed a series B.181-00-123.09 (Figure 5 and Figure 6), based on Soviet designs of shield and panel wooden houses, and it output a set of houses on the basis of panels for construction in France. However, they have some drawbacks: low shape stability, rather large overall dimensions, high thermal conductivity of connecting units for panels, as well as many non-standard precast components are used, what essentially increases labour intensity during installation of structures.

![Figure 5. Typical design of series B.181-00-123.09. General view of a wooden individual panel](image)

![Figure 6. Typical design of series B.181-00-123.09. Angular joint of panels](image)
Structural Insulated Panels (SIP) (according to the Western literature) can still be found, which consist of two OSB slabs and a heat insulating layer between them (as a rule – foamed polystyrene or foamed polyurethane). SIP panels have the following drawbacks: insufficient acoustic isolation, they are less environment-oriented due to styrene emission from heat insulation, as well as they have less strength and rigidity indicators than the first type of panels (Figure 7).

![Figure 7. Example of structural SIP-panel.](image)

But being so, panel connecting units which are rather good from the point of view of heat absorptive capacity have been offered. The general structural scheme and the connecting unit for ordinary panels are shown on Figure 8 and Figure 9.

![Figure 8. Structural solution of houses based on SIP-panels. General view of a wooden individual panel house](image)

![Figure 9. Structural solution of houses based on SIP-panels. Angular joint of panels](image)

The problem of panels connection from the point of constructability and high thermotechnical characteristics was rather profoundly studied by A.V. Vlasov [9]. It was pointed out in this work that a tongue-and-groove joint is the best from the point of view of thermotechnical features (Figure 10).
Figure 10. Structural solution of most frequently used connections. Assembled tongue-and-groove joint. 1 – thermal insulation; 2 – end post of panel frame; 3 – sealing tape

By taking into account the experience of former generations, problems during construction of modern low storey houses, technological and installation requirements, the following type of connections of ordinary panels (Figure 11) is offered with the aid of bars having dimensions 70*70 mm, glued to the panel by means of the cold method.

Figure 11. Structural solution of the unit connection of ordinary wall glued plywood panels of a new type: 1 – sealing tape; 2 – glued ledger strip; 3 – external paneling

3. Results and Discussion
Besides, the construction of floor and wall panels was completed and shown on figure 9. Connection of panels to the house structure was shown on Figure 12, Figure 13 and Figure 14.
Figure 12. External view of ordinary panel-floor. 1 – glued ledger strip; 2 – plywood covering; 3 – mitre joint of plywood sheets; 4 – plywood binding component

Figure 13. External view of ordinary wall panel. 1 – glued ledger strip; 2 – plywood covering; 3 – mitre joint of plywood sheets; 4 – plywood binding component

Figure 14. Example of structural solution of linking of ordinary wall panels, floor covering panels and foundation (1 – post footing; 2 – binding bar; 3 – floor covering panel; 4 – wall panel)
4. **Conclusions**

In the end, it should be pointed out, that wooden houses based on glued plywood panels of a new type will make it possible to resolve the problem of insufficient housing for both young families and the people who suffered in natural and man-triggered cataclysms.

At the same time, for introduction to mass construction panels should be fabricated on the basis of the provided materials, they should be tested for various indicators: strength, rigidity, thermal technical features, fire resistance and biostability. Theoretical prerequisites must be confirmed for calculation, engineering methods of calculation must be worked out.

**References**

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