

УДК 692.237

CALCULATION OF ANCHORS OF FRAME-FILLING PANEL WITH APPLICATION OF FRAME OF ROLLED-FORMED GALVANIZED SECTION

*Doctor of Technical Science N.V. Savitskii, junior researcher A.A. Nesin
State institute of higher education "Prydniprovsk State Academy of Civil
Engineering and Architecture"*

Actuality: Nowadays steady increase of segment of building with application of rolled-formed galvanized sections is observed. Light thin-walled steel constructions (LTSC) became a wide-spread solution for low-rise buildings, attic floors, frame-filling constructions of multistorey buildings.

The authors have developed a high- industrialized, power efficient frame-filling panel of low cost with application of frame of rolled-formed galvanized sections with breakthroughs (thermosection) [1,2].

Connections with scientific and practical tasks. The work was carried out in accordance with national-budget scientific-research themes of Ministry of Science and Education, Youth and Sport of Ukraine "High-performance constructions of low-rise buildings for construction of affordable social accommodation" (state registration number 0109U001396) and "Creation of methodology of rational design of resource-saving architectural-constructional-technological systems for construction of social accommodation" (state registration number 0111U000455).

The aim of the research is calculation of anchors for fixing frame-filling panel with frame of rolled-formed galvanized sections.

Description of basic material. Selection of anchors was made for 4 dimension types of frame-filling panels with frame of rolled-formed galvanized sections: 5700 x 2700 mm, 5700 x 3000 mm, 5700 x 3300 mm and 5700 x 3600 mm (fig.1) for 3, 5, 9, 23 and 33-storey buildings. Step of sections equals 600 mm. Type of steel – C255 with design resistance $R_y=250$ MPa. Cellulose wool with density of 55 kg/m^3 was accepted as the efficient heat insulation. Two gypsum plasterboards 12.5 mm wide were used for encasement from within. Magnesite slab 10 mm wide was used for encasement from the outside.

Type of concrete B25 (C20/25) for load-carrying structure of the building frame was taken.

Calculation of anchors for frame-filling panel was carried out for conditions of Dnipropetrovsk city (2 climatic region [3], 3 wind region [4]) for the following loads:

Permanent:

- sole weight of galvanized sections and heat insulation;
- loads of window filler;
- loads of heat radiator in under-window zone;
- loads of outside (magnesite slab, metal leading sections) and inside encasement (gypsum plasterboards).

Short-term:
- wind load.

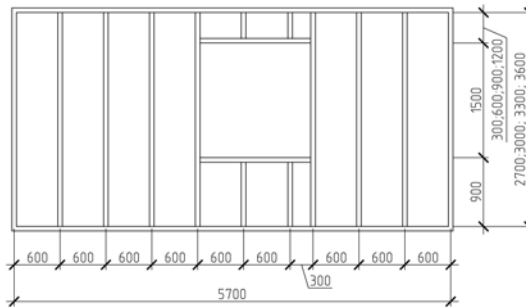


Figure 1. Construction of frame-filling panel with frame of rolled-formed galvanized sections for 4 dimension types

Static calculation of frame-filling panel was made by means of calculation complex “Lira 9.6”. Calculated model is represented as finite-element two-dimensional scheme (fig.2). Performance of frame elements was modeled with universal spatial stem finite element KE 10.

Depending on the character of loads and aims of calculation there were used two kinds of calculated value such as limiting design value and operational value of loads according to Ukrainian National Construction Regulation B.1.2-2: 2006 [4].

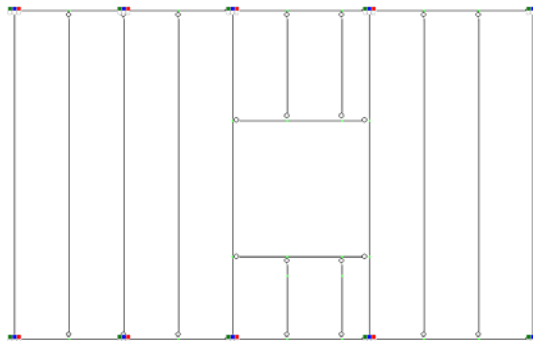


Figure 2. Design model of frame-filling panel with frame of rolled-formed galvanized sections

By reason of absence of clear methodology of calculation of modern façade anchors in domestic regulations, methodology of calculation of anchors Hilti [5] was taken as a basis.

Given methodology is based on the method of calculation of load-carrying capacity of concrete (method CC) [6].

According to this methodology, calculation of anchors is carried out on 5 possible cases of destruction:

- anchor disruption;
- anchor tear-out from the base;
- destruction of concrete;
- anchor body cut-off
- break of base edge.

For fixing wall panel to load-bearing constructions of the building frame the following anchors Hilti were used: universal anchor HUD-1 with length of anchor 70 mm and diameter 12 mm and façade anchor HRD with length of anchor 80 mm and diameter 12 mm. Scheme of fastening wall panel to load-bearing constructions of the building frame is presented in the figure 3.

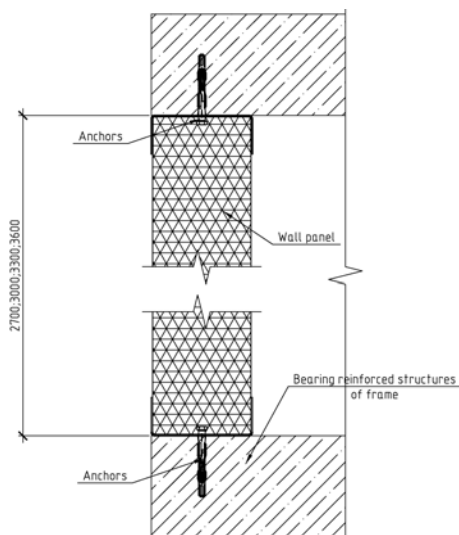


Figure 3. Scheme of fastening wall panel to load-bearing constructions of the building frame

In the table 1, there are given the results of selection of anchors of wall panels for 3, 5, 9, 23 and 33-storey buildings in conditions of Dnipropetrovsk city.

Analogous calculations of anchors of wall panels with application of frame of rolled-formed galvanized sections were made for 3, 5, 9, 23 and 33-storey buildings, situated in different climatic regions of Ukraine.

Table 1

Results in selection of anchors of wall panel
for conditions of Dnipropetrovsk city

| Num ber of store ys | Geometric dimensions of panel, m | Anchor type | | | |
|---------------------------------|--|---------------------|--------------------|--------------------|--------------------|
| | | Type of surrounding | | | |
| | | 1 | 2 | 3 | 4 |
| 3 fl. | 5,7 x 2,7 m | HRD- U14 | HRD- U14 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,0 m | HRD- U14 | HRD- U14 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,3 m | HRD- U14 | HRD- U14 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,6 m | HUD-1-14x70 | HRD- U14 | HRD- U14 | HRD- U14 |
| 5 fl. | 5,7 x 2,7 m | HRD- U14 | HRD- U14 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,0 m | HRD- U14 | HRD- U14 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,3 m | HUD-1-14x70 | HRD- U14 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,6 m | HUD-1-14x70 | HUD-1-14x70 | HRD- U14 | HRD- U14 |
| 9 fl. | 5,7 x 2,7 m | HRD- U14 | HRD- U14 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,0 m | HUD-1-14x70 | HRD- U14 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,3 m | HUD-1-14x70 | HUD-1-14x70 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,6 m | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 | HRD- U14 |
| 23 fl. | 5,7 x 2,7 m | HUD-1-14x70 | HUD-1-14x70 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,0 m | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 | HRD- U14 |
| | 5,7 x 3,3 m | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 |
| | 5,7 x 3,6 m | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 |
| 33 fl. | 5,7 x 2,7 m | HUD-1-14x70 | HUD-1-14x70 | HRD- U14 | HRD- U14 |
| | 5,7 x 3,0 m | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 | HRD- U14 |
| | 5,7 x 3,3 m | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 |
| | 5,7 x 3,6 m | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 | HUD-1-14x70 |

Conclusion. The selection of anchors for fixing frame-filling panel with frame of rolled-formed galvanized sections for construction of 3, 5, 9, 23 and 33-storey buildings in conditions of Dnipropetrovsk city was carried out.

Bibliography

1. Ограждающая конструкция с каркасом из термопрофилей / Савицкий Н.В., Несин А.А. // Строительство, материаловедение, машиностроение: Сб. научн. трудов. №50 – Дн-вск: ПГАСА, 2009. – С. 479-481.
2. Экспериментальное исследование теплотехнической эффективности термопрофилей / Савицкий Н.В., Несин А.А., Береза И.В. // Строительство, материаловедение, машиностроение: Сб. научн. трудов. №56 – Дн-вск: ПГАСА, 2009. – С. 431-436.
3. ДБН В.2.6-31: 2006 Конструкції будівель і споруд. Теплова ізоляція будівель.- К.: Міністерство будівництва, архітектури та житлово-комунального господарства України, 2006 – 70 с.
4. ДБН В.1.2-2:2006 Система обеспечения надежности и безопасности строительных объектов. Нагрузки и воздействия. Нормы проектирования.- К.: Минстрой Украины, 2006 – 78 с.