BEARING CAPACITY OF COMPRESSIONAL NOTCHED C-PROFILE MEMBERS

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LIGHT STEEL THIN-WALLED STRUCTURES

Low weight of the load-bearing steel framework (between 20 - 25 kg/m²), short payback period and high energy efficiency of buildings made of cold-formed thin-walled members are the facts which make them in great demand for housing as well as for construction of industrial and public building.
BUILDINGS' RECONSTRUCTION

Light steel thin-walled structures are able to solve main problems of buildings' reconstruction: to lower foundation and walls loads, to carry out construction works in restrained urban conditions without use of heavy equipment and without shutdown of the process inside the building.
separate elements of the framework are joined in one panel with the help of guide casings and sheets.

- the structures based on cold-bent steel galvanized thin-walled C-profiles with the thickness up to 3 mm.

cold-bent C-profile is used for interior panel

cold-bent notched C-profile is used in exterior panel
Purpose of research

to find ultimate bearing capacity and to study stress-strain behavior of compressional cold-bent notched C-profile members of different cross-sections area as well as comparison study of their work and that of cold-formed solid section C-profile members

Objective of research

- analyze areas of cold-bent profile in construction
- theoretical investigations on global buckling and bearing capacity of members of C-shaped notched profiles
- experimental investigations on global buckling and bearing capacity of members of C-shaped notched profiles
- to find and estimate factors influencing bearing capacity
- numerical simulation of members of C-shaped notched profiles
- methodology
Subject of research

Cold-formed steel notched C-shaped profile

Problems

But in Russian national standards there is no clear systematization of thin-walled members’ calculations
THEORETICAL ESTIMATION OF THE CROSS-SECTION

\[ \sigma = \frac{P}{F} + \frac{M_x}{W_x} + \frac{M_y}{W_y} + \frac{B_\omega}{W_\omega} \]
## THEORETICAL ESTIMATION OF TEST MEMBERS’

<table>
<thead>
<tr>
<th>local (L)</th>
<th>distortional (D)</th>
<th>flexural (F)</th>
<th>torsional (T)</th>
<th>flexural-torsional (FT)</th>
</tr>
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<tbody>
<tr>
<td>местная</td>
<td>«искаженная» (полки)</td>
<td>изгибная</td>
<td>крутильная</td>
<td>изгибно-крутильная</td>
</tr>
</tbody>
</table>
| L + D           | F + L            | F + D            | FT + L       | FT + D                  | F + FT
THEORETICAL ESTIMATION OF TEST MEMBERS’

Thus, strength condition is considered to be provided if the reinforcing force caused by environmental loads does not exceed the breaking stress the element can bear.

\[ N_{c,e} \leq N_{uc,e} \]

Where \( N_{c,e} \) is the stress in a compressed thin-walled element from the intended loads; \( N_{uc,e} \) is the breaking stress, which the compressed thin-walled element can bear (minimal bearing capacity of the thin-walled element cross section).

\[ N_{uc,e} = A R_y \varphi_{nt} \]

\( N_{uc,e} \) is a breaking stress, kN; \( A \) is the cross-sectional area, cm\(^2\); \( R_y \) is design strength of steel that equals the yield point, MPa; \( \varphi_{nt} \) is the empirical constant, that takes into account profile type, \( N_{c,e} \) is stress in the element as a result of statistical calculation, kN.
TESTING COMPLEX B50 (2500mm/50t)
During the tests objects are under the loads which are equal or higher than those in actual conditions. Main advance of carrying out tests at the testing bed is possibility to estimate the object's response to specific conditions (load limits, definite type and load value), all other things constant. This helps to find out latent defects or reserve of structure bearing capacity. Testing bed is usually a rigid frame which the model is bearing on.
THE SCHEME OF STRAIN-GAUGES’ INSTALLATION ALONG THE CROSS-SECTION OF NOTCHED C-SHAPED PROFILE
THE SCHEME OF STRAIN-GAUGES’ INSTALLATION ALONG THE CROSS-SECTION OF NOTCHED C-SHAPED PROFILE
TEST RESULTS – C-shaped notched profile – TC-150-2,0
TEST RESULTS – C-shaped profile – ΠС-150-2,0
TEST RESULTS – C-shaped profile

ПС-150-2,0

ТС-150-2,0
Comparison study of bending curves for the members with cross-sectional height of 150 mm
Load-deformation curves for long members-tests (2.2 m) with thickness = 2.0 mm
TEST RESULTS - Stress diagram

**ТС-150-2,0**

- 20 kN
- 40 kN
- 50 kN

**ПС-150-2,0**

- 20 kN
- 30 kN
- 50 kN
- 62.5 kN
Nastran’s triangle and fore-cornered fracture finite elements of plate type were used to create finite-element model of the whole member. Fine grid at the places of bending was made manually.
Numerical Simulation
PLM Femap 10.1 Nastran

This calculation was carried out to see postbuckling behavior of the member. And its results were almost completely the same as those of experimental investigation.
NUMERICAL SIMULATION PLM Femap 10.1 Nastran
CONCLUSIONS

1. Members in a frame building panel undergo eccentric compression with biaxial eccentricity.
2. The critical factor for them is flexure-torsion global buckling.
3. The yield strength point overrunning is considered bearing capacity exhaustion factor, and the structure undergone this should be considered unusable.
4. Bearing capacity value is influenced by value of eccentricity that increases bimoment, effective area, and some initial imperfections.
5. Factors’ impact on the cold-bent notched C-profile members’ work is suggested to take into account with the help of $\varphi_{nt}$ coefficient.
6. The experimental work proved relevance of theoretical background and conclusions.
7. It is found that notches’ presence in the walls of profile influences the stress-strain behavior of eccentrically compressed members. Profile wall buckling increases as the wall is weaken by notches, as the result eccentricity increases, and cross-sectional stress becomes 20-25 % higher. Difference of received empirical constant was 5 – 7 %. 
THANK YOU