Evaluation of the overstrength factors of timber connections.

Massimo Fragiacomo

Abstract.

The aim of the research is the evaluation of the overstrength factors for a number of timber connections. The overstrength factors are needed when a ductile seismic design is carried out. In that case, capacity design shall be applied, in order to ensure that the ductile mechanisms selected by the designer will take place during the earthquake. Provisions for the overstrength factors are reported in some regulations such as the New Zealand Standards 3603 and the Eurocode 8 for steel and concrete structures. For timber structures, however, no numerical value is provided in the Eurocode 8. The value of two suggested by the NZS cannot be directly applied to the Eurocode since the safety coefficients are different but, most of all, the design values of the connection shear strengths are calculated using a completely different approach (the European Yielding Model in the Eurocode, and other formulas in the NZS).

The research should be carried out according to the following:

1) Evaluation of the overstrength factors from experimental tests performed on single connectors or connections with few fasteners under pure shear.
2) Evaluation of the overstrength factors from experimental tests and numerical modelling of connections subjected to bending moment.
3) Evaluation of the overstrength factors from experimental tests and numerical modelling of timber members such as ply shear walls subjected to shear.

Outline of Phase 1.

Phase 1 may be carried out right now using the experimental outcomes of the several tests performed across Europe. A literature survey would be needed to find out all the experimental results available to date.

Then, for each type of fastener, the procedure detailed in the following should be used:

1) The experimental failure ($F_{v,u,i,exp}$, $v_{u,i}$) of each specimen i should be defined in accordance with EN26891 (either the maximum load, or the load corresponding to a maximum slip of 15 mm, whichever occurs first).

2) The yielding ($F_{v,y,i,exp}$, $v_{y,i}$) of each specimen i should be defined in accordance with EN12512 for cyclic tests.

3) The statistical values of the ultimate ($F_{v,u,0.05,exp}$, $F_{v,u,m,exp}$, $F_{v,u,0.95,exp}$) and yielding loads ($F_{v,y,0.05,exp}$, $F_{v,y,m,exp}$, $F_{v,y,0.95,exp}$) should be estimated, as well as for the ultimate (v_u) and yielding (v_y) slips.

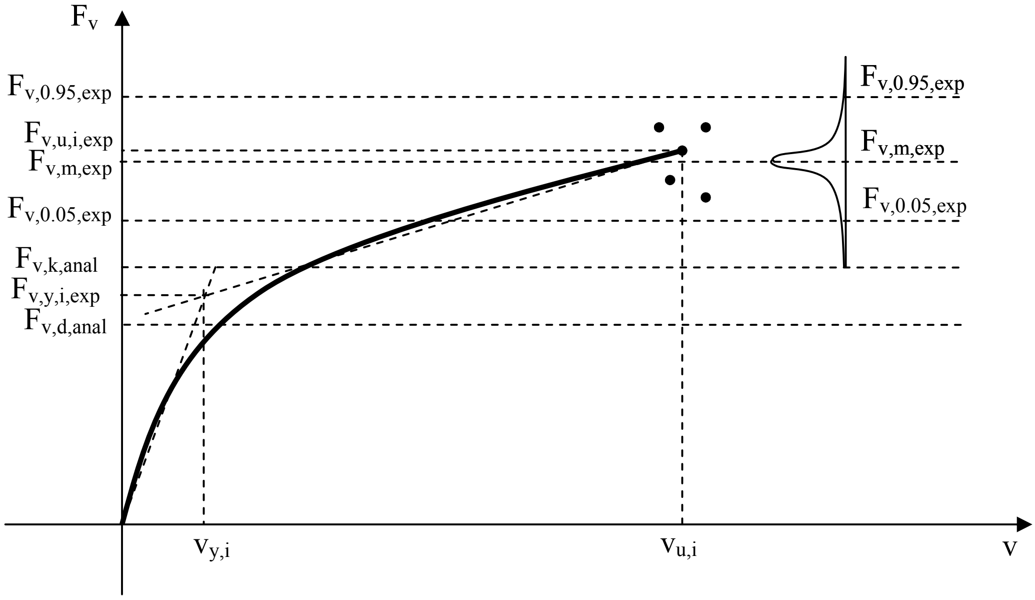
4) The analytical values of the characteristic ultimate shear load ($F_{v,k,anal}$) should be calculated using the Johanssen's equations, with the embedding strengths $f_{h,k}$ and yielding moment $M_{y,k}$ of the fasteners calculated using the analytical relationships proposed by the Eurocode 5, NOT the experimental values.

5) The analytical values of the design shear load ($F_{v,d,anal}$) can be calculated assuming k_{mod}=1 and γ_m=1 as for ductile design, the material safety coefficient is assumed equal to 1 (therefore, $F_{v,d,anal} = F_{v,k,anal}$).

6) The ductility ratio can be obtained with the formula: $\mu = \dfrac{v_u}{v_y}$

7) The statistical values of μ ($\mu_{0.05}$, μ_m, $\mu_{0.95}$) can then be obtained.

8) The overstrength factor can be obtained with the formula: $\gamma_{Rd} = \dfrac{F_{v,0.95,\exp}}{F_{v,0.05,\exp}} \cdot \dfrac{F_{v,k,\exp}}{F_{v,k,anal}} \cdot \dfrac{F_{v,k,anal}}{F_{v,d,anal}} = \gamma_{R,stat} \cdot \gamma_{R,anal} \cdot \gamma_m$ (γ_m=1 for ductile seismic design).



Following phases (2 and 3).

In order to undertake the following phases, a numerical algorithm is needed to extend the experimental results obtained on the single fastener to the entire connection or member.

Possible outcomes of the research.

The research will provide a missing information, the overstrength factor for timber connections, to the Eurocode 8 – Timber part.