FEM Racking and Shelving Product Group

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ERF Guide 09 European Racking Federation (ERF) **English Version** **March 2017**	**Information Bulletin No. 9** **Revisions to FEM 10.2.09** **Design of Cantilever Racking**

Revisions to FEM 10.2.09 - Design of Cantilever Racking

Minor revisions have been made to FEM 10.2.09 - Design of Cantilever Racking. These include revisions to
Serviceability loads for external racking and revisions to formulae F1, F3 and F4 have been made as highlighted on the following pages.

FEM RACKING AND SHELVING PRODUCT GROUP
(European Racking Federation)

The Design of Cantilever Racking

June 2015

Revised March 2017

This FEM document has been prepared by Working Group 2 (WG2) of Product Group Racking and Shelving of FEM and deals with the requirements of the design of Static Cantilever Racking. A clear understanding of these aspects is required for the provision of safe storage design as a compliment to the safe working conditions of the product.

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5.2 Methods of design

5.2.1 General

The design of the structure or its parts shall be carried out by one of the methods given in this document. In all cases the details of the members and connections shall be in accordance with the assumptions made in the design.

5.2.2 Ultimate limit state

The ultimate limit state corresponds to the maximum load carrying capacity and shall be generally characterised by one of the following:-

— Strength, (including widespread yielding, rupture, buckling and transformation into a mechanism)

— Stability against overturning and sway

— Excessive local deformation

— Fracture due to fatigue. Cantilever rack structures by the nature of their operation are generally not subject to fatigue

5.2.3 Serviceability limit state

The verification of the serviceability limit state ensures the proper functioning of the elements under service conditions. It shall be sufficient simply to consider deflections or other deformations which affect the appearance or effective use of the structure.

Serviceability limits for external racking, including wind loads, shall be acceptable for wind velocities of 70% of the values stated in national rules relating to the design loads for buildings.

Serviceability limits are due to live loading and should be considered in addition to the installation tolerances.

The deformations shall be calculated making due allowance for all the elements of the system, see Section 9.

5.3 Imperfections

5.3.1 General

The influence of imperfections shall be considered in the analysis by taking due account of:

— column imperfections;

— bracing system imperfections;

— member imperfections.

Member imperfections may be neglected in modelling structures for global analysis, however, they shall be included for member checks.

5.3.2 Imperfections in cross-aisle direction

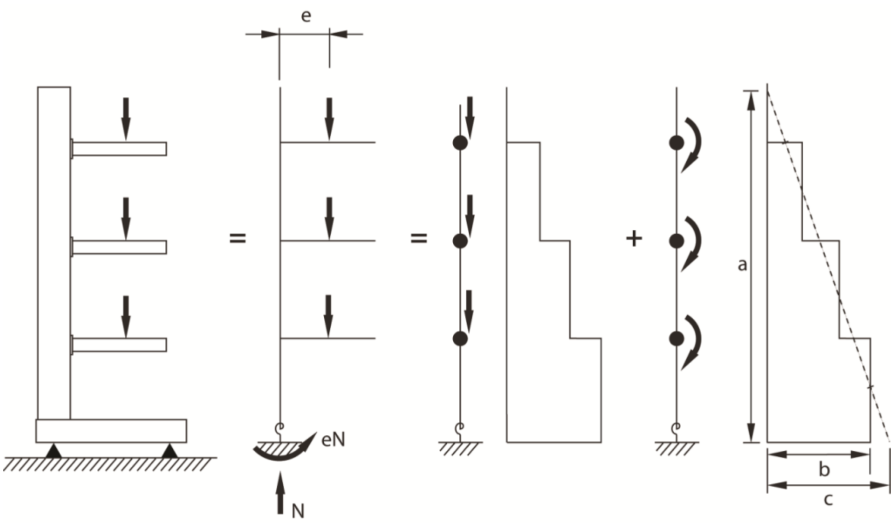
The effects of column imperfections shall be considered in global analysis either by means of an initial sway imperfection or by a closed system of equivalent horizontal forces.

NOTE:- More sophisticated modelling of the global imperfection than an initial sway imperfection or a closed system of equivalent horizontal forces may be carried out, however, care needs to be taken in the generation of the model to reflect the practical application.

F.2 Design for Lateral Torsional Buckling of columns of cantilever racking in the cross-aisle direction - Hot rolled I-sections

F.2.1 General static scheme

For the one side loaded case the cantilever column is loaded in compression and bending. Figure F3 shows the equivalent bending moment distribution.



Key

a Equivalent column length L_{LFTB} for the lateral-flexural buckling check

b Actual bending moment at floor level, e N

c Equivalent bending moment at floor level, M_{LFTB}

Figure F3. - Static scheme of the one side loaded cantilever column

F.2.2 Determination of $M_{TFB;crit}$ for hot rolled I sections

For a hot rolled I section cantilever beam loaded by a concentrated force at the end of the beam, acting at the centre of gravity of the cross section and without any rotational restraint over the beam length, the elastic critical moment $M_{TFB;crit;el}$ is:-

$$M_{TFB;crit;el} = \gamma_2 \sqrt{\left(\frac{EI_z GI_T}{L^2}\right)} \quad \text{(F1)}$$

$M_{TFB;crit}$ can be determined by substituting (0.66E) / [(Lh) / (bt_f)] by ($M_{TFB;crit;el}$) / (W_{el}) .

where:

$L = L_{TFB}$

I_z = moment of inertia with regard to the weak axis of the I-section

$C = G\, I_T$

$C_1 = EC_w$

I_T = Saint Venant torsional rigidity

I_w = Warping constant

γ_2 to be determined from Table F.1.

$M_{TFB;crit}$ can be determined from the literature or from below.

If: $\frac{Lh}{bt_f} \leq 250$

$$\sigma_{TFB;crit} \leq f_y \qquad (F2)$$

(no load reduction due to torsional-flexural buckling)

If: $250 \leq \frac{Lh}{bt_f} \leq \frac{0,66E}{0.7f_y}$:

$$\sigma_{TFB;crit} = f_y - \{[(Lh)/(bt_f) - 250]/[\{(0.66E)/(0.7 f_y)\} - 250]\} 0.3 f_y \qquad (F3)$$

If: $\frac{Lh}{bt_f} \geq \frac{0.66E}{0.7f_y}$

$$\sigma_{TFB;cril} = (0.66E)/[(Lh)(bt_f)] \qquad (F4)$$

$M_{TFB;crit} = \sigma_{TFB;crit}\ W_{el}$

where:

L is the distance between 2 adjacent adequate torsional restraints
h is the height if the I-section
b is the width of the flanges of the I-section
t_f is the thickness of a flange of the I-section

$\sigma_{TFB;crit}$ is the critical bending stress at which torsional-flexural buckling will develop
W_{el} is the elastic section modulus of the I-section, with regard to the strong axis
The relationships given above are shown in figure F.7