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Interaction between patch loading, bending moment, and shear stress in steel girders

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Introduction

- Buckling problem arise most of the time in thin wallet plate such as web of steel girders.
- The web panel of steel girders during the incremental lauching are subjected to combined patch loading, bending and shear forces which act altogether.

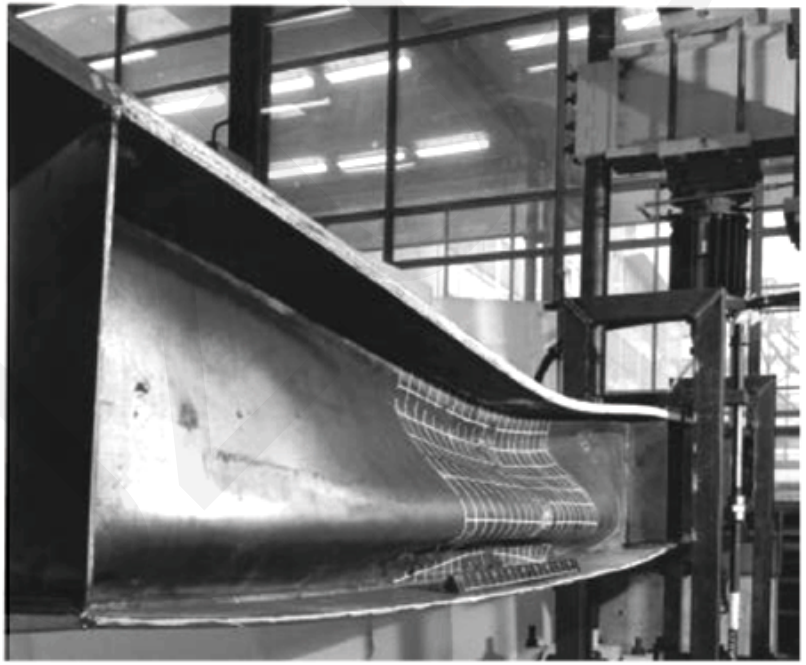


Fig. 1: Buckling of the steel veb

Parametric studies

During the parametric studies, the following variables have been considered:

- The patch loading F_y and the patch loading length l_0
- The panel aspect ratio a/b.
- The slenderness of the plate $\lambda=b/t$.
- The corresponding bending force F_x and the shear action V_y.

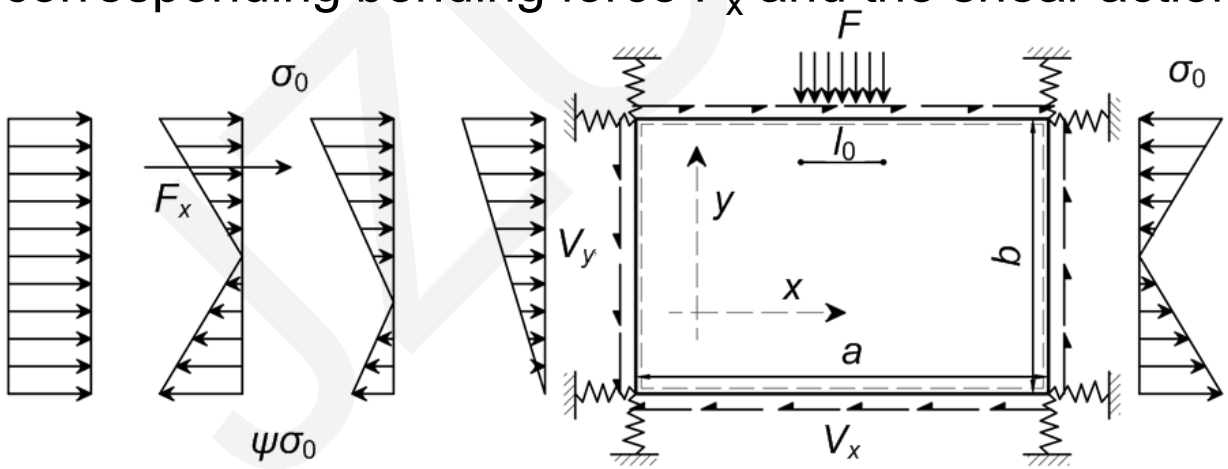


Fig. 2. Plate subjected to combined patch loading, bending and shear

Parametric studies

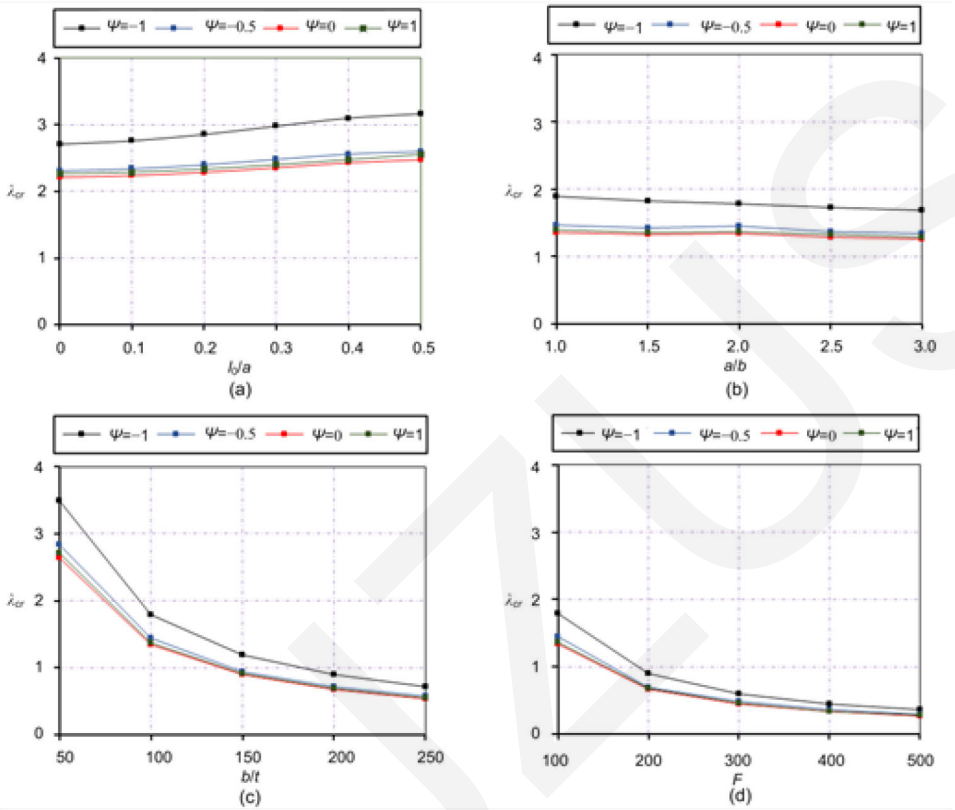


Fig. 3. Variation of the critical buckling load factor for steel plate section subjected to combined patch loading bending and shear force F=100 kN; F_x=4F; V_y=F_x

when the bending stress acting on the steel plate with a stress ratio ψ=0, we observed a rapid decrease of critical buckling coefficient..

Several analyses showed that the critical buckling load of a plate subjected to combined in-plane loadings will increase with the patch loading length.

Parametric studies

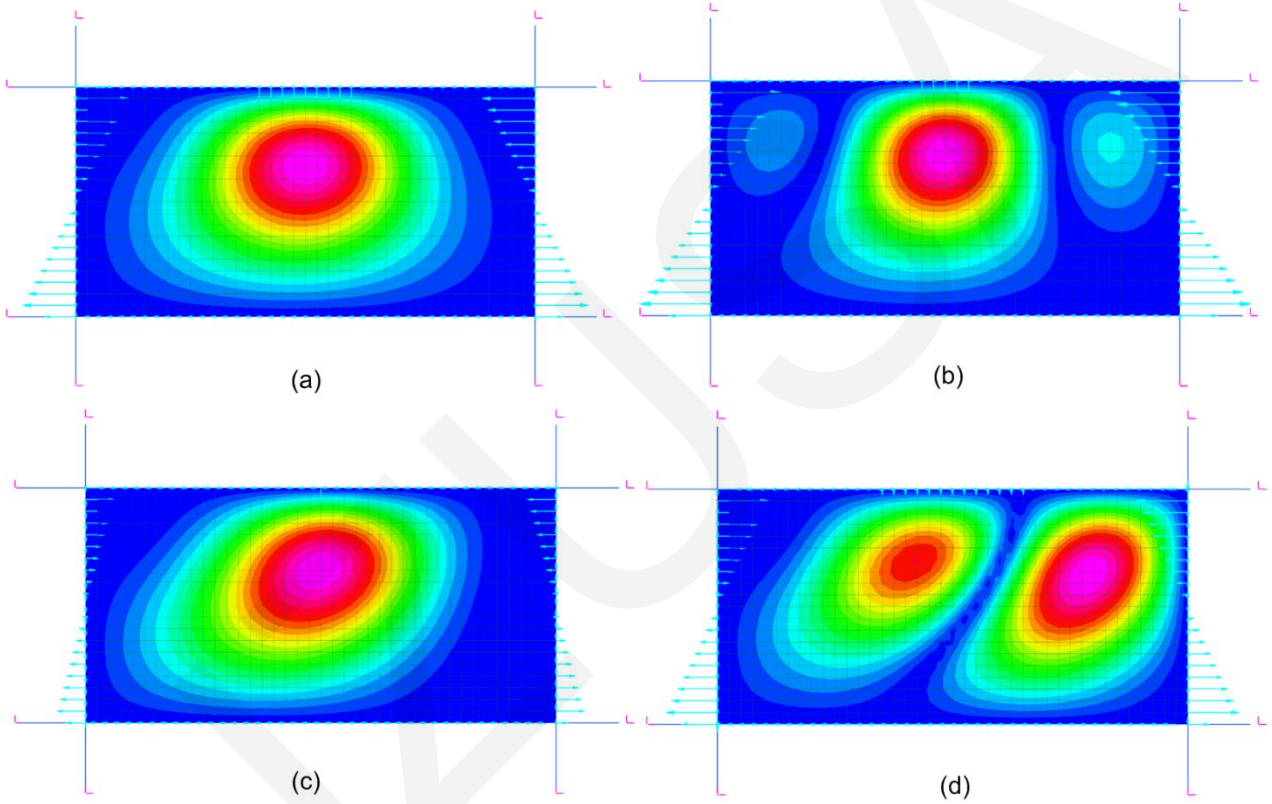
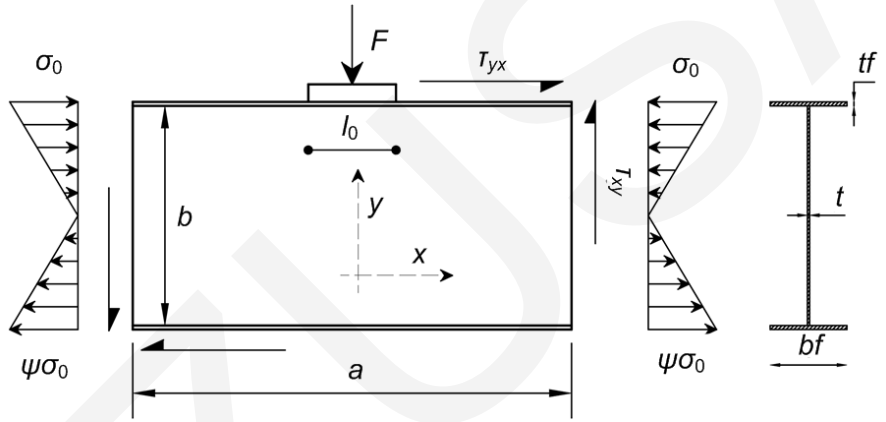


Fig. 4. Influence of slenderness in the critical buckling load
(a) *b*/*t*=150; (b) *b*/*t*=200; (c) *b*/*t*=250

Design example

a (mm)	t (mm)	b (mm)	t_f (mm)	b_f (mm)	λ	α
2200	14	1500	18	500	107.1	1.466



F (kN)	F_x (kN)	V_x (kN)	V_y (kN)	ψ	A	B
300	900	360	720	-1	3	0.4

$F_{cr,F}^{AN}$ (kN)	$F_{cr,M+F+V}^{AN}$ (kN)	$F_{cr,M+F+V}^{FEM}$ (kN)
899.9	489,5	480,6

Conclusions

- The buckling deformation observed in the interaction of in-plane combined loadings depends on the amplitude of each load and is similar to either the buckling shape of steel plates under a single load or the combined deformation.
- The slenderness is the most influential parameter of the plate stability;
- The panel aspect ratio showed a slight influence with respect to the shear and bending actions;