User Manual

C. COLD FORMED CROSS - SECTIONS

cold formed steel

CONTENTS

## 1. METALLIC ELEMENTS OF COLD SPRING

Cold-rolled elements are a group of metallic elements with the main characteristic of the production process as well as the small thickness. These characteristics dictate a number of differences from the process of analysis and dimensioning of hot-rolled metallic elements known to us so far. Numerous cross-sections can be found on the market, however the use of cold rolled members is generally limited due to the feeling that they are auxiliary elements. However, the reality is different as, in addition to tesserae/slugs, they may well be used as main load-bearing members. Due to the impossibility of lamination they are designed for practically elastic behaviour with corresponding seismic behaviour coefficients.

In this version of SCADA PRO the cold rolled cross sections:

- They are a different module from the other metallic sections
- Can be used for all structural members (not just purlins/bevels)
- Controlled under EC3-1-3

2. AVAILABLE CROSS-SECTIONS

The cross-sections that can be used are of type C, S, Z and H (see picture).

Cross section C   Cross section S   Cross section Z   Cross section H
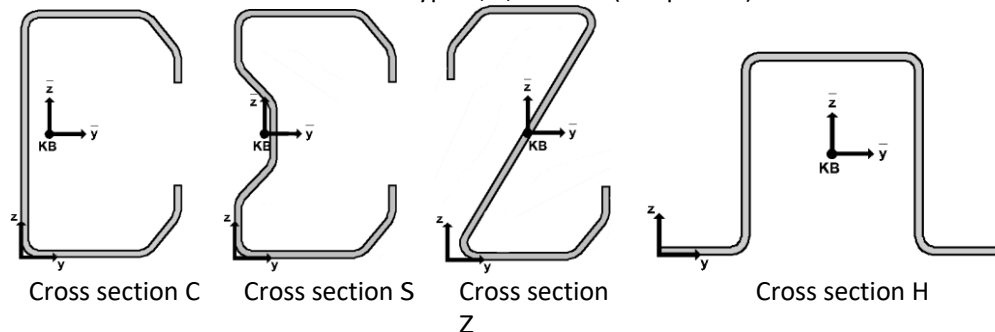
The sections can be either unreinforced or have single or double end reinforcements (see picture below). The bending angle of the reinforcements and the cross-sectional beam Z is also parametrically defined.
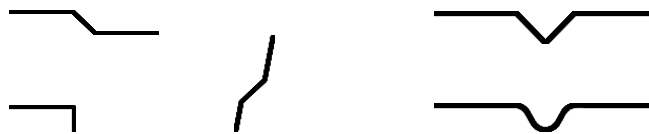
Note that this parametric property is not a user attribute but a feature of the code in the program. The user can only place **ready-made profiles** defined by the manufacturer (and us) and **cannot modify them.**

The library includes sections of Greek and foreign companies. More specifically:

Greek Companies	Foreign Companies
ELASTRON	METSEC
CAMARIDES	SADEF
ARKHON	BOUWEN MET STAAL
	RUUKKI

3. GEOMETRIC PROPORTIONS

The provisions for design based EC3-1-3 calculations apply only to section width - thickness ratios b/t, h/t, c/t and d/t within the limits of the following Table.

The limits for the reasons given are considered to represent the field for which there is sufficient experience and verification by experimental results. Cross-sections with larger width-to-thickness ratios may also be used, provided that their strength at failure limit state and their behaviour in the serviceability limit state are verified by experiments and/or calculations, confirmed by an appropriate number of experiments.
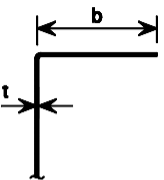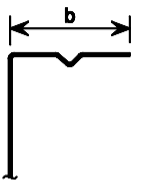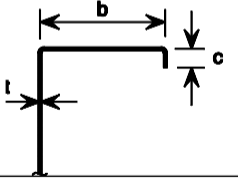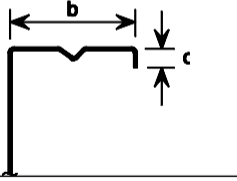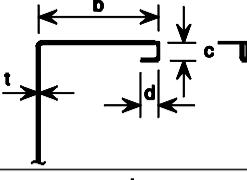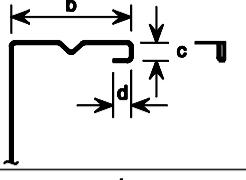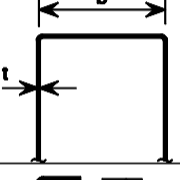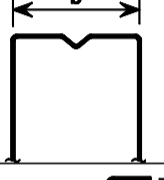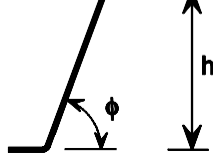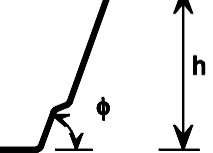
The dimensions of the reinforcements shall be within the following limits so as provide adequate stiffness and to avoid buckling of the reinforcement itself.

$$0.2 \leq c / b \leq 0.6$$
$$0.1 \leq d / b \leq 0.3$$

If c / b< 0,2 or d / b< 0,1 the edge is ignored and set c= 0 or d= 0.

NOTE: According to EC3-1-3 the length of the rim c is measured perpendicular to the tread in the case where the rim is not perpendicular to the tread. However, in SCADA PRO the angled length is taken into account, not the projection

Cross-section data	Maximum
	price
	b / t≤ 60 c / t≤ 50
	b / t≤ 90 c / t≤ 60 d / t≤ 50
	b / t≤ 500
	45 °≤f≤ 90° h / t≤ 500 sinφ

4. MODELING

The insertion of the elements is carried out in a similar way to that of hot rolled elements. For both beams and columns, the cross-sections have been placed in a new category called 'Cold rolled'.
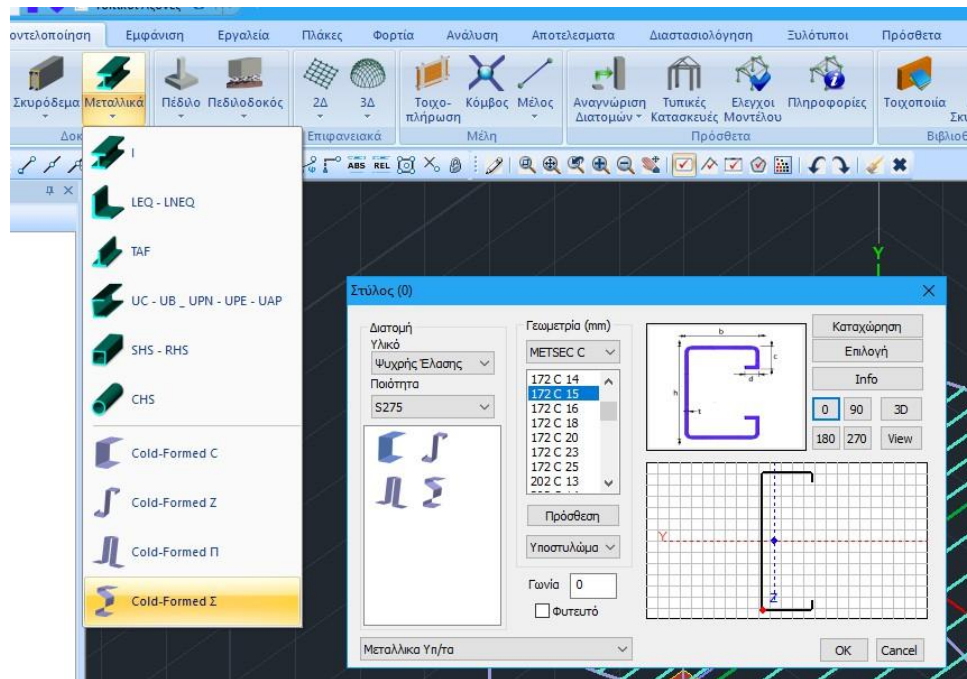
In the window that appears we select:
- **Type of cross-section**
- **Company**
- **Cross section**
- **Material**
- **Quality**

5. ANALYSIS

According to EC3-1-3 for the analysis the properties of the cross-sections must be modified, taking into account the influence of rounded corners.

In SCADA Pro the properties of the original cross-section are used without modifying the inertial characteristics. The transformation to ideal with sharp corners as well as the influence of rounded corners is only considered in the dimensioning.

6. DIMENSIONING

The sizing of cold-rolled components involves:
- **Strength check at section level**
- **Strength check at member level**
- **Functionality check**

The main difference with hot-rolled elements is that now the checks at section and member level are carried out with a **common command** and not separately. Another important feature is that all members and their cross-sections are checked for **all combinations**.
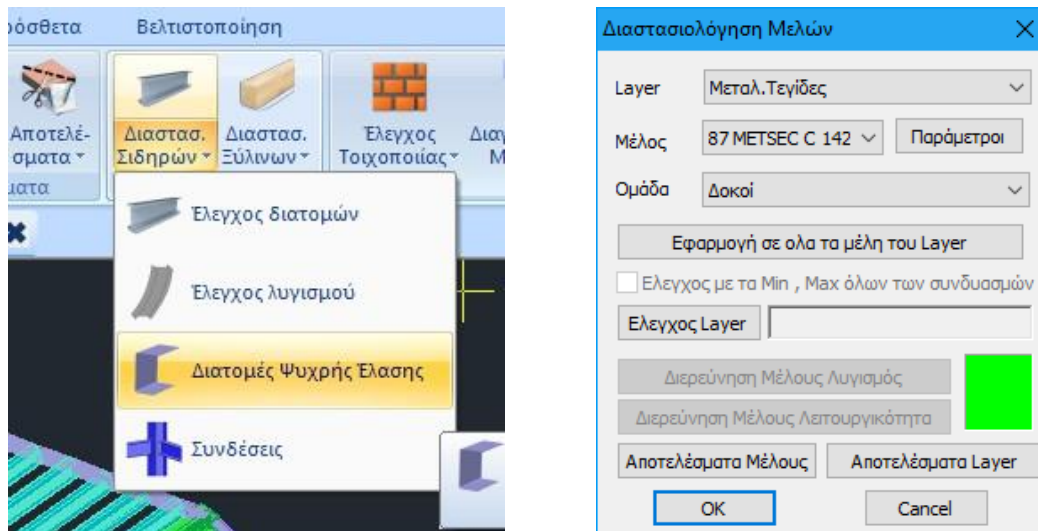
Otherwise, the sizing steps are the same as for hot rolled elements (per layer, member consolidation, bending parameters, etc.).

7. DIMENSIONING DOCUMENT

The results of the sizing are displayed either per member or per layer. In the second and more general case the structure of the issue is as follows:

1. **Page 1: General cross-section data 1**
   Dimensional and property information of the original and ideal cross-section
2. **Page 2: Active cross-section of cross-section 1 (Part A)**
   Active cross-sectional dimension information of N, My and Mz ratios
3. **Page 3: Active cross-section of cross-section 1 (Part B)**
   Active cross-section properties information of N, My and Mz ratios
4. **Page 4: Cross-section level check for the 1th member with cross-section 1**
   Endurance tests according to §6.1
5. **Page 5: Member level check for the 1th member with cross-section 1**
   Durability checks according to §6.2 & 6.3 and functionality check §7
6. **Repeat steps 4 & 5 :** In case of several members of the same cross-section within the layer.
7. **Repeat steps 1 to 6:** In case of several cross-sections within the layer.

The issue per layer can also be extracted when creating the **Study Sheet.**
Typical format of the issue is given below.

Σελίδα : 3

ΔΙΑΤΟΜΕΣ ΨΥΧΡΗΣ ΕΛΑΣΗΣ - ΕΝΕΡΓΗ ΔΙΑΤΟΜΗ

1 ΕΝΕΡΓΟΣ N	2 ΕΝΕΡΓΟΣ My (+)	3 ΕΝΕΡΓΟΣ My (-)

4 ΕΝΕΡΓΟΣ Mz (+)	5 ΕΝΕΡΓΟΣ Mz (-)

ΙΔΙΟΤΗΤΕΣ	N	My (+)	My (-)	Mz (+)	Mz (-)
A_{eff} (cm²)	3.51	4.79	4.79	4.79	3.89
y_{eff} $_c$ (cm)	1.80	1.54	1.54	1.52	2.08
z_{eff} $_c$ (cm)	6.93	7.14	6.72	6.93	6.93
I_{eff} $_y$ (cm⁴)	-	147.31	147.31	147.62	151.44
I_{eff} $_z$ (cm⁴)	-	20.09	20.09	19.62	18.07
W_{eff} $_{y,c}$ (cm³)	-	20.62	20.62	21.30	21.85
W_{eff} $_{y,t}$ (cm³)	-	4.88	4.88	4.74	8.71
W_{eff} $_{z,c}$ (cm³)	-	21.92	21.92	21.30	21.85
W_{eff} $_{z,t}$ (cm³)	-	4.88	4.88	12.89	5.04
W_{pl} $_{y,T}$ (cm³)	-	15.69	15.69	8.65	7.12
W_{pl} $_{z,T}$ (cm³)	-	3.89	3.89	0.00	0.00
W_{el} $_{y,M}$ (cm³)	-	24.59	24.59	21.99	21.25
W_{el} $_{z,M}$ (cm³)	-	9.32	9.31	7.26	5.95

¨ Η ροπή αντίστασης W_{eff} $_r$ σύμφωνα με ΕΝ 1993-1-5 υπολογίζεται για την διατομή αποτελούμενη μόνο από ενεργά πέλματα.

¨¨ Η πλαστική ροπή αντίστασης W_{pl} $_{T}$ σύμφωνα με ΕΝ 1993-1-5 υπολογίζεται για την διατομή αποτελούμενη από τα ενεργά πέλματα και τον πλήρη κορμό.

Σελίδα : 4

ΔΙΑΣΤΑΣΙΟΛΟΓΗΣΗ ΣΤΟΙΧΕΙΩΝ ΨΥΧΡΗΣ ΕΛΑΣΗΣ
ΕΛΕΓΧΟΣ ΔΙΑΤΟΜΩΝ (ΕΝ 1993-1-3)

Μέλος	61	Κόμβος i	31	Κόμβος j	36
		Αρχικό Μήκος L	300.00	cm	

ΔΕΔΟΜΕΝΑ ΕΝΟΠΟΙΗΣΗΣ		
ΕνοποίησηL_{yy}		cm
ΕνοποίησηL_{zz}		cm

Άκρο	Rigid Offsets			Ελευθερίες μελών					
	dX (cm)	dY (cm)	dZ (cm)	N	V_y	V_z	M_t	M_y	M_z
i	0.00	0.00	0.00						
j	0.00	0.00	0.00						

ΕΛΕΓΧΟΣ ΣΕ ΑΞΟΝΙΚΗ

ΕΦΕΛΚΥΣΜΟΣ (§ 6.1.2)		ΘΛΙΨΗ (§ 6.1.3)	
Συνδ.	94	Συνδ.	222
N_{Ed} (kN)	0.61	N_{Ed} (kN)	-0.75
A_g (cm²)	4.94	A_{eff} (cm²)	3.51
$F_{n,Rd}$ (kN)	-	$\lambda_{e,max}/\lambda_{e0}$	2.18
$N_{t,Rd}$ (kN)	149.93	$N_{c,Rd}$ (kN)	96.57
$N_{Ed}/N_{t,Rd}$	0.00	$N_{Ed}/N_{c,Rd}$	0.01
ΕΠΑΡΚΕΙΑ	Ναι	ΕΠΑΡΚΕΙΑ	Ναι

ΕΛΕΓΧΟΣ ΣΕ ΚΑΜΨΗ (§ 6.1.4)

	y-y	z-z
Συνδ.	230	298
M_{Ed} (kN)	-1.45	-0.33
W_{eff} (cm³)	20.62	5.04
M_{Rd} (kNm)	5.67	1.39
Πέλμα	Θλιβόμενο	Εφελκυόμενο
M_{Ed}/M_{Rd}	0.26	0.24
ΕΠΑΡΚΕΙΑ	Ναι	Ναι

ΕΛΕΓΧΟΣ ΣΕ ΣΤΡΕΨΗ (§ 6.1.6)

	Ορθές	Διατμητικές	Von Mises
Συνδ.	94	298	298
Δράση (MPa)	172.62	13.03	184.85
Αντοχή (MPa)	303.46	175.20	333.81
Δράση / Αντοχή	0.57	0.07	0.55
ΕΠΑΡΚΕΙΑ	Ναι	Ναι	Ναι

Πρέπει να ισχύει:
$\sigma_{tot,Ed} = \sigma_{N,Ed} + \sigma_{My,Ed} + \sigma_{Mz,Ed} + \sigma_{w,Ed} \leq f_{ya} / \gamma_{M0}$
$\tau_{tot,Ed} = \tau_{Vy,Ed} + \tau_{Vz,Ed} + \tau_{t,Ed} + \tau_{w,Ed} \leq (f_{ya}/\sqrt{3}) / \gamma_{M0}$
$\sqrt{(\sigma_{tot,Ed}^2 + 3\tau_{tot,Ed}^2)} \leq 1.1 f_{ya} / \gamma_{M0}$

ΕΛΕΓΧΟΣ ΣΕ ΔΙΑΤΜΗΣΗ (§ 6.1.5)

	y-y	z-z
Συνδ.	298	230
V_{Ed} (kN)	0.66	2.45
Ενίσχυση	ΟΧΙ	ΟΧΙ
Πλήθος Κορμών	2.00	1.00
$V_{b,Rd}$ (kN)	32.51	34.16
$V_{Ed}/V_{b,Rd}$	0.02	0.07
ΕΠΑΡΚΕΙΑ	Ναι	Ναι

ΕΛΕΓΧΟΣ ΣΕ ΕΦΕΛΚΥΣΜΟ & ΚΑΜΨΗ (§ 6.1.8)

ΑΞΟΝΙΚΗ N (kN)		ΡΟΠΗ My (kNm)		ΡΟΠΗ Mz (kNm)		Συνδυασμός
N_{Ed}	0.61	$M_{y,Ed}$	1.33	$M_{z,Ed}$	0.30	94
$N_{t,Rd}$	149.93	$M_{y,Rd}$	5.67	$M_{z,Rd}$	1.30	ΕΠΑΡΚΕΙΑ
Εξίσωση Κριτηρίου Αλληλεπίδρασης		...(6.24)			Τιμή	0.47	Ναι

ΕΛΕΓΧΟΣ ΣΕ ΘΛΙΨΗ & ΚΑΜΨΗ (§ 6.1.9)

ΑΞΟΝΙΚΗ N (kN)		ΡΟΠΗ My (kNm)		ΡΟΠΗ Mz (kNm)		Συνδυασμός
N_{Ed}	-0.49	$M_{y,Ed}$	-1.45	$M_{z,Ed}$	-0.32	230
		$\Delta M_{y,Ed}$	-0.08	$\Delta M_{z,Ed}$	-0.00	
$N_{c,Rd}$	96.57	$M_{y,Rd}$	6.03	$M_{z,Rd}$	1.39	ΕΠΑΡΚΕΙΑ
Εξίσωση Κριτηρίου Αλληλεπίδρασης		...(6.26)			Τιμή	0.49	Ναι

ΕΛΕΓΧΟΣ ΣΕ ΔΙΑΤΜΗΣΗ, ΑΞΟΝΙΚΗ & ΚΑΜΨΗ (§ 6.1.10)

ΤΕΜΝΟΥΣΑ Vz (kN)		ΑΞΟΝΙΚΗ N (kN)		ΡΟΠΗ My (kNm)				Συνδυασμός
$V_{z,Ed}$	0.07	N_{Ed}	-0.07	$M_{y,Ed}$	-0.04	$W_{f,Rd}$	15.69	772
$V_{w,Rd}$	34.16	N_{Rd}	96.57	$M_{y,Rd}$	5.67	$W_{pl,Rd}$	24.59	ΕΠΑΡΚΕΙΑ
Εξίσωση Κριτηρίου Αλληλεπίδρασης						Τιμή	0.00	Ναι

ΤΕΜΝΟΥΣΑ Vy (kN)		ΑΞΟΝΙΚΗ N (kN)		ΡΟΠΗ Mz (kNm)				Συνδυασμός
$V_{y,Ed}$	0.02	N_{Ed}	-0.07	$M_{z,Ed}$	-0.01	$W_{f,Rd}$	0.00	772
$V_{w,Rd}$	32.51	N_{Rd}	96.57	$M_{z,Rd}$	1.39	$W_{pl,Rd}$	5.95	ΕΠΑΡΚΕΙΑ
Εξίσωση Κριτηρίου Αλληλεπίδρασης						Τιμή	0.00	Ναι