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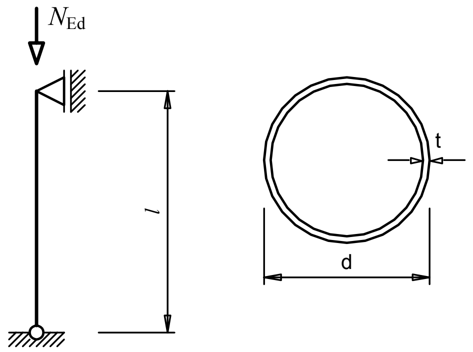
CALCULATION SHEET

Job No.	OSM 466	Sheet	1 of 2	Rev	B
Job Title	ECSC Stainless Steel Valorisation Project				
Subject	Design Example 1 – CHS column				
Client	ECSC	Made by	HS	Date	Jul 2002
		Checked by	AB/IR	Date	Oct 2002
		Revised by	JBL	Date	March 2006

DESIGN EXAMPLE 1 – CHS COLUMN

The circular hollow section column to be designed is an interior column of a multi-storey building. The column is simply supported at its ends. The inter-storey height is 3,50 m.



Structure

Simply supported column, length between supports:

$l = 3{,}50$ m

Actions

Permanent and variable actions result into a vertical design compression force equal to:

$N_{Ed} = 250$ kN

Cross-section properties

Try a 159 × 4 CHS, grade 1.4401

Geometric properties

$d = 159$ mm	$t = 4$ mm
$A = 19{,}5$ cm²	$I = 585{,}3$ cm^4
$W_{el} = 73{,}6$ cm^3	$W_{pl} = 96{,}1$ cm^3

Material properties

0,2% proof stress = 220 N/mm^2. Take f_y = 220 N/mm^2. — Table 3.1

E = 200 000 N/mm^2 and G = 76 900 N/mm^2 — Section 3.2.4

Classification of the cross-section

$\varepsilon = 1{,}01$ — Table 4.2

Section in compression : $\frac{d}{t} = \frac{159}{4} = 39{,}8$

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For Class 1, $\frac{d}{t} \leq 50\varepsilon^2$, therefore the section is Class 1

Compression resistance of the cross-section — Section 4.7.3

For a Class 1 cross-section

$$N_{c,Rd} = A_g f_y / \gamma_{M0}$$ Eq. 4.25

$$N_{c,Rd} = \frac{19,5 \times 220 \times 10^{-1}}{1,1} = 390 \text{ kN}$$

Resistance to flexural buckling — Section 5.3.3

$$N_{b,Rd} = \chi A f_y / \gamma_{M1}$$ Eq. 5.2a

$$\varphi = 0,5\left(1 + \alpha(\bar{\lambda} - \bar{\lambda}_0) + \bar{\lambda}^2\right)$$ Eq. 5.4

$$\chi = \frac{1}{\varphi + \left[\varphi^2 - \bar{\lambda}^2\right]^{0,5}} \leq 1$$ Eq. 5.3

$$\bar{\lambda} = \sqrt{\frac{A f_y}{N_{cr}}}$$ Eq. 5.5a

Determine the elastic critical buckling load:

$$N_{cr} = \frac{\pi^2 EI}{L_{cr}^2} = \frac{\pi^2 \times 200000 \times 585,3 \times 10^4}{\left(3,50 \times 10^3\right)^2} \times 10^{-3} = 943,1 \text{ kN}$$

Determine the flexural buckling slenderness:

$$\bar{\lambda} = \sqrt{\frac{19,5 \times 10^2 \times 220}{943,1 \times 10^3}} = 0,67$$

Using an imperfection factor $\alpha = 0,49$ and $\bar{\lambda}_0 = 0,4$ for hollow sections — Table 5.1

$$\varphi = 0,5\left(1 + 0,49(0,67 - 0,4) + 0,67^2\right) = 0,79$$

$$\chi = \frac{1}{0,79 + \left[0,79^2 - 0,67^2\right]^{0,5}} = 0,83$$

$$N_{b,Rd} = 0,83 \times 19,5 \times 220 \times 10^{-1} / 1,1$$
$$= 323,7 \text{ kN}$$

The applied axial load is $N_{Ed} = 250$ kN.

Thus the member has adequate resistance to flexural buckling.