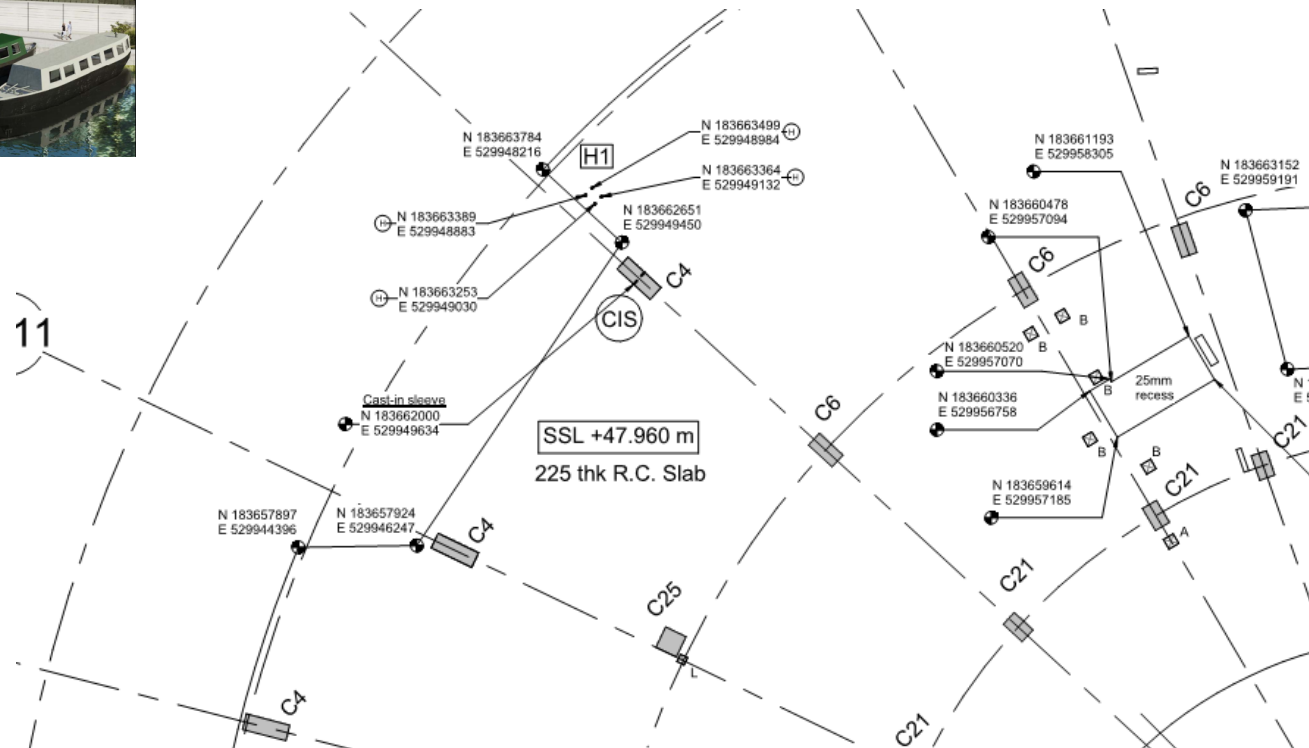# Blade Columns – An EC2 Discussion

ARUP

Eurocode 2 – "Method A"

Method A overview

$$R = 120 \left((R_{\eta fi} + R_a + R_l + R_b + R_n)/120 \right)^{1,8}$$

Load ratio term

Number of rebars term

Rebar cover term

Column length term

Cross section size term

- 2 approaches:
  - Use of Equation 5.7 (developed by Liege based on best-fit correlations with test data)
  - Tabulated data created by using Eq. 7.5 with specific generic assumptions.

Table 5.2a: Minimum column dimensions and axis distances for columns with rectangular or circular section

Standard fire resistance	Minimum dimensions (mm) Column width b_{min}/axis distance a of the main bars			
	Column exposed on more than one side			Exposed on one side
	$\mu_{fi} = 0.2$	$\mu_{fi} = 0.5$	$\mu_{fi} = 0.7$	$\mu_{fi} = 0.7$
1	2	3	4	5
R 30	200/25	200/25	200/32 300/27	155/25
R 60	200/25	200/36 300/31	250/46 350/40	155/25
R 90	200/31 300/25	300/45 400/38	350/53 450/40**	155/25
R 120	250/40 350/35	350/45** 450/40**	350/57** 450/51**	175/35
R 180	350/45**	350/63**	450/70**	230/55
R 240	350/61**	450/75**	-	295/70

**
Minimum 8 bars
[AC1] For prestressed columns the increase of axis distance according to 5.2. (5) should be noted. [AC1]

ARUP

EC2 limitations

- Effective Length: $2m < l_{o,fi} < 6m$

- Axis distance: $25mm < a < 80mm$

- Effective breadth: $250mm < b' < 450mm$

- Height: $h < 1.5b$

**DESIGN OF CONCRETE COLUMNS BASED ON EC2
TABULATED DATA - A CRITICAL REVIEW**

Jean-Marc FRANSSEN
Univ. of Liege, 1, Chemin des Chevreuils, 4000, Liège 1, Belgium
jm.franssen@ulg.ac.be

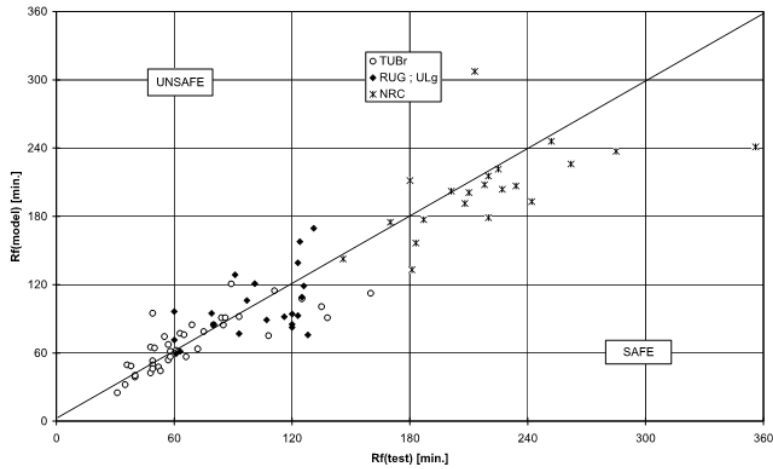|			
Load level	$0.15 \leq \upsilon_{fi} \leq 0,80$	Reinforcement ratio	$0.9\,\% \leq A_s/A_c \leq 4.0\,\%$
Dimensions of the section	$200 \leq b' \leq 450$ mm	Concrete strength	$24 \leq f_{cm} \leq 53$ MPa
	$b_2 \leq 1.5\,b_1$	Eccentricity	$e \leq 15$ cm
Concrete cover	$25 \leq a \leq 80$ mm	Diameter of the bars	$\phi < 25$ mm
Length of the column	$1.50 \leq L \leq 6.00$ m		

ARUP

Results of original study

FIGURE 7 : Comparison between new model and tests
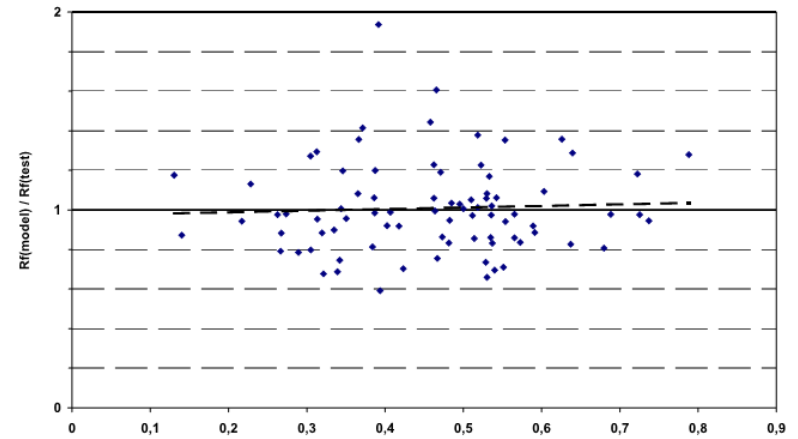
FIGURE 8 : R_f(model) / R_f(test) as a function of υ_{fi}
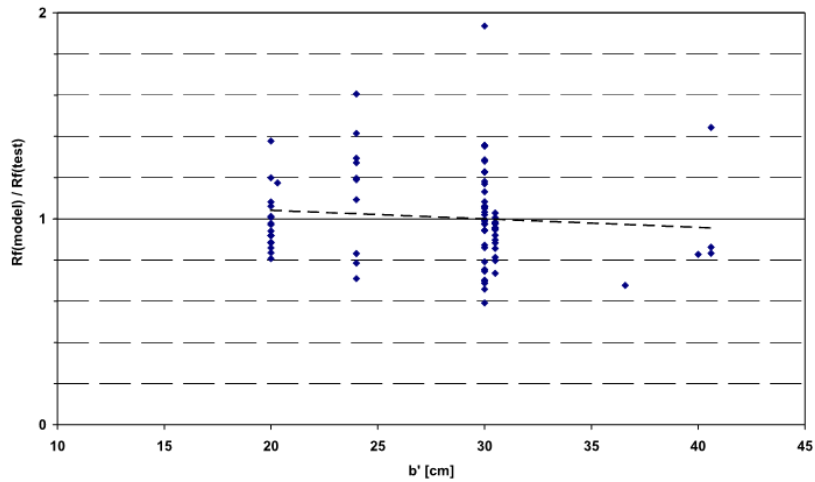
FIGURE 9 : R_f(model) / R_f(test) as a function of b '
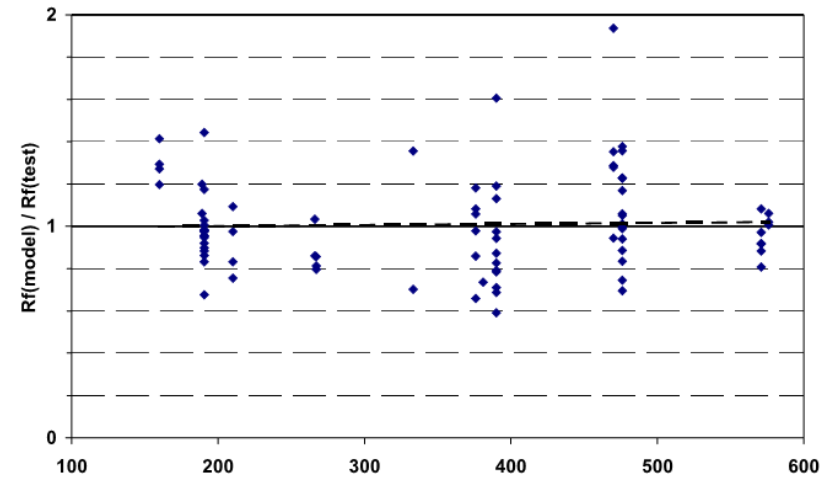
FIGURE 12 : R_f(model) / R_f(test) as a function of L

Excerpts from

ARUP

New Liege Study

Table 1- Cross-sections considered in the study

Aspect ratio h/b	b [mm]	h [mm]	Quant. of bars	Diam. (mm)	As [mm²]	Ac [mm²]	As / Ac	Axis distance [mm]
1	250	250	4	14	615.75	61884	0.0100	35
1.5	250	375	6	14	923.63	92826	0.0100	35
2	250	500	8	14	1231.5	123768	0.0100	35
2.5	250	625	10	14	1539.4	154711	0.0100	35
3	250	750	12	14	1847.3	185653	0.0100	35
3.5	250	875	14	14	2155.1	216595	0.0100	35
4	250	1000	16	14	2463	247537	0.0100	35
5	250	1250	20	14	3078.8	309421	0.0100	35

- Load ratios between 0.085 and 1.046

- Column capacity determined by SAFIR models

- Capacities determined using ambient material partial factors for concrete and steel.

ARUP

New Liege study Results

- Increasing aspect ratio does not significantly affect failure mechanism
- **<u>Large proportion of results in this particular study are unconservative</u>**
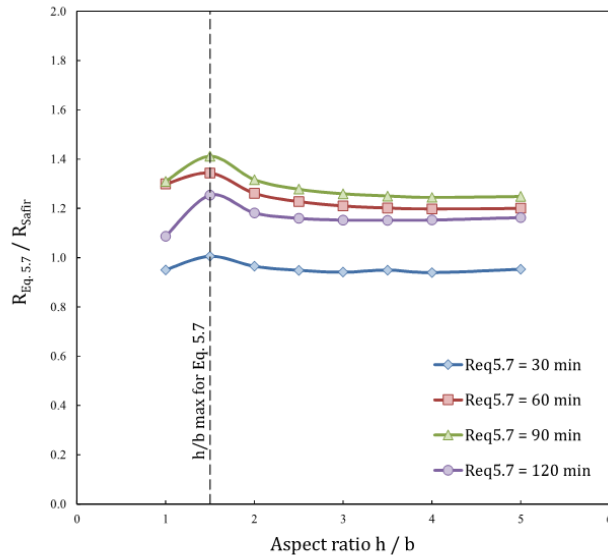 - **<u>(up to 80% difference)</u>**

Figure 3 – Comparison between results obtained with SAFIR© and with Eq. 5.7 for the different aspect ratios – minimum eccentricity applied (e = 8.75mm)
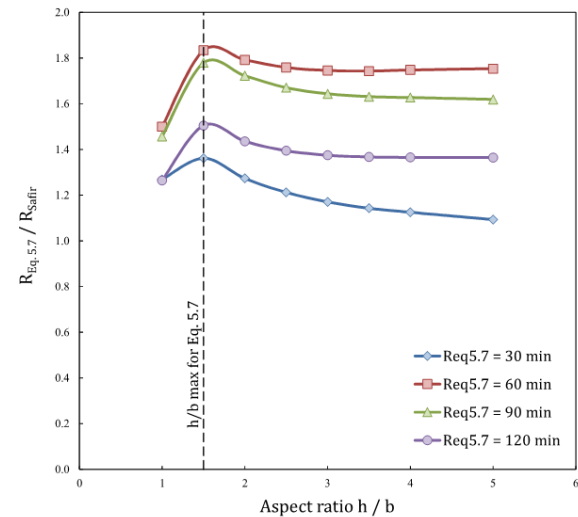

Figure 4 – Comparison between results obtained with SAFIR© and with Eq. 5.7 for the different aspect ratios – maximum eccentricity applied (e = 37.5mm)

ARUP

Conclusions

- Method A can be used for Blade columns
- Method A accuracy in line with other types of construction
- Column tests are particularly difficult to characterise
- Results in large degree of variability
- Need Blade column tests for verification
- How can we get a better column test?

ARUP