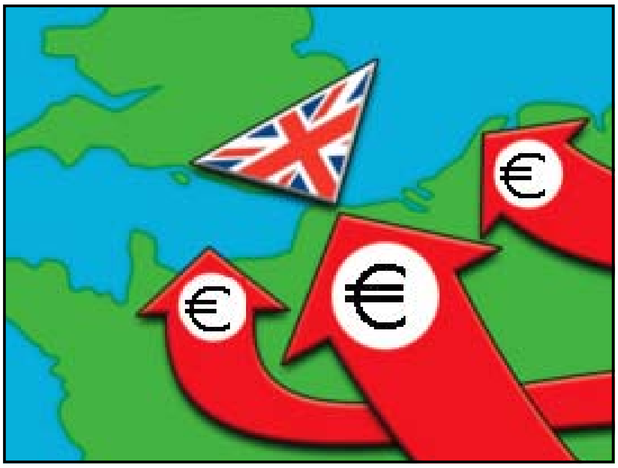
Steel Structures to EC3
What to expect….

David Brown, Deputy Director, SCI



Not a lot of change….

- The steel itself knows no better
- It obeys physics, despite what the code says
- Our existing UK codes are mature

Not a lot of change….

- The steel itself knows no better
- It obeys physics, despite what the code says
- Our existing UK codes are mature
- So don't expect doubling
- Don't expect halving
- Bad details will still be bad

Change was not the driver

- Originally support a central goal of the EU
  - "removal of barriers to trade"
- Not to improve the science
  - Though the opportunity has been taken

When?

- Building Regs. due to change in March 2010
  - Eurocodes will be cited
  - *Perhaps* BS 5950 will not be referenced
- October 2010 implementation?

When?

- When clients request?
- When designing highway structures?
- When changing in one material – change in all?
  - BS 8110 “obsolescent”
- CE Marked products
  - Resistances to the Eurocodes
- For the *advantages*?

What’s needed?

- All the Parts
  - Loading
  - Resistance
- All the National Annexes (UK NA for UK!)

What’s available?

- All the Parts
- All the UK NAs
- … and NCCI

- Could design tomorrow
- A lengthy period of concurrent use with BS 5950.

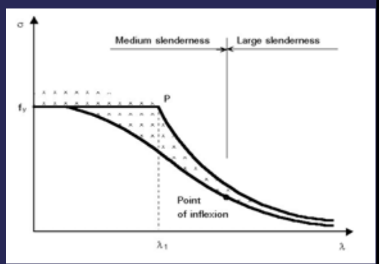
Changes

- Nomenclature and axis
- “permanent” and “variable” action2
- Resistance checks presented by structural phenomena, not by design routine
  - (but there will be guidance)
- Increased transparency of structural phenomena?
- Less look-up tables, more equations
- Greek symbols, and important subscripts

Different symbols

BS5950	EC3	BS5950	EC3	BS5950	EC3
A	A	P	N	p_y	f_y
Z	W_{el}	M_x	M_y	p_b	$\chi_{LT} f_y$
S	W_{pl}	V	V	p_c	χf_y
I_x	I_y	H	I_w	r	i
I_y	I_z	J	I_t		

Nothing fundamental has changed!



Transparent identical phenomena?

6.3.1.2 Buckling curves

(1) For axial compression in members the va[…] should be determined from the relevant buckling […]

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \quad \text{but } \chi \le 1{,}0$$

where $\Phi = 0{,}5\left[1 + \alpha(\bar{\lambda} - 0{,}2) + \bar{\lambda}^2\right]$

$\bar{\lambda} = \sqrt{\frac{A f_y}{N_{cr}}}$ for Class 1, 2 and 3 cross-[…]

$\bar{\lambda} = \sqrt{\frac{A_{eff} f_y}{N_{cr}}}$ for Class 4 cross-sections

α is an imperfection factor

N_{cr} is the elastic critical force for the relevant buckling mode based on the gross cross sectional properties.

Annex C (normative)
Compressive strength

C.1 Strut formula

The compressive strength p_c should be taken as the smaller root of:

$$(p_E - p_c)(p_y - p_c) = \eta p_E p_c$$

from which the value of p_c may be obtained using:

$$p_c = \frac{p_E p_y}{\phi + (\phi^2 - p_E p_y)^{0.5}}$$

in which:

$$\phi = \frac{p_y + (\eta + 1)p_E}{2}$$

$$p_E = (\pi^2 E/\lambda^2)$$

where

p_y is the design strength;

λ is the slenderness, see 4.7.2.

Familiar friends in disguise

4.2.3 Shear capacity

The shear force F_v should not

$P_v = 0.6 p_y A_v$

$$V_{pl,Rd} = \frac{A_v (f_y/\sqrt{3})}{\gamma_{M0}}$$

Basis of structural design (load combinations)

EN 1990

Scope of EN 1990

- SLS, ULS, durability
  - Partial factors and combination factors
- ULS checks for
  - EQU: static equilibrium
  - STR: strength/buckling etc
  - GEO: soils deformation/failure
  - FAT: fatigue
- Reliability

ULS

- Either 6.10
- Or the more onerous of 6.10a, 6.10b

Common ULS load combinations

- Either 6.10

$$\sum_{j\ge1} \gamma_{G,j} G_{k,j} \text{ "+" } \gamma_P P \text{ "+" } \gamma_{Q,1} Q_{k,1} \text{ "+" } \sum_{i>1} \gamma_{Q,i} \psi_{0,i} Q_{k,i}$$

Common ULS load combinations

- Either 6.10

$$\sum_{j\geq 1}\gamma_{G,j}G_{k,j}\text{ "+" }\gamma_P P\text{ "+" }\gamma_{Q,1}Q_{k,1}\text{ "+" }\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i}$$

- Or (for STR and GEO) 6.10a & 6.10b

$$\sum_{j\geq 1}\gamma_{G,j}G_{k,j}\text{ "+" }\gamma_P P\text{ "+" }\gamma_{Q,1}\psi_{0,1}Q_{k,1}\text{ "+" }\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i}$$

$$\sum_{j\geq 1}\xi_j\gamma_{G,j}G_{k,j}\text{ "+" }\gamma_P P\text{ "+" }\gamma_{Q,1}Q_{k,1}\text{ "+" }\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i}$$

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$$\sum_{j\geq 1}\xi_j\gamma_{G,j}G_{k,j}\text{ "+" }\gamma_P P\text{ "+" }\gamma_{Q,1}Q_{k,1}\text{ "+" }\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i}$$

NA.2.2.3.2 *Values for the symbols γ and ξ of Table A1.2 (B)*

Table NA.A1.2 (B) provides the values for the symbols γ and ξ of Table A1.2 (B)

$\gamma_{Gj,sup} = 1,35$

$\gamma_{Gj,inf} = 1,00$

$\gamma_{Q,1} = 1,50$ where unfavourable (0 where favourable)

$\gamma_{Q,i} = 1,50$ where unfavourable (0 where favourable)

$\xi = 0,925$

NOTE For ψ values see Table NA.A1.1.

($\xi = 0.85$ in 1990)

Equation 6.10 as an example

Permanent	Imposed (floor)	Imposed (wind)	Imposed (snow)
1.35	1.5	0.75	0.75
1.35	1.05	1.5	0.75
1.35	1.05	0.75	1.5

- Equation 6.10b will be (mostly) used

Permanent	Imposed (floor)	Imposed (wind)	Imposed (snow)
1.25	1.5	0.75	0.75
1.25	1.05	1.5	0.75
1.25	1.05	0.75	1.5

6.10a and 6.10b

- 6.10b will be appropriate, as long as: Permanent load < (4.5 × imposed)

(if ξ = 0.925 and ψ = 0.7)

Implications

- Reduced loads if not affected by wind

  1.25 + 1.5 for gravity loads on floors
  (1.4 + 1.6 under current codes)

- Increased loads in the bracing system – which also (always) include equivalent horizontal forces - "NHF" in the UK

SLS

Refers to the material standard….
….which refers to the NA

- Check deflections using exactly as BS 5950 (unfactored imposed loads, and same limits)

Material and Brittle Fracture

- No changes to material
- Watch the yield strengths
  - Table 3.1 in BS EN 1993-1-1
  - (change in f_y at 40mm)
- NA choice is allowed
  - UK NA reintroduces the product Standard (BS EN10025)
  - Same steps at 16, 40, 63 mm etc

A good example of the important influence of the NA!

EN 1993-1-10

- Looks terribly complicated!
  - Especially the calculation of the reference temperature
- Refer to the Published Document (PD) 6695

PD 6695

- Reference temperatures of -5 and -15°C

"NOTE: The minimum temperatures in Tables 2 and 3 are expected to cover the majority of future steel building locations in the UK."

Table 2 Maximum thicknesses for internal steelwork in buildings for $T_{md} = -5°C$ (1).

Detail type: Description(2)	ΔT_{RD}	Tensile stress level, $\sigma_{Ed}/f_y(t)$(3)									
'Plain material'	+30°C	≤0	0.15	0.3	≥0.5						
'Bolted'	+20°C		≤0	0.15	0.3	≥0.5					
'Welded - moderate'	0°C				≤0	[illegible]	0.3	≥0.5			
'Welded - severe'	-20°C						≤0	[illegible]	0.3	≥0.5	
'Welded - very severe'	-30°C							≤0	0.15	0.3	≥0.5
Steel grade	**Subgrade**	**Maximum thickness, mm**									
S235	JR	135	115	97.5	82.5	67.5	55	45	37.5	32.5	27.5
	JO	199.5	182.5	157.5	135	115	97.5	[illegible]	67.5	55	45
	J2	200	200	197.5	182.5	157.5	135	[illegible]	97.5	82.5	67.5
S275	JR	122.5	102.5	85	70	60	50	40	32.5	27.5	22.5
	JO	192.5	172.5	147.5	122.5	102.5	85	70	60	50	40
	J2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102.5	85	70	60
	M, N	200	200	200	192.5	172.5	147.5	122.5	102.5	85	70
	ML, NL	200	200	200	200	200	192.5	172.5	147.5	122.5	102.5
S355	JR	82.5	67.5	55	45	37.5	30	22.5	17.5	15	12.5
	JO	142.5	120	100	82.5	67.5	55	45	37.5	30	22.5
	J2	190	167.5	142.5	120	100	82.5	67.5	55	45	37.5
	22.5	200	190	167.5	142.5	120	100	82.5	67.5	55	45
	ML, NL	200	200	200	190	167.5	142.5	120	100	82.5	67.5

Sub-grade – important?

- Inside – not likely
- Exposed – likely
- If its not specified, what will be provided?....

Cross-sectional resistance

- Section classification
- Different ratios
  - Always based on the "flat bit"
- Don't expect changes!

Resistance

- Cross sectional
  - As expected – an area, or modulus, multiplied by a strength

Tension, Compression and Bending

- Tension: check gross and net areas
- Compression: use A or A_{eff} as appropriate
- Bending: use W_{pl}, W_{el} or W_{eff} as appropriate

Familiar friends in disguise

4.2.3 Shear capacity

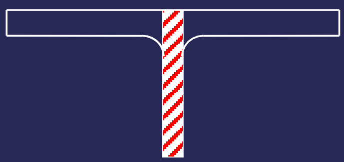
The shear force F_v should not

$P_v = 0.6 p_y A_v$

$$V_{pl,Rd} = \frac{A_v \left(f_y / \sqrt{3}\right)}{\gamma_{M0}}$$

Shear areas

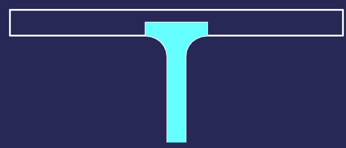
- Many formulae for A_v, some surprising
- BS 5950:



Shear areas

- Many formulae for A_v , some surprising
- rolled I and H, load parallel to web:

$$A_v = A - 2bt_f + (t_w + 2r)t_f$$

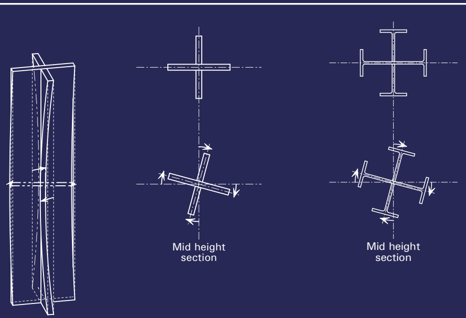


Member buckling

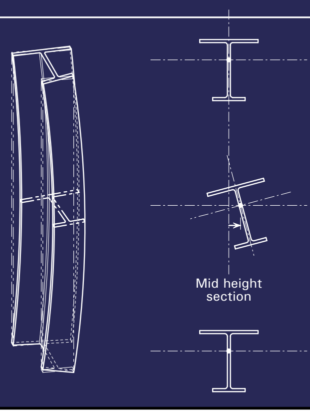
What modes of buckling?

- EC3 Part 1.1 covers
  - Flexural buckling
  - Lateral-torsional buckling
  - Torsional buckling (part covered)
  - Torsional flexural buckling
- (do we know of the last two?)

Torsional



Torsional-flexural

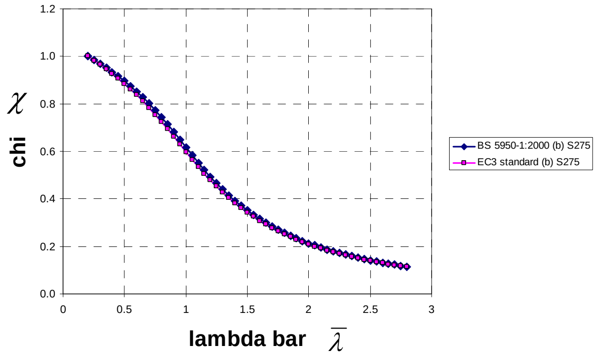


Axial compression

EC3 $$N_{b.Rd} = \chi A \frac{f_y}{\gamma_{M1}}$$

BS5950-1 $$P_c = A_g p_c$$

Column curves



Transparent phenomena?

6.3.1.2 Buckling curves

(1) For axial compression in members the value of χ for the appropriate non-dimensional slenderness $\bar{\lambda}$ should be determined from the relevant buckling curve according to:

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \quad \text{but } \chi \leq 1{,}0 \qquad (6.49)$$

where $\Phi = 0{,}5\left[1 + \alpha\left(\bar{\lambda} - 0{,}2\right) + \bar{\lambda}^2\right]$

$\bar{\lambda} = \sqrt{\frac{A f_y}{N_{cr}}}$ for Class 1, 2 and 3 cross-sections

$\bar{\lambda} = \sqrt{\frac{A_{eff} f_y}{N_{cr}}}$ for Class 4 cross-sections

α is an imperfection factor

N_{cr} is the elastic critical force for the relevant buckling mode based on the gross cross sectional properties.

Flexural buckling

- For normal compression members….
  …….99% of the time

$\bar{\lambda}$ for *flexural* buckling

The non-dimensional slenderness $\bar{\lambda}$ is given by:

$$\bar{\lambda} = \sqrt{\frac{A f_y}{N_{cr}}} = \frac{L_{cr}}{i}\frac{1}{\lambda_1}$$ for Class 1, 2 and 3 cross-sections

$$N_{cr} = \text{Euler} = \frac{\pi^2 EI}{L^2}$$

$\bar{\lambda}$ for *flexural* buckling

The non-dimensional slenderness $\bar{\lambda}$ is given by:

$$\bar{\lambda} = \sqrt{\frac{A f_y}{N_{cr}}} = \frac{L_{cr}}{i}\frac{1}{\lambda_1}$$ for Class 1, 2 and 3 cross-sections

$$\lambda_1 = \pi\sqrt{\frac{E}{f_y}} = 93{,}9\varepsilon$$

$$\varepsilon = \sqrt{\frac{235}{f_y}} \quad (f_y \text{ in N/mm}^2)$$

$$\frac{l / r_{yy}}{\lambda_1}$$

Transparent identical phenomena?

6.3.1.2 Buckling curves

(1) For axial compression in members the va... should be determined from the relevant buckling ...

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \quad \text{but } \chi \le 1{,}0$$

where $\Phi = 0{,}5\left[1 + \alpha(\bar{\lambda} - 0{,}2) + \bar{\lambda}^2\right]$

$\bar{\lambda} = \sqrt{\frac{Af_y}{N_{cr}}}$ for Class 1, 2 and 3 cross-...

$\bar{\lambda} = \sqrt{\frac{A_{eff}f_y}{N_{cr}}}$ for Class 4 cross-sections

α is an imperfection factor

N_{cr} is the elastic critical force for the relevant buckling mode based on the gross cross sectional properties.

Annex C (normative)
Compressive strength

C.1 Strut formula

The compressive strength p_c should be taken as the smaller root of:

$$(p_E - p_c)(p_y - p_c) = \eta p_E p_c$$

from which the value of p_c may be obtained using:

$$p_c = \frac{p_E p_y}{\phi + (\phi^2 - p_E p_y)^{0.5}}$$

in which:

$$\phi = \frac{p_y + (\eta + 1)p_E}{2}$$

$$p_E = (\pi^2 E / \lambda^2)$$

where

p_y is the design strength;

λ is the slenderness, see 4.7.2.

And BS 449

Appendix B Formula from which Table 17 has been derived

The average stress on the gross sectional area of a strut or other compression member in steel with a specified minimum yield stress shall not exceed the value of p_c obtained by the formula:

$$K_2 p_c = \frac{Y_s + (\eta + 1)C_0}{2} - \sqrt{\left\{\left(\frac{Y_s + (\eta + 1)C_0}{2}\right)^2 - Y_s C_0\right\}}$$

where p_c = the permissible average stress, N/mm².

K_2 = load factor or coefficient, taken as 1·7 for the purposes of this standard.

Y_s = minimum yield stress, N/mm².

C_0 = Euler critical stress $= \frac{\pi^2 E}{(l/r)^2} = \frac{\pi^2 210\,000}{(l/r)^2}$ N/mm².

η = 0.3 $(l/100r)^2$.

l/r = slenderness ratio = effective length/radius of gyration.

χ from:

- Equations, or
- A graph

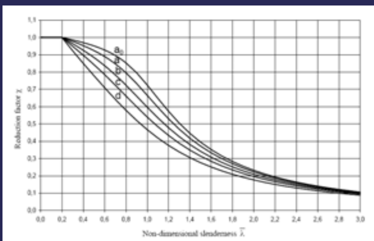


Figure 6.4: Buckling curves

Column curves

- Very slightly different buckling curves
- Almost the same results as BS 5950-1:2000 for strut buckling

BS 5950

- What type of member, how thick, which axis?

Table 23 — Allocation of strut curve

Type of section	Maximum thickness (see note 1)	Axis of buckling x-x	Axis of buckling y-y
Hot-finished structural hollow section		a)	a)
Cold-formed structural hollow section		c)	c)
Rolled I-section	≤40 mm	a)	b)
	>40 mm	b)	c)
Rolled H-section	≤40 mm	b)	c)
	>40 mm	c)	d)

- UC, thin, y-y, so curve “c”

BS 5950

- Slenderness?
- $\lambda = l/r_{yy} = 94.3$
- Design strength?
- Flange is 17.3 mm so p_y is 265 N/mm²

BS 5950

- Choose the correct table:
- Curve “c”, p_y = 265 N/mm^2
- Read the compressive strength, p_c

Table 24 — Compressive strength p_c (N/mm²) (*continued*)

5) Values of p_c (N/mm²) with λ < 110 for strut curve c

λ	Steel grade and design strength p_y (N/mm²)														
	S 275					S 355					S 460				
	235	245	255	265	275	315	325	335	345	355	400	410	430	440	460
15	235	245	255	265	275	315	325	335	345	355	398	408	427	436	455
20	233	242	252	261	271	308	317	326	336	345	387	396	414	424	442
25	226	235	245	254	263	299	308	317	326	335	375	384	402	410	428
30	220	228	237	246	255	289	298	307	315	324	363	371	388	396	413
35	213	221	230	238	247	280	288	296	305	313	349	357	374	382	397

90	129	133	136	139	142
92	126	130	133	136	139
94	124	127	130	133	135
96	121	124	127	129	132
98	118	121	123	126	129

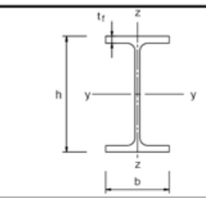
p_c is 133 N/mm^2

P_c is 133 × area = 1202 kN

EC3

- What type of member, how thick, which axis?

Table 6.2: Selection of buckling curve for a cross-section

Cross section		Limits		Buckling about axis	Buckling curve S 235 S 275 S 355 S 420	Buckling curve S 460
Rolled sections		h/b > 1,2	$t_f \le 40$ mm	y – y z – z	a b	a_0 a_0
			40 mm < $t_f \le 100$	y – y z – z	b c	a a
		h/b ≤ 1,2	$t_f \le 100$ mm	y – y z – z	b c	a a
			$t_f > 100$ mm	y – y z – z	d d	c c

EC3

- Slenderness?

$$N_{cr} = \frac{\pi^2 EI}{L^2}$$

= 2105 kN

$$\bar{\lambda} = \sqrt{\frac{Af_y}{N_{cr}}} = 1.067$$

- Slenderness?

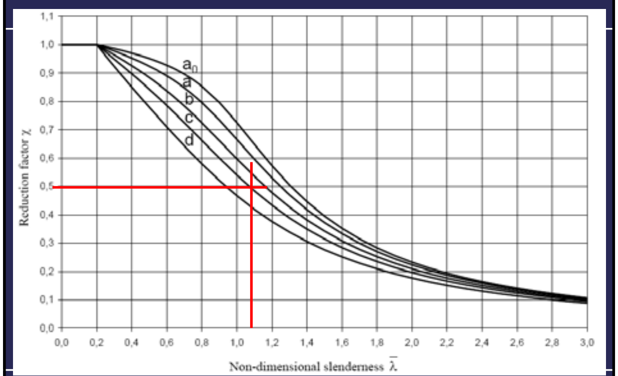
$$\lambda_1 = 93.9\varepsilon = 88.4$$

$$\bar{\lambda} = \frac{BS\ 5950\ slenderness}{88.4}$$

$$\bar{\lambda} = \frac{93.4}{88.4} = 1.067$$

EC3

- Calculate χ
- Use the graph, curve “c”



EC3

- Calculate χ
- Use the graph, curve "c"
- χ = 0.5

EC3

- Calculate χ
- Use the graph, curve "c"
- χ = 0.5

- Calculate χ
- Imperfection factor?

Table 6.1: Imperfection factors for buckling curves

Buckling curve	a_0	a	b	c	d
Imperfection factor α	0,13	0,21	0,34	0,49	0,76

EC3

- Calculate χ
- Use the graph, curve "c"
- χ = 0.5

- Calculate χ
- Imperfection factor?
- α = 0.49

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \quad \text{but } \chi \le 1,0$$

where $\Phi = 0,5\left[1 + \alpha(\bar{\lambda} - 0,2) + \bar{\lambda}^2\right]$

EC3

- Calculate χ
- Use the graph, curve "c"
- χ = 0.5

- Calculate χ
- Imperfection factor?
- α = 0.49
- χ = 0.5

EC3

- Calculate χ
- Use the graph, curve "c"
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- Calculate χ
- Imperfection factor?
- α = 0.49
- χ = 0.5

Axial resistance = χ × Area × f_y/γ_m = 1205 kN

BS 5950 was 1202 kN

Compression members

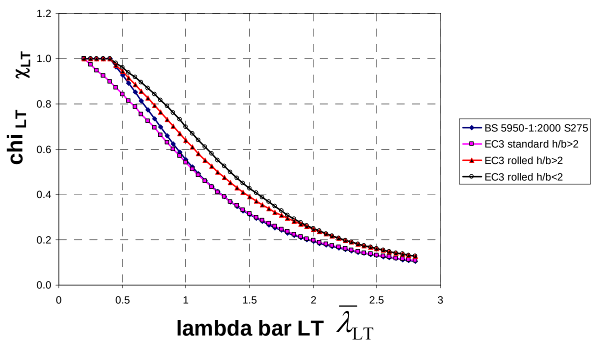
- Very close to the BS 5950 resistances
- On a desert island – use the BS 5950 tables

Lateral torsional buckling

L T Bending

$$M_{b.Rd} = \chi_{LT} W_y \frac{f_y}{\gamma_{M1}}$$

LTB curves for S 275



Bending

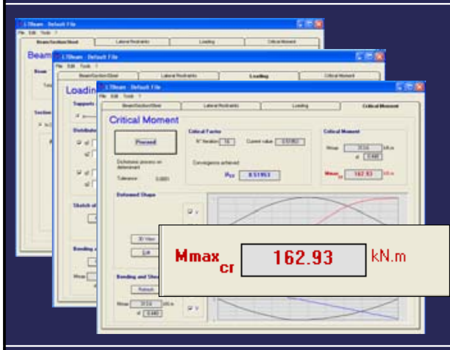
$$\bar{\lambda}_{LT} = \sqrt{\frac{W_y f_y}{M_{cr}}}$$

But M_{cr} is not given!

M_{cr} – an interesting challenge

- Use the free software

M_{cr} – an interesting challenge



www.cticm.com

M_{cr} – an interesting challenge

- Use a spreadsheet and do a simple calculation

$$M_{cr} = C_1 \frac{\pi^2 EI_z}{L^2} \sqrt{\frac{I_w}{I_z} + \frac{L^2 GI_t}{\pi^2 EI_z}}$$

…when loads are not destabilising

Alternative option

- Instead of calculating M_{cr} and then $\bar{\lambda}_{LT}$
- $\bar{\lambda}_{LT}$ may be calculated directly, based on the BS 5950 slenderness

M_{cr} – an interesting challenge

$$\bar{\lambda}_{LT} = \frac{1}{\sqrt{C_1}} UV \bar{\lambda}_z \sqrt{\beta_w}$$

$$\bar{\lambda}_{LT} = \frac{1}{\sqrt{C_1}} \times 0.9 \times \bar{\lambda}_z \sqrt{\beta_w}$$

$$\bar{\lambda}_z = \frac{\text{BS 5950 slenderness}}{a \ \text{factor}}$$

 = 

a factor

Nothing new?

- C_1 adjusts for the shape of the bending moment diagram

………… Just like m_{LT} in BS 5950

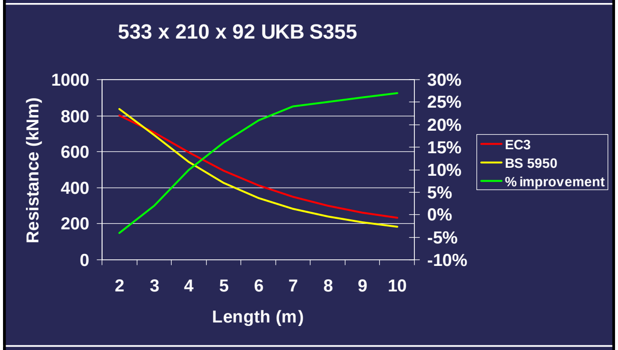
- M_{cr} is the elastic critical buckling moment

……… Just like the critical stress C_s in BS 449

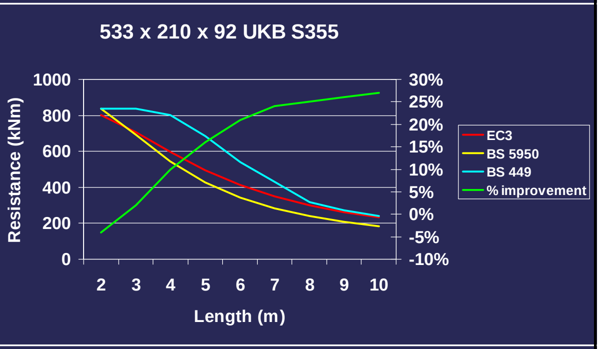
And the answer is….

- Some significant improvements in LTB resistance (i.e. for unrestrained members)…
- Combined with a significant reduction in loads…
- Could be ^very^ attractive to some.

Typical LTB example



Typical LTB example



LTB

- Significant “improvement” compared to BS 5950 at medium spans
  - But deflection may still dominate

Checking a steel beam to EC3

- Loads
  - 1.35 Permanent + 1.5 Variable
- Is it restrained? (yes)
  - Bending resistance (f_y × modulus)
  - Shear resistance (unlikely to be critical)
  - Deflection (likely to be important)

Checking a steel beam to EC3

- Loads
  - 1.35 Permanent + 1.5 Variable
- Is it restrained? (no)
  - Effective length
    - Always doubt end conditions! At least the span!
  - Buckling resistance (tables)
  - Shear resistance (unlikely to be critical)
  - Deflection (may be important)

For columns in simple construction

- From access-steel.com:

The following expression may be used to verify the member:

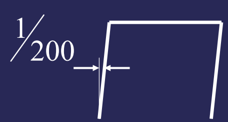
$$\frac{N_{\mathrm{Ed}}}{N_{\mathrm{b,Rd}}} + \frac{M_{\mathrm{y,Ed}}}{M_{\mathrm{y,b,Rd}}} + 1.5\frac{M_{\mathrm{z,Ed}}}{M_{\mathrm{z,cb,Rd}}} \leq 1$$

Frame stability

- Imperfections for global analysis

$$\phi = \phi_0 \alpha_h \alpha_m \qquad \phi_0 = 1/200$$

or Equivalent Horizontal Forces (as BS 5950)



Equivalent imperfection forces

- Applied in *every* load combination
- Not just gravity as BS 5950

Measure of frame stability

$$\alpha_{cr} = \left(\frac{H_{Ed}}{V_{Ed}}\right)\left(\frac{h}{\delta_{H,Ed}}\right)$$

Almost exactly as BS 5950:

$$\lambda_{cr} = {}^{h}\!/_{200\delta}$$

With a limit when no action is needed

$$\alpha_{cr} = \frac{F_{cr}}{F_{Ed}} \geq 10$$

And a multiplier when action is required

$$\left(\frac{1}{1 - \frac{1}{\alpha_{cr}}}\right)$$

Which is exactly
As BS 5950:

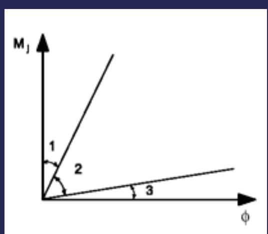
$$\frac{\lambda_{cr}}{\lambda_{cr} - 1}$$

Connections

- No major change from BS 5950
  - Significant increase in bearing resistance
- Differences in edge and end distances
- Different presentation of design rules

Elastic design:

- Classification by stiffness
  - Nominally pinned?
  - Semi-rigid?
  - Rigid



Pages of calculations

Joint classification

- *A joint may be classified on the basis of experimental evidence,* ***experience of previous satisfactory performance*** *in similar cases or by calculations based on test evidence*

Joint classification

- The UK NA refers to the "Green Book" – details that follow the rules are "pinned"

Nominally pinned connections

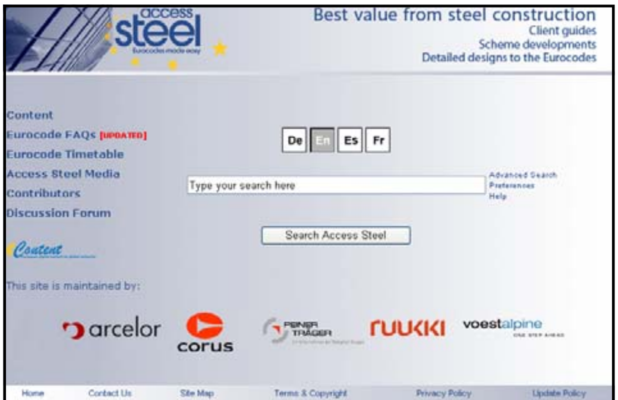
- Don't expect any radical changes!
  - The steel cannot tell how it was designed!
- But more generally (not EC3), beware the higher tying forces
  - Is a thick fully welded plate still "pinned"?

Resistance

- Different routes, new symbols… …same steel
- Consistent principles – e.g. frame imperfections

- Compression almost the same
- Tension the same
- Shear almost the same
- Connections almost the same
- Significant improvements in LTB
- Significant savings in ULS loads

Information



www.access-steel.com

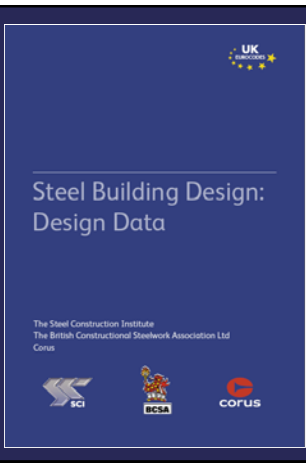
Information for designers

10 new SCI/BCSA/Corus guides,

- Introduction to the Eurocodes
- Concise Eurocode for steel buildings
- Resistance tables to EC3 (many!)
- Worked examples to EC3 (open and tubes)
- Medium rise braced frames to EC3
- Student worked examples

Blue Book

- Of course!

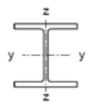


BS EN 1993-1-1:2005
BS 4-1:2005

COMPRESSION

UNIVERSAL COLUMNS
Advance UKC

S275 / Advance275



Section Designation	Axis	Compression resistance $N_{b,y,Rd}$, $N_{b,z,Rd}$, $N_{b,T,Rd}$ (kN) for Buckling lengths L_{cr} (m) 2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
305x305x283	$N_{b,y,Rd}$	9180	9100	8850	8590	8320	8020	7690	7320	6930	6510	6070	5630	5200
	$N_{b,z,Rd}$	8860	8230	7550	6820	6050	5290	4580	3950	3410	2960	2580	2270	2000
	$N_{b,T,Rd}$	9030	8750	8590	8480	8420	8370	8340	8320	8310	8290	8290	8280	8270
305x305x240	$N_{b,y,Rd}$	8110	8010	7780	7540	7280	7000	6690	6350	5970	5580	5170	4770	4380
	$N_{b,z,Rd}$	7790	7210	6580	5910	5200	4510	3880	3330	2870	2480	2160	1890	1670
	$N_{b,T,Rd}$	7910	7610	7420	7300	7220	7170	7130	7100	7080	7060	7050	7040	7030
305x305x198	$N_{b,y,Rd}$	6680	6590	6390	6190	5970	5730	5460	5170	4850	4520	4180	3840	3510
	$N_{b,z,Rd}$	6400	5910	5390	4830	4240	3670	3150	2690	2320	2000	1740	1530	1350
	$N_{b,T,Rd}$	6470	6180	5980	5850	5750	5690	5640	5600	5580	5560	5540	5530	5520
305x305x158	$N_{b,y,Rd}$	5330	5240	5090	4920	4740	4540	4320	4080	3810	3540	3260	2990	2730
	$N_{b,z,Rd}$	5090	4700	4270	3810	3330	2870	2450	2100	1800	1550	1350	1180	1040
	$N_{b,T,Rd}$	5120	4850	4640	4490	4380	4290	4230	4180	4150	4120	4100	4080	4070

Examples

Helpful look-up tables

Table 5.4 *Flexural buckling reduction factor, χ*

$\bar{\lambda}$	Buckling curves a	b	c	d
0.20	1.00	1.00	1.00	1.00
0.25	0.99	0.98	0.97	0.96
0.30	0.98	0.96	0.95	0.92
0.35	0.97	0.95	0.92	0.89
0.40	0.95	0.93	0.90	0.85
0.42	0.95	0.92	0.89	0.84
0.44	0.94	0.91	0.88	0.82
0.46	0.94	0.90	0.87	0.81
0.48	0.93	0.89	0.85	0.79
0.50	0.92	0.88	0.84	0.78
0.52	0.92	0.88	0.83	0.77
0.54	0.91	0.87	0.82	0.75
0.56	0.90	0.86	0.81	0.74
0.58	0.90	0.85	0.80	0.72
0.60	0.89	0.84	0.79	0.71
0.62	0.88	0.83	0.77	0.70
0.64	0.87	0.82	0.76	0.68
0.66	0.87	0.81	0.75	0.67
0.68	0.86	0.79	0.74	0.66
0.70	0.85	0.78	0.72	0.64

Conclusions

- *Some* good things
  - Loading
  - LTB resistance
- *Some* irritating, some maddening things
- A view that the Design Standard should be a nanny
- The Eurocodes *will* be used
  - The young will know no different
  - The continentals grew with them