A COMPARATIVE STUDY OF AISC-360 AND EUROCODE 3 STRENGTH LIMIT STATES

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ABSTRACT

A COMPARATIVE STUDY OF AISC-360 AND EUROCODE 3 STRENGTH LIMIT STATES

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Nowadays; design, fabrication and erection of steel structures can be taken place at different locations as a result of rapid globalization; owners may require the use of widely accepted steel design codes. Therefore, engineers are faced with the challenge of being competent with several design specifications for a particular material type. AISC-360 and EC3 are widely accepted steel structure design specifications that utilize limit state principles with some similarities and differences in application. Hereby a study has been undertaken to put together the nominal strength expressions presented in both AISC-360 and EC3 codes in a single document, to identify the similarities and the differences in calculated strengths and to facilitate rapid learning of either of the specifications with prior knowledge of the other. Because of the wide scope of specifications, only fundamental failure modes are considered in this thesis. Resistance equations are directly compared with each other wherever possible. For cases where the treatment of specifications is entirely different, representative members were considered for comparison purposes.

Keywords: Limit state design, AISC-360, eurocode 3, cross-section classification, tension member, compression member, flexural member, shear design, bolts, welds.

ÖZ

AISC-360 VE EUROCODE 3 ŞARTNAMELERİNİN DAYANIM LİMİT DURUMLARININ KARŞILAŞTIRILMASI

Şahin, Serkan
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Günümüzde hızlı küreselleşmenin bir sonucu olarak; çelik yapıların tasarım, üretim ve uygulama yerlerinin birbirlerinden farklı yerlerde yapılması, işverenleri geniş kabul görmüş çelik yapı şartnamelerini kullanmaya mecbur bırakmıştır. Bu da mühendisleri belirli bir malzeme üzerinde farklı şartnameleri uzmanlıkla kullanabilmeleri durumuyla yüz yüze bırakmıştır. AISC-360 ve EC3 limit durum kurallarını uygulamada bazı benzerlik ve farklılıklarla kullanan, geniş kabul görmüş çelik yapı şartnameleridir. Burada AISC-360 ve EC3 şartnamelerinin nominal dayanım denklemlerini tek bir dökümanda toplamak, şartnamelerde yer alan dayanım denklemlerinin benzerliklerini ve farklılıklarını belirtmek ve şartnameleri incelemek açısından bir ön bilgi olması amaçlanarak bir çalışma yürtülmüştür. Şartnamelerin çok geniş kapsamlı olması nedeniyle, burada sadece temel kontrol durumları incelenmiştir. Direnç denklemleri mümkün olan noktalarda direkt olarak karşılaştırılmıştır. Şartnamelerin tamamen farklı olan durumlarında ise örnek elemanlar kullanılarak karşılaştırma yapılmıştır.

Anahtar kelimeler: Limit durum tasarımı, AISC-360, eurocode 3, kesit sınıflandırılması, çekme elemanı, basınç elemanı, eğilme elemanı, kesme tasarımı, civatalar, kaynaklar.

To My Family

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LIST OF SYMBOLS AND ABBREVIATIONS

A: accidental action

A_b: gross cross section area of the bolt

A_c: area in compressin

A_d: design value of accidental action

A_{Ed}: design value of seismic action

$A_{c,eff}$: effective cross sectional area

A_f: area of flange

A_g: gross area of member

A_n: net area of member

A_w: web area

A_s: tensile stress area of the bolt

A_{wl}: effective area of the weld

C_b: lateral-torsional buckling modification factor for uniform moment diagrams when both ends of the unsupported segment are braced

C_v: web shear coefficient

C_w: warping constant

D: dead load

E: earthquake load

E: modulus of elasticity of steel

E_d: is the design value of the effect of actions such as internal force, moment or a vector representing several internal forces or moments

F_{EXX}: electrode strength

F_{nt}: nominal tensile stress

F_{nv}: nominal shear stress

F_y: specified minimum yield stress of the type of steel being used

F_{yf}: specified minimum yield stress of the flange

F_{yw}: specified minimum yield stress of the web

F_u: specified minimum tensile strength of the type of steel being used

F_{ub}: ultimate tensile strength of bolt

F_w: nominal strength of the weld metal per unit area

G: permanent action

GEO: Failure or excessive deformation of the ground where the strengths of soil or rock are significant in providing resistance

H: load due to lateral earth pressure, ground water pressure, or pressure of bulk materials

J: torsional constant

K: effective length factor

L: live load

L: length of the member

L_b: length between points that are braced against lateral displacement

L_p: limiting laterally unbraced length for the limit state of yielding

L_r: limiting laterally unbraced length for the limit state of inelastic-torsional buckling

L_r: roof live load

M_{Ed}: design value of the bending moment

$M_{f,Rd}$: moment resistance of the cross section consisting of the area of the effective flanges only

M_n: nominal flexural strength

M_p: plastic flexural strength

M_y: yield moment about the axis of bending

P: prestressing action

P_n: nominal axial strength

Q: variable action

R: rain load

R_{pg}: bending strength reduction factor

S: snow load

S_{eff}: effective section modulus

S_x: elastic section modulus

STR: Internal failure or excessive deformation of the structure or structural members, including footings, piles, basement walls, etc., where the strength of construction materials of the structure governs

W: wind load

U: shear lag factor

V_n: nominal shear strength

V_p: plastic design shear strength

Z: plastic section modulus about the axis of bending

a: clear distance between transverse stiffeners

b_c: compression length of web

b_{eff}: effective plate width

b_f: flange width

b_t: tension length of web

f_t: required tensile stress

f_v: required shear stress

g: distance between two adjacent holes in the perpendicular direction of force

h: web height

k_c: coefficient for slender unstiffened elements

k_v: plate buckling coefficient

r: governing radius of gyration

r_{ts}: effective radius of gyration used in determination of L_r for the lateral-torsional buckling limit state for major axis bending of doubly symmetric compact I-shaped members

s: distance between two adjacent holes in the direction of force

t_e: effective throat thickness

t_f: thickness of flange

t_w: thickness of the web

α: imperfection factor

β_w: correlation factor

η: conversion factor

Φ: value to determine the reduction factor χ

χ: reduction factor for relevant buckling mode

λ: slenderness parameter

λ_{FB}: non-dimensional slenderness for flexural buckling

λ_{pf}: limiting slenderness parameter for compact flange

λ_{pw}: limiting slenderness parameter for compact web

λ_{rf}: limiting slenderness parameter for non-compact flange

λ_{rw}: limiting slenderness parameter for non-compact web

λ_{w}: web slenderness

γ_{G}: partial factor for permanent actions

γ_{Q}: partial factor for variable actions

γ_{P}: partial factor for prestressing actions

Ψ: combination factor

"+": implies "to be combined with"

Σ: implies "the combined effect of

ξ: is a reduction factor for unfavourable permanent actions G

ρ: reduction factor for effective area

σ_{r}: design stress of weld strength

σ_{II}: normal stress perpendicular the throat

$\sigma_{\perp}$: normal stress parallel the throat

τ_{II}: shear stress (in the plane of the throat) parallel to the axis of the weld

$\tau_{\perp}$: shear stress (in the plane of the throat) perpendicular to the axis of the weld

θ: angle of loading measured from the weld longitudinal axis

CHAPTER 1

INTRODUCTION

1.1 Motivation

Nowadays design, fabrication and erection of steel structures may take place at disparate locations as a result of rapid globalization. Owners may require the use of widely accepted steel design codes regardless of the location where the structure is going to be built. Engineers are now faced with the challenge of being competent with several design specifications for a particular material type. Two of the widely used steel design specifications for buildings are the American and the European ones.

In the United States, "Specification for Structural Steel Buildings (2005)" was developed by the American Institute of Steel Construction (AISC). This specification, hereafter referred to as AISC-360, utilizes both Load and Resistance Factor Design (LRFD) and Allowable Strength Design (ASD) formats. In general, limit states that govern the design under a particular loading are given by the AISC-360 and the nominal strength based on these limit states is either used in the LRFD or the ASD format. In the LRFD format, the nominal strength is multiplied by a resistance factor (ϕ). The purpose of the resistance factor is to include the uncertainties in the material and geometric properties as well as the ones in modeling. Resistance factors of 0.75 and 0.9 are used for fracture and yielding/instability limit states, respectively.

In Europe, "Design of Steel Structures, EN 1993 (2003)" was developed by the European Committee for Standardization. This specification, hereafter referred to as EC3, is based on limit state principles using partial safety factors (γ_M). In general, the characteristic strength is divided by a partial safety factor and then compared with the factored loads. The partial safety factors are used to account for the same types of uncertainties that were explained for the resistance factors (ϕ) in AISC-360. In other words, partial safety factors (γ_M) can be thought of as the inverse of resistance factors (ϕ). The recommended γ_M values are 1.0 for yielding, 1.0 for buckling, and 1.25 for fracture limit states. Because Eurocodes are used in a number of different countries, each member state has the right to choose its own partial safety factors and publish these in a National Annex.

Based on the above discussion, it is apparent that both AISC-360 and EC3 utilize limit state principles with differing factors to account for uncertainties. A study has been undertaken with the following objectives; (i) put together the nominal strength expressions presented in both codes in a single document, (ii) to identify the similarities and the differences in calculated strengths, (iii) to facilitate rapid learning of either of the specifications with prior knowledge of the other. Because of the wide scope of specifications, only fundamental failure modes are considered in this thesis. Resistance equations are directly compared with each other wherever possible. For cases where the treatment of specifications is entirely different, representative members were considered for comparison purposes.

1.2 Layout of Specifications

AISC-360 is an integral document whereas EC3 consists of parts and subparts. In general, each part is focused on a particular structure type such as buildings, bridges, towers, silos, and etc. General rules and rules for buildings are specified in Part 1 of EC3. This part is divided into 11 subparts. Among these, parts 1.1 (General rules and rules for buildings), 1.5 (Plated structural elements), and 1.8 (Design of joints) are utilized in this thesis.

1.3 Load Factors and Load Combinations

Load factors and load combinations are not considered to compare the resistance of members under fundamental failure modes in the thesis. However, load factors and load combinations are presented here for each specification to give a general idea about load factors and load combinations.

Load factors and combinations are presented in the Minimum Design Loads for Buildings and Other Structures (ASCE Standard 7-05). The structures should be designed according to following load combinations if they are designed according to AISC-360.

1) 1.4*D
2) 1.2*D + 1.6*L + 0.5*(L_r or S or R)
3) 1.2*D + 1.6*(L_r or S or R) + (L or 0.8W)
4) 1.2*D + 1.6*W + L + 0.5*(L_r or S or R)
5) 1.2*D + 1.0*E + L + 0.2*S
6) 0.9*D + 1.0*E + 1.6*H
7) 0.9*D + 1.6*W + 1.6*H

Load factors and combinations are presented in the Basis of Structural Design (EN 1990) in EC3. The applied load actions are categorized in three parts as permanent actions, variable actions, and accidental actions. In addition, EC3 divides into categories the areas of buildings for imposed load (variable) actions. The following load combinations are utilized for the design of structures with EC3.

Combinations of actions for persistent or transient design situations are given below;

$$E_d = E\left\{\gamma_{G,j} G_{k,j} ; \gamma_P P ; \gamma_{Q,1} Q_{k,1} ; \gamma_{Q,i} \psi_{0,i} Q_{k,i}\right\} \qquad j \geq 1 \; ; \; i > 1 \tag{1.1}$$

The combinations in brackets {} may either be expressed as;

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

or, alternatively for STR and GEO limit states less favourable of the two following expressions;

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

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

Combinations of actions for accidental design situations are given below;

$$E_d = E\left\{G_{k,j};P;A_d;\left(\psi_{1,1}\text{ or }\psi_{2,1}\right)Q_{k,1};\psi_{2,1}Q_{k,i}\right\}\qquad j\geq 1\ ;\ i>1 \tag{1.2}$$

The combinations in brackets {} may either be expressed as;

$$\sum_{j\geq 1}G_{k,j}\text{"+"}P\text{"+"}A_d\text{"+"}\left(\psi_{1,1}\text{ or }\psi_{2,1}\right)Q_{k,1}\text{"+"}\sum_{i>1}\psi_{2,1}Q_{k,i}$$

Combinations of actions for seismic design situations are given below;

$$E_d = E\left\{G_{k,j};P;A_{Ed};\psi_{2,1}Q_{k,i}\right\}\qquad j\geq 1\ ;\ i>1 \tag{1.3}$$

The combinations in brackets {} may either be expressed as;

$$\sum_{j\geq 1}G_{k,j}\text{"+"}P\text{"+"}A_{Ed}\text{"+"}\sum_{i>1}\psi_{2,1}Q_{k,i}$$

1.4 Materials

In the United States, structural steel material should conform to the standards set forth by the American Society for Testing and Materials (ASTM). Widely used structural steels are A36 (Fy= 220 MPa, Fu= 340 MPa), A572 Gr50 or A992 (Fy=350 MPa, Fu=500 MPa)

In Europe, structural steel material properties are documented in Euronorm EN 10025. Widely used structural steels are S235 (Fy=235 MPa, Fu=360 MPa), S275 (Fy=275 MPa, Fu=430 MPa), S355 (Fy=355 MPa, Fu=510 MPa).

1.5 Organization of the Thesis

Each of the following chapters focuses on a limit state. Classification of cross sections is treated in Chapter 2. In Chapter 3, design of tension members is investigated. Compression member design is treated in Chapter 4. Both laterally supported and unsupported flexural members are focused in Chapter 5. Chapter 6 investigates the design of members for shear. Design of connections is treated in Chapter 7. Finally, conclusions for each chapter are defined in Chapter 8.

CHAPTER 2

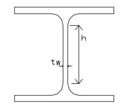
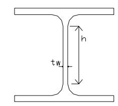
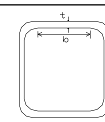
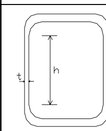
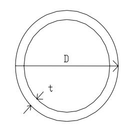
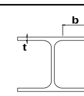
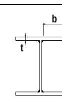
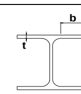
CLASSIFICATION OF CROSS SECTIONS

Both specifications provide cross section classifications for local buckling. In AISC-360, sections are classified as compact, non-compact, and slender. In addition to AISC-360 requirements, the Seismic Provisions for Structural Steel Buildings (AISC-341) has an additional classification named as seismically compact. On the other hand, in EC3 sections are classified as Class 1 through Class 4.

The definitions for cross-sections in both specifications have similarities. Class 4 or slender cross sections are those in which local buckling of the plate element(s) will occur before the attainment of yield stress. Class 3 or non-compact cross sections are those in which the stress in the extreme compression fiber can reach to the yield strength, but local buckling is liable to prevent the development of the plastic moment capacity. Class 2 or compact sections are those which can develop their plastic moment capacity, but have limited rotation capacity because of local buckling. Finally, Class 1 or seismically compact sections are those which can develop their plastic moment capacity and provide significant amount of rotation capacity.

Limiting width-thickness ratios of stiffened and unstiffened elements for typical cases are summarized in Table 2.1 together with the ratio of EC3 to AISC-360 limits. According to this table, the limits set by the two specifications are generally close to each other. Major differences arise for HSS members. In addition, the Class 3 or non-compact limits for flexure in flanges of rolled or built-up I-shapes differ significantly.

Table 2.1: Classification of Cross-Sections

	Maximum Width-Thickness Ratios for Compression Parts											
	Description of Element	Width-Thickness Ratio	Limiting Width-Thickness Ratio									Example
			EC3	LRFD	Ratio	EC3	LRFD	Ratio	EC3	LRFD	Ratio	
			Class 1	λ_{ps}	λ_{ps} / Class1	Class 2	λ_p	λ_p / Class2	Class 3	λ_r	λ_r / Class3	
Stiffened Elements	Flexure in webs of doubly symmetric I-shapes (rolled or built-up)	h/t_w	2.46*A	2.45*A	0.996	2.85*A	3.76*A	1.319	4.25*A	5.70*A	1.341	
	Uniform compression in webs of doubly symmetric I-shapes (rolled or built-up)	h/t_w	1.13*A	N.A	----	1.30*A	N.A.	----	1.44*A	1.49*A	1.035	
	Uniform compression in flanges of rectangular box and hollow sections (uniform thickness)	b/t	1.13*A	0.64*A	0.566	1.30*A	1.12*A	0.862	1.44*A	1.40*A	0.972	
	Flexure in webs of rectangular HSS	h/t	2.46*A	0.64*A	0.26	2.85*A	2.42*A	0.849	4.25*A	5.70*A	1.341	
	Cicular Hollow Sections In uniform compression	D/t	$0.059{*}A^2$	$0.044{*}A^2$	0.746	$0.082{*}A^2$	N.A.	----	$0.11{*}A^2$	$0.11{*}A^2$	1	
	In flexure	D/t	$0.059{*}A^2$	$0.044{*}A^2$	0.746	$0.082{*}A^2$	$0.07{*}A^2$	0.854	$0.11{*}A^2$	$0.31{*}A^2$	2.818	
Unstiffened Elements	Flexure in flanges of rolled I-shapes (rolled or built-up)	b/t	0.30*A	0.30*A	1	0.34*A	0.38*A	1.118	0.48*A	1.0*A	2.083	
	Flexure in flanges of built-up I-shapes (rolled or built-up)	b/t	0.30*A	0.30*A	1	0.34*A	0.38*A	1.118	0.48*A	from 0.67*A to.95*A	from 1.396 to 1.979	
	Uniform compression in flanges of rolled I-shaped	b/t	0.30*A	0.30*A	1	0.34*A	N.A.	----	0.48*A	0.56*A	1.167	

$$A = \sqrt{\frac{E}{F_Y}}$$

It should also be emphasized that minor differences in the width-thickness ratio definitions are also present. For example, in AISC-360 half the flange width is used in determining the flange slenderness. In EC3, however, only the outstanding portion of the flange that is measured from the toe of the fillet is used in calculations.

CHAPTER 3

DESIGN OF MEMBERS FOR TENSION

Both specifications consider tensile yielding in the gross section and tensile rupture in the net section as the two primary limit states for tension members. The nominal resistance of members to these limit states are calculated as follows:

$P_n = A_g F_y$ (yielding) (AISC-360 and EC3) (3.1)

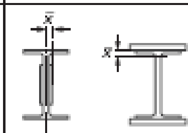
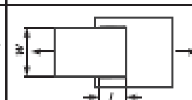
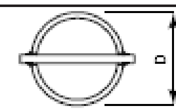
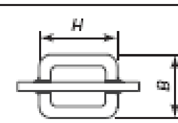
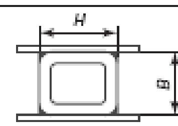
$P_n = U A_n F_u$ (fracture) (AISC-360) (3.2)

$P_n = 0.9 A_n F_u$ (fracture) (EC3) (3.3)

The fundamental difference between two specifications comes from the way that the shear lag factor U is calculated. In AISC-360, a shear lag factor of 1.0 is used if the tension load is transmitted directly to each of the cross sectional elements. An elaborate treatment is tabulated in the AISC Specification for other types of connections. Separate rules are presented for I-section, L-shaped, and HSS members. Usually shear lag factors that range between 0.6 and 0.9 are found based on the recommended procedure. On the other hand, a less elaborate treatment for shear lag is given in EC3. In general, a 10 percent reduction in tensile fracture capacity is considered even if all cross sectional elements are connected. Some specific rules for single angles connected by one leg and other unsymmetrically connected members are given in Part 1.8 Section 3.10.3 of EC3. According to these rules, the 0.9 coefficient is replaced with a reduction factor that varies between 0.4 and 0.7. Shear lag factors for different connections as recommended by the AISC specification is given in Table 3.1.

Table 3.1: Table of Shear Lag Factors (AISC-360)

Shear Lag Factors for Connections to Tension Members

Case	Description of Element		Shear Lag Factor, U	Example
1	All tension members where the tension load is transmitted directly to each of cross-sectional elements by fasteners or welds. (except as in Cases 3, 4, 5 and 6)		$U = 1.0$	—
2	All tension members, except plates and HSS, where the tension load is transmitted to some but not all of the cross-sectional elements by fasteners or longitudinal welds (Alternatively, for W, M, S and HP, Case 7 may be used.)		$U = 1 - \bar{x}/l$	
3	All tension members where the tension load is transmitted by transverse welds to some but not all of the cross-sectional elements.		$U = 1.0$ and A_n = area of the directly connected elements	—
4	Plates where the tension load is transmitted by longitudinal welds only.		$l \geq 2w \ldots U = 1.0$ $2w > l \geq 1.5w \ldots U = 0.87$ $1.5w > l \geq w \ldots U = 0.75$	
5	Round HSS with a single concentric gusset plate		$l \geq 1.3D \ldots U = 1.0$ $D \leq l < 1.3D \ldots U = 1 - \bar{x}/l$ $\bar{x} = D/\pi$	
6	Rectangular HSS	with a single concentric gusset plate	$l \geq H \ldots U = 1 - \bar{x}/l$ $\bar{x} = \dfrac{B^2 + 2BH}{4(B+H)}$	
		with two side gusset plates	$l \geq H \ldots U = 1 - \bar{x}/l$ $\bar{x} = \dfrac{B^2}{4(B+H)}$	
7	W, M, S or HP Shapes or Tees cut from these shapes. (If U is calculated per Case 2, the larger value is permitted to be used)	with flange connected with 3 or more fasteners per line in direction of loading	$b_f \geq 2/3d \ldots U = 0.90$ $b_f < 2/3d \ldots U = 0.85$	—
		with web connected with 4 or more fasteners in the direction of loading	$U = 0.70$	—
8	Single angles (If U is calculated per Case 2, the larger value is permitted to be used)	with 4 or more fasteners per line in direction of loading	$U = 0.80$	—
		with 2 or 3 fasteners per line in the direction of loading	$U = 0.60$	—

l = length of connection, in. (mm); w = plate width, in. (mm); $\bar{x}$ = connection eccentricity, in. (mm); B = overall width of rectangular HSS member, measured 90 degrees to the plane of the connection, in. (mm); H = overall height of rectangular HSS member, measured in the plane of the connection, in. (mm)

Both specifications favor the use of $s^2/4g$ rule in determining the net area in staggered connections. In AISC-360, the width of a bolt hole is taken 2 mm greater than the nominal dimensions of the hole to account for damage in hole making process. No such damage allowance is recommended in EC3.

CHAPTER 4

DESIGN OF MEMBERS FOR COMPRESSION

A single column strength curve is given in AISC-360 whereas five separate curves are presented in EC3. In general, both specifications use a non-dimensional slenderness for flexural buckling (λ_{FB}) to define the reduction in capacity. In Eurocode a unified approach has been adopted for various forms of member buckling. In other words, flexural buckling, torsional buckling, flexural-torsional buckling, and lateral torsional buckling are treated using a unified set of reduction factors. The nominal axial strength for flexural buckling is computed as follows:

$$P_n = \chi F_y A_g \qquad \text{(AISC-360 and EC3)} \tag{4.1}$$

The non-dimensional slenderness for flexural buckling, λ_{FB}, can be expressed as follows:

$$\lambda_{FB} = \sqrt{\frac{A_g F_y}{P_{cr}}} = \frac{KL}{\pi r}\sqrt{\frac{F_y}{E}} \tag{4.2}$$

The reduction factor (χ) has the following forms depending on the specification:

$$\chi = 0.658^{\lambda_{FB}^2} \quad \lambda_{FB} \leq 1.5 \qquad \chi = \frac{0.877}{\lambda_{FB}^2} \quad \lambda_{FB} > 1.5 \qquad \text{(AISC-360)} \tag{4.3}$$

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \lambda_{FB}^2}} \qquad \Phi = 0.5\left[1 + \alpha\left(\lambda_{FB} - 0.2\right) + \lambda_{FB}^2\right] \qquad \text{(EC3)} \qquad (4.4)$$

EC3 utilizes an imperfection coefficient (α) to distinguish between different column strength curves. For flexural buckling, five cases termed as a_o, a, b, c, d are given for which the α values are 0.13, 0.21, 0.34, 0.49, and 0.76, respectively. The choice as to which buckling curve to adopt is dependent upon the geometry and material properties of the cross section and upon the axis of buckling. The rules for selecting the appropriate column strength curve are tabulated in EC3. Hereby the appropriate column strength curve is presented in Fig. 4.1. In general, curve "a_o" is used for rolled I-shapes made up of high strength material (F_y=460 MPa). For steels with a yield strength in the range 235 MPa to 420 MPa curve "a" is used for major axis buckling of rolled I-shapes (t_f<40 mm) and hot rolled HSS. Curve "b" is used for minor axis buckling of I-shaped members (t_f<40 mm) and buckling of angles. Curve "c" is used for minor axis buckling of built-up I-shapes and cold formed HSS. Curve "d" is used for major and minor axis buckling of rolled I-shapes with t_f>100 mm and etc.

A comparison of reduction factors are presented in Fig. 4.2. According to this figure, buckling curve "a" is very similar to the one of AISC-360. Buckling curve "a_o" tends to give higher capacities but the use of this curve is quite limited. All other strength curves (b,c,d) give lower capacity values as compared with AISC-360 recommended capacities.

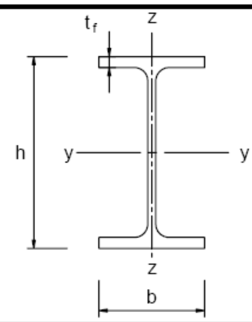
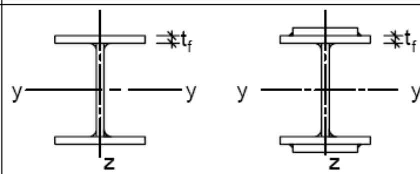
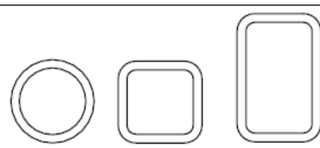
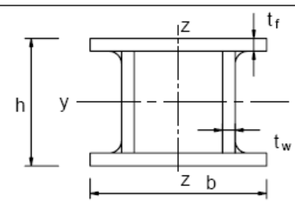
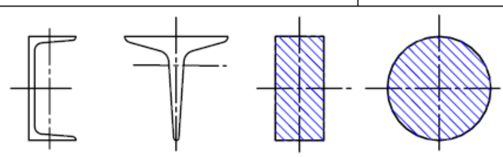
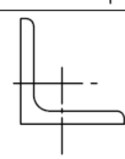
Cross section		Limits		Buckling about axis	Buckling curve S 235 S 275 S 355 S 420	Buckling curve S 460
Rolled sections		h/b > 1,2	$t_f \leq 40$ mm	y – y z – z	a b	a_0 a_0
			40 mm < $t_f \leq 100$	y – y z – z	b c	a a
		h/b ≤ 1,2	$t_f \leq 100$ mm	y – y z – z	b c	a a
			$t_f > 100$ mm	y – y z – z	d d	c c
Welded I-sections		$t_f \leq 40$ mm		y – y z – z	b c	b c
		$t_f > 40$ mm		y – y z – z	c d	c d
Hollow sections		hot finished		any	a	a_0
		cold formed		any	c	c
Welded box sections		generally (except as below)		any	b	b
		thick welds: $a > 0{,}5t_f$ $b/t_f < 30$ $h/t_w < 30$		any	c	c
U-, T- and solid sections				any	c	c
L-sections				any	b	b

Fig. 4.1: Selection of Buckling Curve for a Cross Section (EC3)

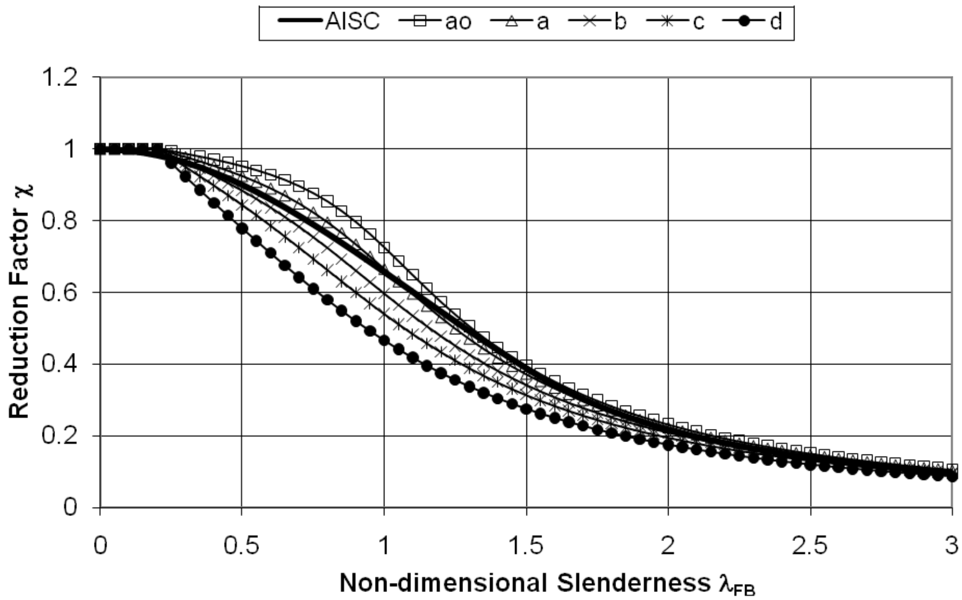


Fig. 4.2: Comparison of Reduction Factors for Flexural Buckling between AISC-360 and EC3

Strictly speaking the comparisons presented in this section are for members having no slender elements. Both specifications have special rules for the treatment of slender element or Class 4 sections under pure axial compression.

CHAPTER 5

DESIGN OF MEMBERS FOR FLEXURE

According to both specifications, yielding and lateral torsional buckling are the two limit states for flexural members. Yielding and lateral torsional buckling are treated separately for clarity of comparisons.

5.1 Limit State of Yielding – Laterally Supported Beams

The nominal moment capacity (M_n) of a cross-section is influenced by the slenderness of its elements. In AISC-360 separate expressions are provided for the nominal moment capacity depending on the web classification of the member. A similar yet different approach is adopted in EC3. In this section, members having compact flanges (Class 1 or 2 flanges) are studied first by considering different web slenderness. Later, members having compact webs (Class 1or 2) are studied by considering different flange slenderness. Because of the wide range of application of the flexure strength expressions, only doubly symmetric I-shaped members bent about their major axis are considered.

5.1.1 Members with Compact Flanges (Class 1 or 2)

Both specifications allow the member to reach its plastic moment capacity if the web is compact (Class 1 or 2). The nominal moment capacity for these types of sections is determined as follows:

$$M_n = M_p = ZF_y \qquad \text{(AISC360 and EC3)} \tag{5.1}$$

The treatment for non-compact (Class 3) web members is different in AISC-360 and EC3. According to the AISC specification, the nominal moment capacity reduces linearly with an increase in the web slenderness and varies between the plastic moment capacity (M_p) and the yield moment (M_y). On the contrary, the nominal moment capacity is directly equal to the yield moment in the EC3 specification for Class 3 cross-sections.

The nominal moment capacity for members with non-compact webs is determined as follows:

$$M_n = \left[\frac{M_p}{M_y} - \left(\frac{M_p}{M_y} - 1 \right) \left(\frac{\lambda - \lambda_{pw}}{\lambda_{rw} - \lambda_{pw}} \right) \right] M_y \quad \text{where } M_y = S_x F_y \quad \text{(AISC-360)} \qquad (5.2)$$

$$M_n = S_x F_y \qquad \text{(EC3)} \qquad (5.3)$$

While Eqn. 5.2 and 5.3 are applicable to all Class 3 sections (i.e. flange or web being Class 3) there is a special treatment for sections with Class 3 webs and Class 1 or 2 flanges. These sections can be treated as effective Class 2 cross-sections. In the effective section shown in Fig. 5.1, the proportion of the web in compression is replaced by a part of $20\varepsilon t_w$ (where $\varepsilon = \sqrt{235/F_y}$ F_y in MPa) adjacent to the compression flange, with another part of $20\varepsilon t_w$ adjacent to the plastic neutral axis of the effective cross section. The dark portion shown in Fig. 5.1 is neglected.

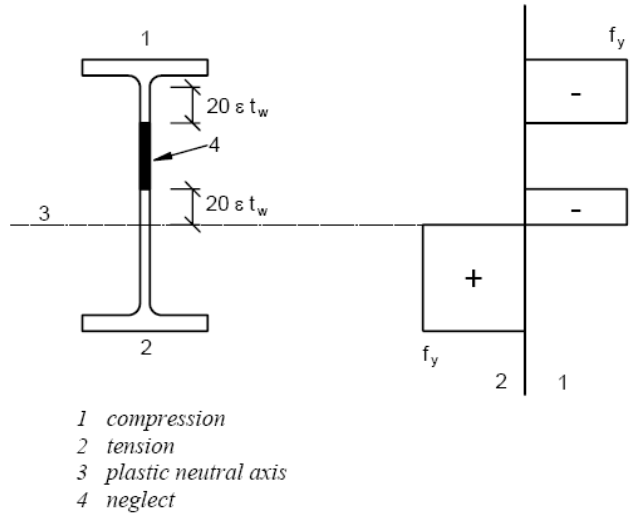


Fig. 5.1: Effective Class 2 Cross Section

For slender web members, elastic buckling of the web occurs before attainment of the yield stress on any of the fibers. According to the theoretical plate buckling solutions, the moment carrying capacity decreases drastically with an increase in the web slenderness. However, restrained thin plates have significant post-buckling capacity. Both specifications favor the use of post-buckling strength possessed by the slender web plates under bending stresses. Treatments for these types of members are different in two specifications. AISC specification has a more direct approach for calculating the nominal moment capacity. Basically a bending strength reduction factor (R_{pg}) is calculated to account for the loss of strength due to the buckling of the web plate. The nominal moment capacity is calculated as follows in AISC-360:

$$M_n = R_{pg} F_y S_x \text{ where } R_{pg} = 1 - \frac{a_w}{1200 + 300 a_w}\left(\frac{h}{t_w} - 5.7\sqrt{\frac{E}{F_y}}\right) \le 1.0 \quad a_w = \frac{h t_w}{b_f t_f} \tag{5.4}$$

In EC3 the slender web members are treated using the effective cross section shown in Fig. 5.2. A certain portion of the web is assumed to be ineffective. The amount of reduction of the cross-section under compression is a function of the web slenderness (h/t_w). The effective area under compression for the web plate is determined as follows:

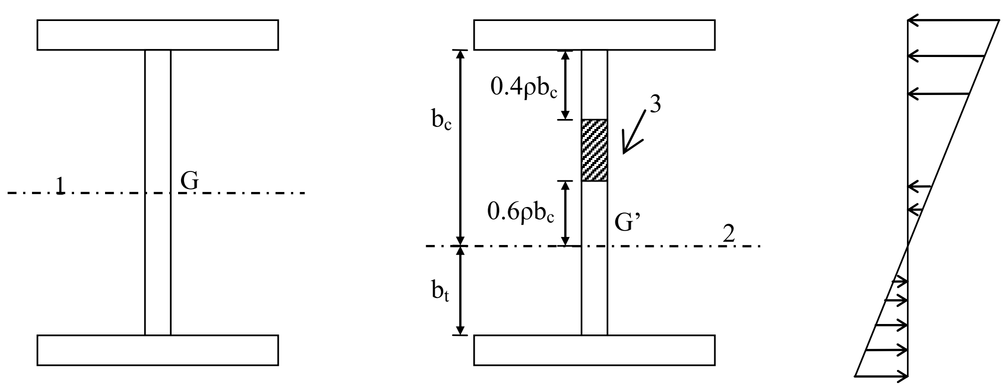
$$A_{c,eff} = b_{eff} t_w = \rho A_c = \rho b_c t_w$$

$$\rho = 1.0 \quad \text{for } \bar{\lambda}_p \leq 0.673$$

$$\rho = \frac{\bar{\lambda}_p - 0.055(3+\psi)}{\bar{\lambda}_p^{\,2}} \quad \text{for } \bar{\lambda}_p > 0.673 \tag{5.5}$$

$$\bar{\lambda}_p = \frac{h/t_w}{28.4\varepsilon\sqrt{k_\sigma}} \qquad \varepsilon = \sqrt{\frac{235}{F_y\,(in\ MPa)}}$$

ψ = -1 and k_σ = 23.9 for doubly symmetric sections under pure bending



G : Centroid of the gross cross section

G' : Centroid of the effective cross section

1 : Centroidal axis of the cross section

2 : Centroidal axis of the effective cross section

3 : None effective zone

Fig. 5.2: Class 4 Cross Section for Bending Moment

According to the effective cross section shown in Fig. 5.2, 40 percent of the effective compression area is adjacent to the compression flange, and the remaining 60 percent is adjacent to the elastic neutral axis of the cross section. Calculation of the effective section properties requires finding the location of the elastic neutral axis. From equilibrium of stress resultants, the following equation was derived to find the depth of the web under compression (b_c):

$$\left[0.4\rho t_w + 0.1\rho^2 t_w - 0.5 t_w\right] b_c^2 + \left[2A_f + h t_w\right] b_c - \left[A_f h + 0.5 h^2 t_w\right] = 0 \quad (5.6)$$

Depending on the geometrical properties, the second order equation can be solved for b_c. After determining the value of b_c the effective inertia (I_{eff}) and the effective section modulus ($S_{eff}=I_{eff}/b_c$) can be found. The nominal moment capacity is calculated as follows:

$$M_n = S_{eff} F_y \quad \text{(EC3)} \quad (5.7)$$

The nominal moment capacities from both specifications were compared by considering doubly symmetric I-shaped members with different web dimensions. For all cases, 300 mm by 20 mm flanges were considered. The web height was varied between 500 mm and 2000 mm and the web thickness was varied between 5 mm and 20 mm. A total of 89 sections were considered which had an average and maximum shape factor of 1.16 and 1.28, respectively. Nominal moment capacities of these sections were calculated according to AISC-360 and EC3. The capacities were normalized by the plastic moment capacity (M_p) and are presented in Fig. 5.3, Fig. 5.4 and values of sections are presented in Table A.1 and Table A.2 for two different yield strength values. According to these figures, the EC3 nominal moment capacities are in general lower than the AISC-360 ones. Maximum differences on the order of 17 percent occur for sections having non-compact flanges (Class 3). For slender web members, the capacities from both specifications are close to each other.

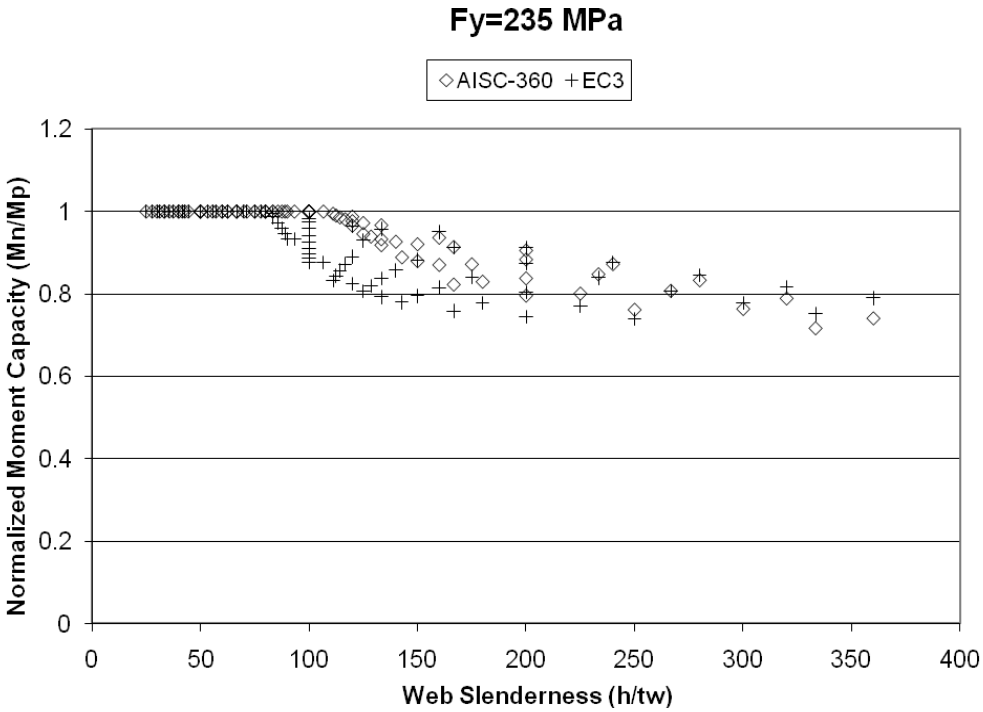


Fig. 5.3: Normalized Moment Capacity vs. Web Slenderness for F_y=235 MPa

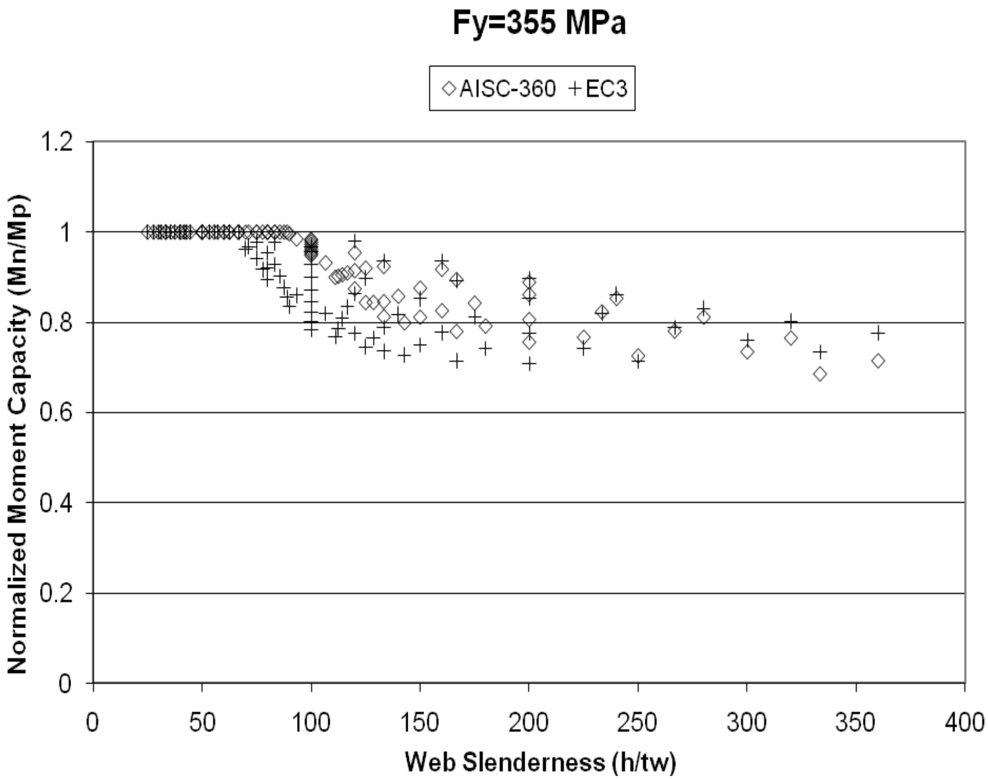


Fig. 5.4: Normalized Moment Capacity vs. Web Slenderness for F_y=355 MPa

It may be hard to discern the differences from Fig 5.3, and Fig 5.4, therefore cross sections with 8 mm thick web and 300 mm by 20 mm flanges were considered. The differences in nominal capacities are given in Fig. 5.5 and Fig. 5.6.

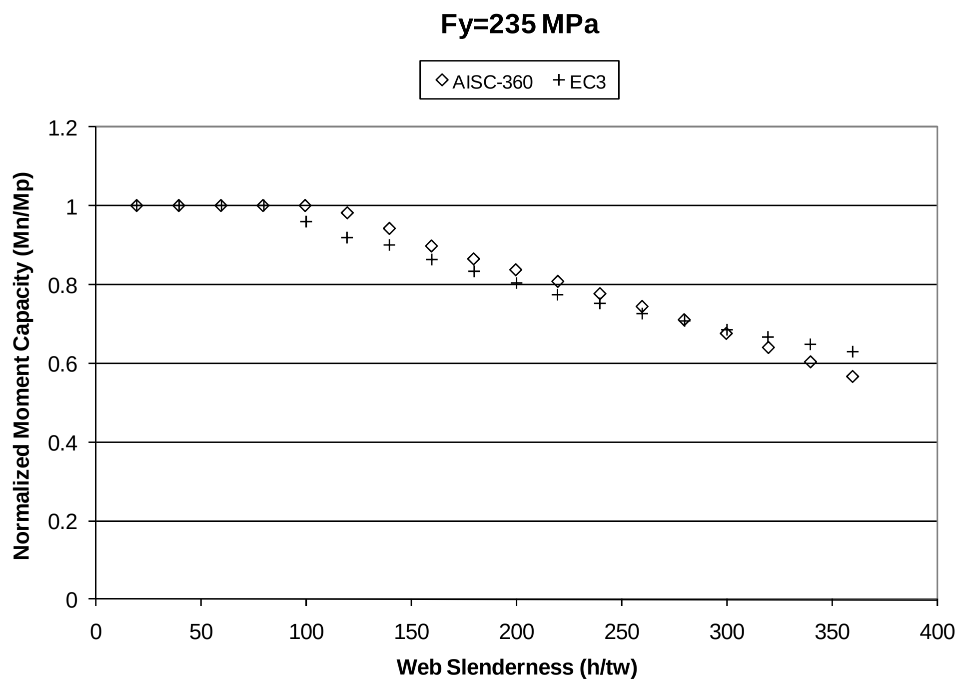


Fig. 5.5: Normalized Moment Capacity vs. Web Slenderness for F_y=235 MPa

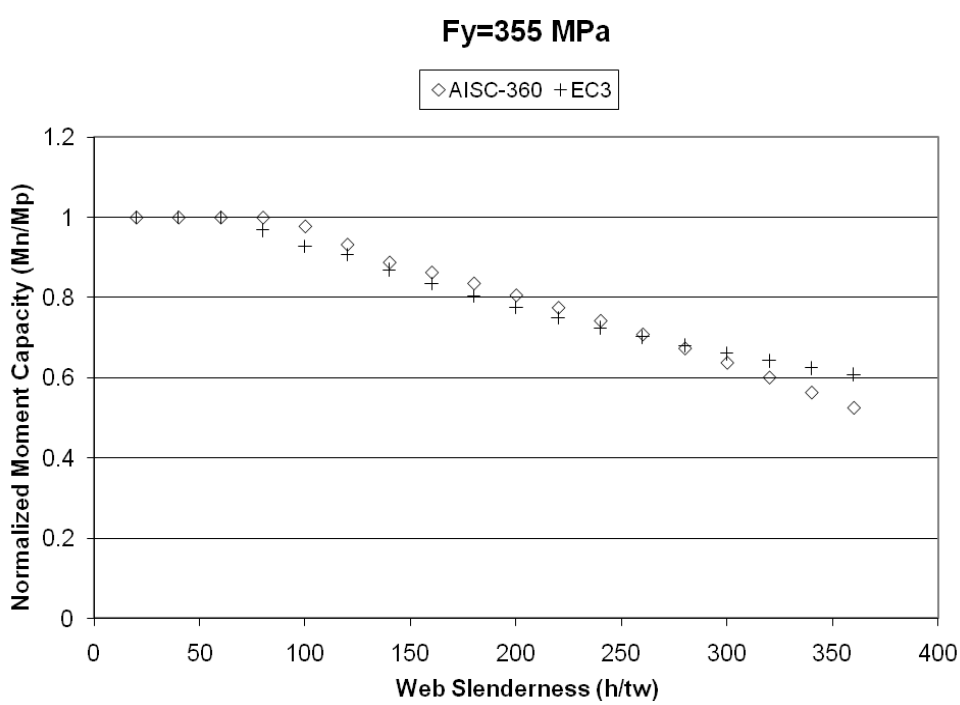


Fig. 5.6: Normalized Moment Capacity vs. Web Slenderness for F_y=355 MPa

A total of 18 cross sections were considered with 8 mm thick web and 300 mm by 20 mm flanges. These cross sections's nominal moment capacities were calculated by changing web height from 160 mm to 2880 mm. These cross sections had an average and maximum shape factor of 1.15 and 1.21, respectively. Calculated nominal capacities (M_n) were normalized by the plastic moment capacity (M_p). Maximum difference on the order of 15 percent occurs for section having slender web (Class 4).

5.1.2 Members with Compact Webs (Class 1 or 2)

The effects of flange slenderness were studied by considering compact web I-shaped members. Usually the flanges of built-up members are designed to be compact (Class 1 or Class 2). Non-compact or slender flanges may be used in some cases due to architectural requirements. Each specification has a different treatment for the flange buckling problem. In the AISC specification, the limiting slenderness ratio for slender flanges is dependent on the web dimensions. In other words, the rotational restraint that is provided by the web to the flange is explicitly taken into account using a k_c factor. In EC3, however, the limiting flange slenderness ratios are not given as a function of the web slenderness. In order to make a fair comparison of the capacities given by both specifications, members with different flange and web slenderness ratios were considered herein. According to both specifications, the member can reach to its plastic moment capacity if the flanges are compact (Class 1 or Class 2). Therefore, Eqn. 5.1 is valid for determining the nominal moment capacity of such members.

Treatment of non-compact flanges is similar to the treatment on non-compact webs in both specifications. According to the AISC specification, the nominal moment capacity reduces linearly with an increase in the flange slenderness and varies between the plastic moment capacity (M_p) and the yield moment considering residual stresses ($0.7M_y$). On the other hand, the nominal moment capacity is equal to the yield moment for Class 3 sections according to the EC3 specification.

The nominal moment capacity for members with non-compact flanges is determined as follows:

$$M_n = \left[M_p - \left(M_p - 0.7 F_y S_x \right) \left(\frac{\lambda - \lambda_{pf}}{\lambda_{rf} - \lambda_{pf}} \right) \right] \qquad \text{(AISC-360)} \qquad (5.8)$$

$$M_n = S_x F_y \qquad \text{(EC3)} \qquad (5.9)$$

For slender flange members the AISC specification utilizes the elastic critical buckling moment approach. According to the AISC specification the nominal moment capacity is calculated as follows:

$$M_n = \frac{0.9 E k_c S_x}{\lambda^2} \text{ where } k_c = \frac{4}{\sqrt{h/t_w}} \qquad (5.10)$$

In EC3, the post buckling reserve strength approach is utilized. An effective cross-section shown in Fig.5.7 is considered for this purpose. In this effective cross section, the outstanding portions of the compression flange are assumed is be ineffective. The nominal moment capacity for sections with Class 4 flanges determined using the elastic section modulus (S_{eff}) of the effective cross section shown in Fig. 5.7. The effective area of the compression flange and the nominal moment capacity are determined as follows:

$$A_{c,eff} = b_{eff} t_f = \rho b_f t_f$$

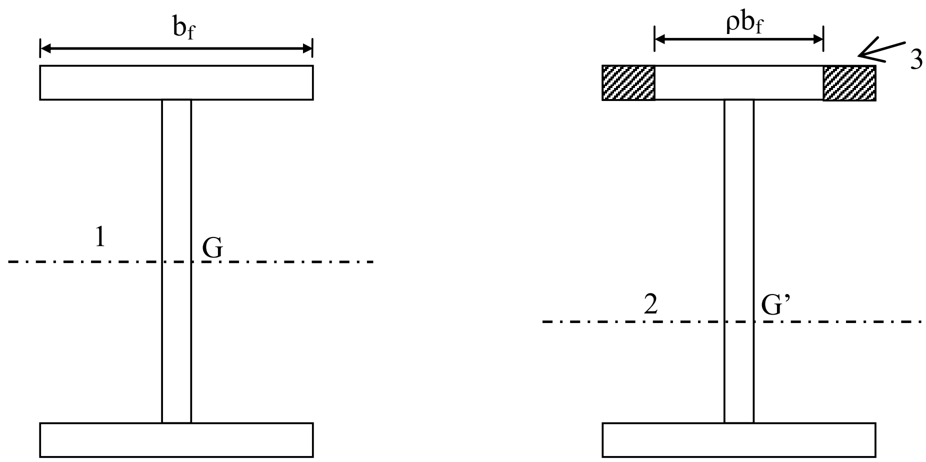
$$\rho = 1.0 \quad \text{for } \bar{\lambda}_p \le 0.748$$

$$\rho = \frac{\bar{\lambda}_p - 0.188}{\bar{\lambda}_p^{\,2}} \quad \text{for } \bar{\lambda}_p > 0.748 \tag{5.11}$$

$$\bar{\lambda}_p = \frac{b_f / t_f}{28.4\varepsilon\sqrt{k_\sigma}} \qquad \varepsilon = \sqrt{\frac{235}{F_y\,(in\ MPa)}}$$

$$k_\sigma = 0.43 \text{ for flanges under uniform compression}$$

$$M_n = S_{eff} F_y$$



G : Centroid of the gross cross section

G' : Centroid of the effective cross section

1 : Centroidal axis of the cross section

2 : Centroidal axis of the effective cross section

3 : None effective zone

Fig. 5.7: Class 4 Flange Effective Cross Section for Bending Moment

The nominal moment capacities from both specifications were compared by considering doubly symmetric I-shaped members with different flange and web dimensions. Compact webs which had a variety of thickness from 8 mm to 20 mm and height from 500 mm to 1000 mm were considered. Both compact, noncompact and slender flanges which had dimensions from 300 mm width to 500 mm width and 10 mm thickness to 20 mm thickness were taken into account. A total of 264 cross sections which had average and maximum shape factor of 1.15 and 1.28 were considered, respectively. The normalized moment capacities are presented in Fig. 5.8, Fig. 5.9, Fig 5.10 and Fig 5.11, section dimensional properties and moment values are shown in Table B.1 and Table B.2 for two different yield strengths.

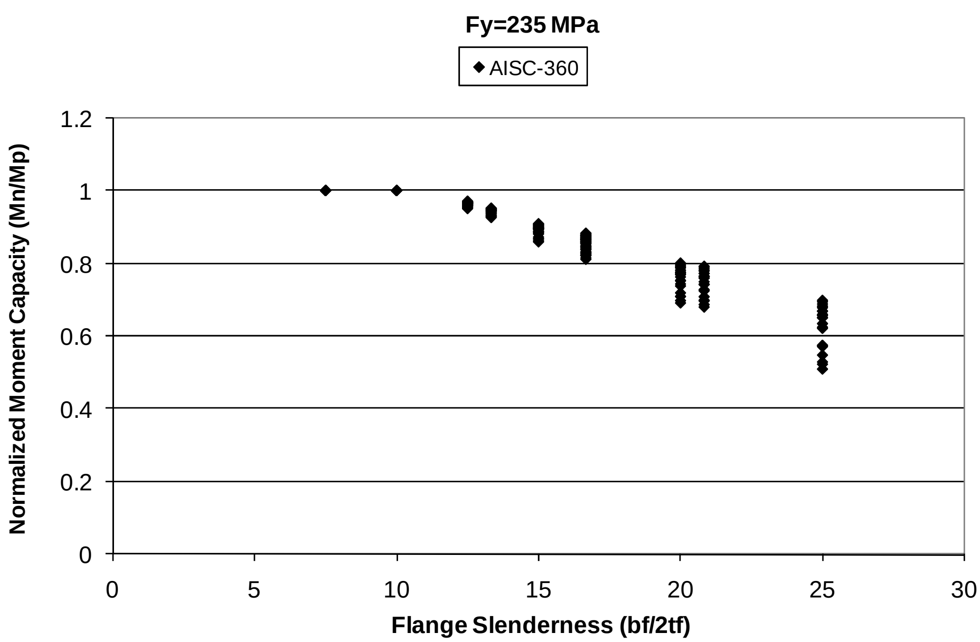


Fig. 5.8: Normalized Moment Capacity vs. Flange Slenderness for F_y=235 MPa (AISC-360)

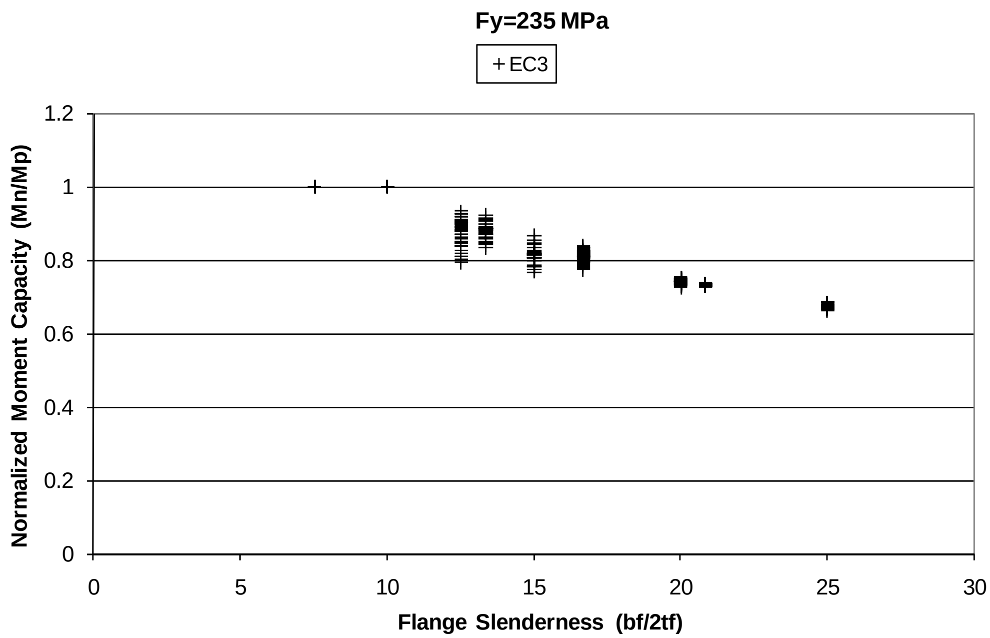


Fig. 5.9: Normalized Moment Capacity vs. Flange Slenderness for F_y=235 MPa (EC3)

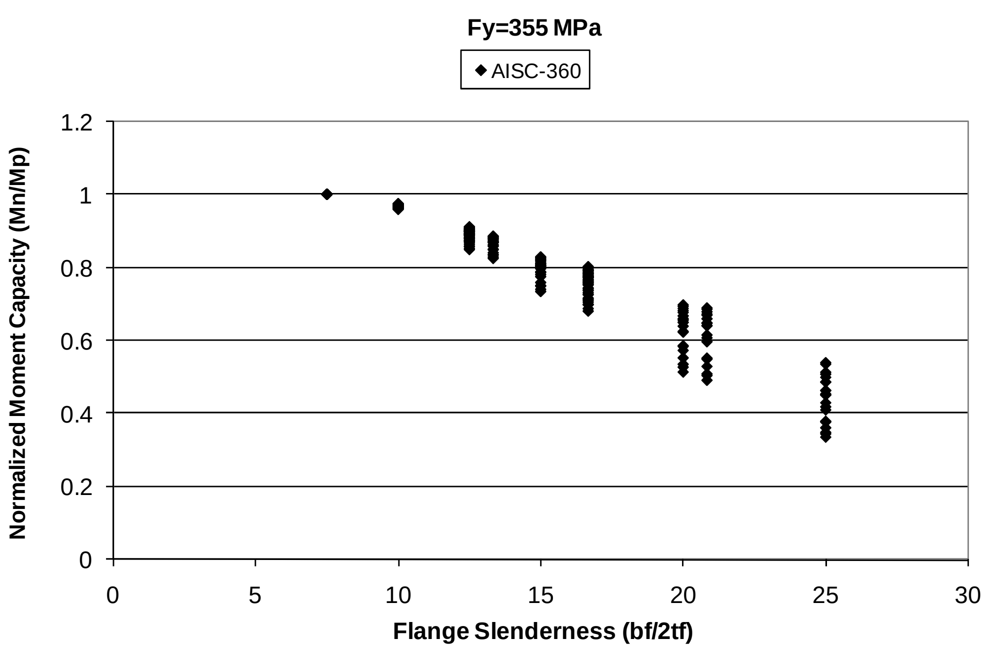


Fig. 5.10: Normalized Moment Capacity vs. Flange Slenderness for F_y=355 MPa (AISC-360)

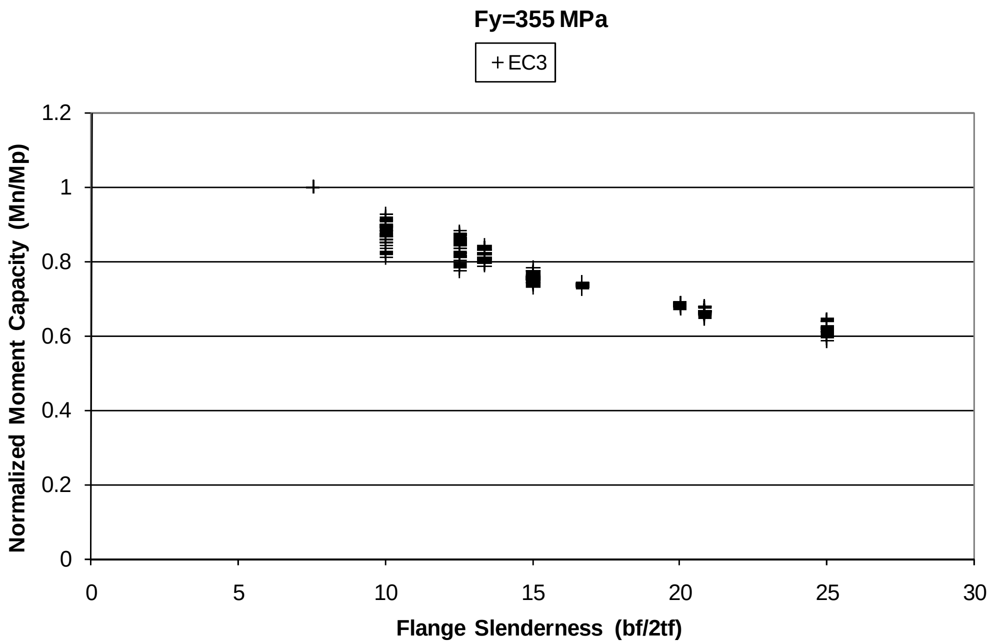


Fig. 5.11: Normalized Moment Capacity vs. Flange Slenderness for F_y=355 MPa (EC3)

To discern the differences from Fig 5.8, Fig 5.9, Fig 5.10 and Fig 5.11; cross sections with 10 mm thick and 500 mm high web were considered. For all cases, flange width was changed from 80 mm to 720 mm. Flange thickness was also kept constant as 10 mm. A total of 33 cross sections which had 1.13 average and 1.29 maximum of shape factor were considered. The normalized moment capacities are presented in Fig. 5.12 and Fig. 5.13 for two different yield strengths.

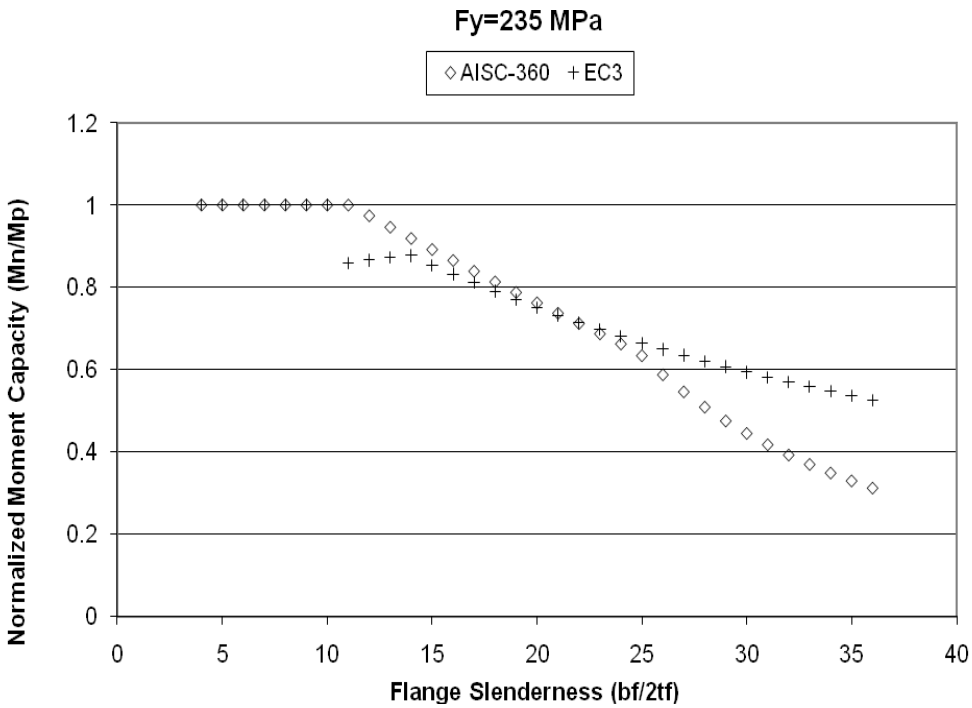


Fig. 5.12: Normalized Moment Capacity vs. Flange Slenderness for F_y=235 MPa

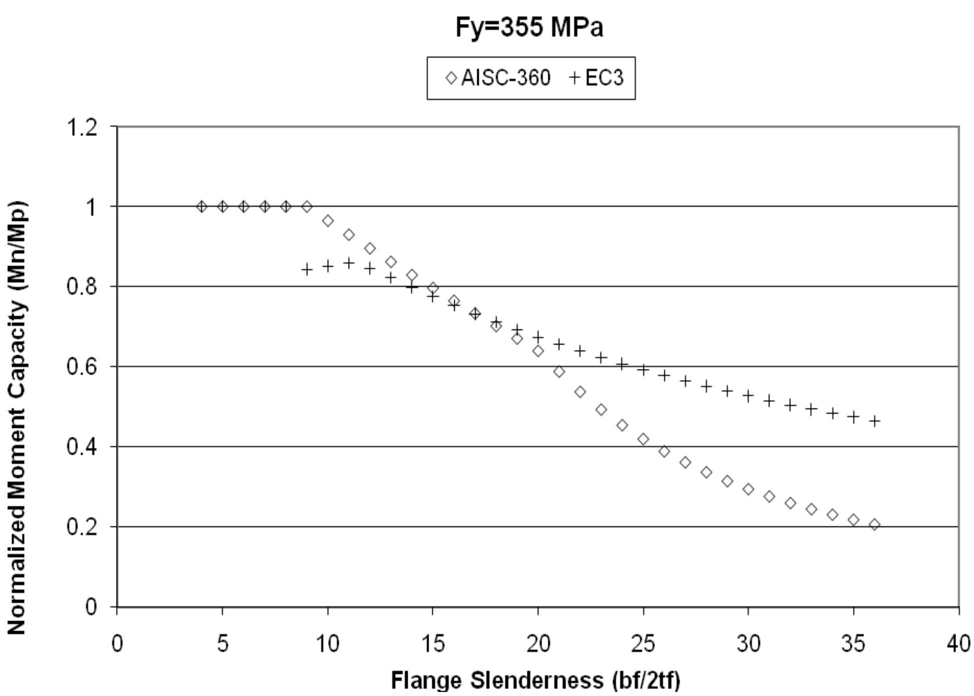


Fig. 5.13: Normalized Moment Capacity vs. Flange Slenderness for F_y=355 MPa

According to the comparison it is evident that EC3 provides higher capacities for slender flange members while AISC-360 provides higher capacities for non-compact flange members.

5.2 Lateral Torsional Buckling of Compact I-shaped Members

AISC-360 and EC3 have differences for the treatment of lateral torsional buckling. AISC-360 specification identifies three regimes of buckling depending on the unbraced length of the member (L_b). Two threshold values for unbraced length namely L_p and L_r are defined in AISC-360. The L_p value provides a dividing line between plastic (no lateral buckling) and inelastic buckling behavior. Similarly, the L_r value provides a dividing line between inelastic and elastic buckling behavior. According to AISC-360, plastic moment capacity of a compact member can develop if the unbraced length is less than L_p. The member's capacity reduces linearly between M_p and $0.7M_y$ if the unbraced length is between L_p and L_r. If the unbraced length is greater than L_r, then elastic buckling is expected to occur and the capacity can be found using elastic critical buckling moment (M_{cr}). The following equations summarize the nominal moment capacity for lateral torsional buckling as per the AISC specification:

$$M_n = M_p = ZF_y \quad \text{when } L_b \le L_p \tag{5.12}$$

$$M_n = C_b\left[M_p - \left(M_p - 0.7S_xF_y\right)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right] \le M_p \quad \text{when } L_p < L_b \le L_r \tag{5.13}$$

$$M_n = M_{cr} = S_x \frac{C_b \pi^2 E}{\left(\frac{L_b}{r_{ts}}\right)^2}\sqrt{1 + 0.078\frac{J}{S_x h_o}\left(\frac{L_b}{r_{ts}}\right)^2} \quad \text{when } L_b > L_r \tag{5.14}$$

$$L_p = 1.76 r_y \sqrt{\frac{E}{F_y}}$$

$$L_r = 1.95 r_{ts} \frac{E}{0.7F_y}\sqrt{\frac{J}{S_x h_o}}\sqrt{1+\sqrt{1+6.76\left(\frac{0.7F_y}{E}\frac{S_x h_o}{J}\right)^2}}$$

$$r_{ts}^2 = \frac{\sqrt{JC_w}}{S_x}$$

As mentioned in the compression members section, EC3 utilizes a reduction factor approach for all buckling problems. The lateral torsional buckling problem is also treated by developing a reduction factor (χ_{LT}) expression. The nominal moment capacity for lateral torsional buckling can be found as:

$$M_n = \chi_{LT} M_p = \chi_{LT} Z F_y \tag{5.15}$$

The reduction factor (χ_{LT}) is defined as:

$$\chi_{LT} = \frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \beta\lambda_{LT}^2}} \quad \text{but } \{\chi_{LT} \le 1.0 \quad \chi_{LT} \le \frac{1}{\lambda_{LT}^2} \tag{5.16}$$

$$\Phi_{LT} = 0.5\left[1 + \alpha_{LT}\left(\lambda_{LT} - \lambda_{LT,o}\right) + \beta\lambda_{LT}^2\right]$$

$$\lambda_{LT} = \sqrt{\frac{M_p}{M_{cr}}}$$

First of all, no M_{cr} expression is recommended in EC3. Any rational analysis to determine M_{cr} is acceptable. In this study, the elastic critical moment expression; Eqn 5.14, provided in AISC specification was considered to be used in the EC3 expressions. As shown in Eqn. 5.16, the EC3 approach requires three parameters namely, α_{LT}, $\lambda_{LT,O}$, and β to be used. The α_{LT} factor is dependent on the imperfections and its value is identical to the α factors given in the compression members section. The proper imperfection curve (i.e. type a, b, c, or d) and the values of $\lambda_{LT,O}$, and β are dependent on the country of use and are specified in the National Annex. On the other hand, a maximum value of 0.4 for $\lambda_{LT,O}$ and a minimum value of 0.75 for β are recommended in the absence of a National Annex. The appropriate buckling curve as per EC3 recommendations is based on the depth to width ratio (d/b_f) of the member. For rolled I-sections, curve "b" is utilized for $d/b_f<2$ and curve "c" for others. Similarly, for welded I-sections, curve "c" is utilized for $d/b_f<2$ and curve "d" for others. Table 5.5 shows the imperfection factor values corresponding to the buckling curves.

Table 5.5: Imperfection Factor; α_{LT} (EC3)

Buckling Curve	a	b	c	d
Imperfection factor α_{LT}	0.21	0.34	0.49	0.76

IPE 400 and HEB 500 rolled I-shaped sections were considered to compare lateral torsional buckling capacity of I shaped members. IPE 400 ($d/b_f<2$) was analyzed for different buckling lengths from 0.1 m to 22 m. HEB 500 ($d/b_f>2$) was analyzed from 0.1 m to 30 m. By using the maximum value for $\lambda_{LT,O}$ and minimum value for β, nominal moment capacities are tabulated in Table C.1, Table C.2, Table C.3 and Table C.4 for IPE 400 and HEB 500 cross sections with two different yield strengths.

For IPE 400 and HEB 500 cross sections, normalized moment capacity is presented in Fig. 5.14, Fig. 5.15, 5.16 and 5.17

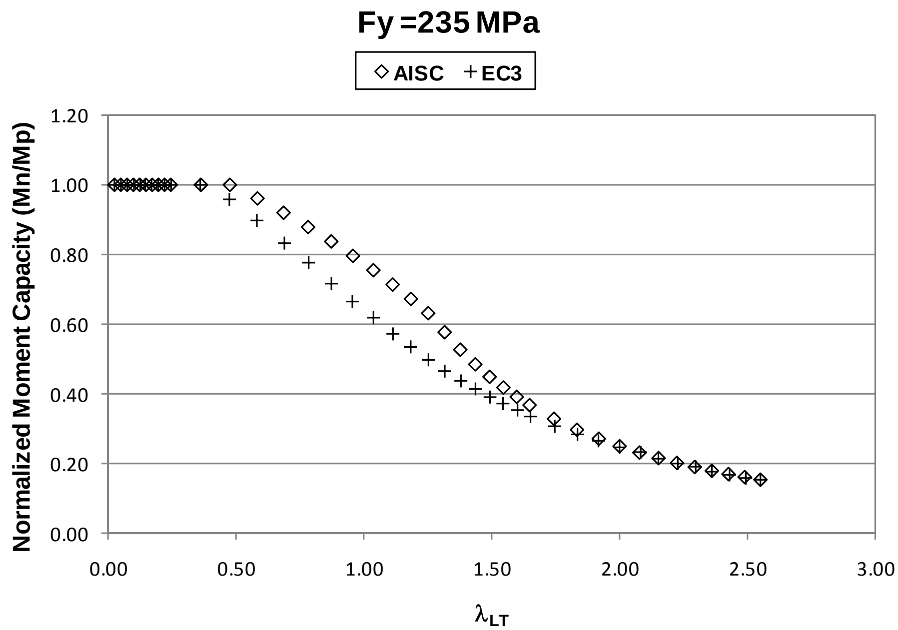


Fig. 5.14: IPE 400-Normalized Moment Capacity vs. Section Slenderness for Fy=235 MPa

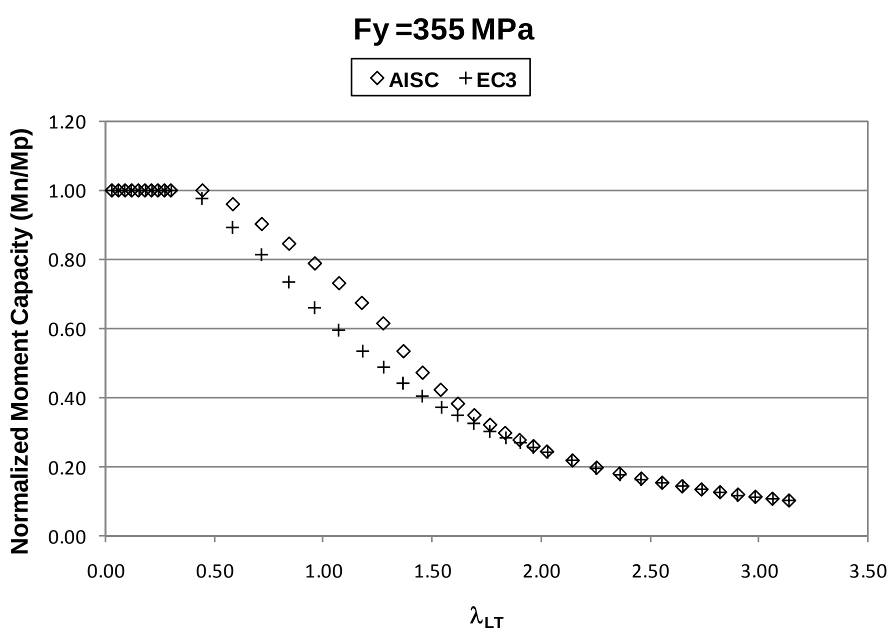


Fig. 5.15: IPE 400- Normalized Moment Capacity vs. Section Slenderness for Fy=355 MPa

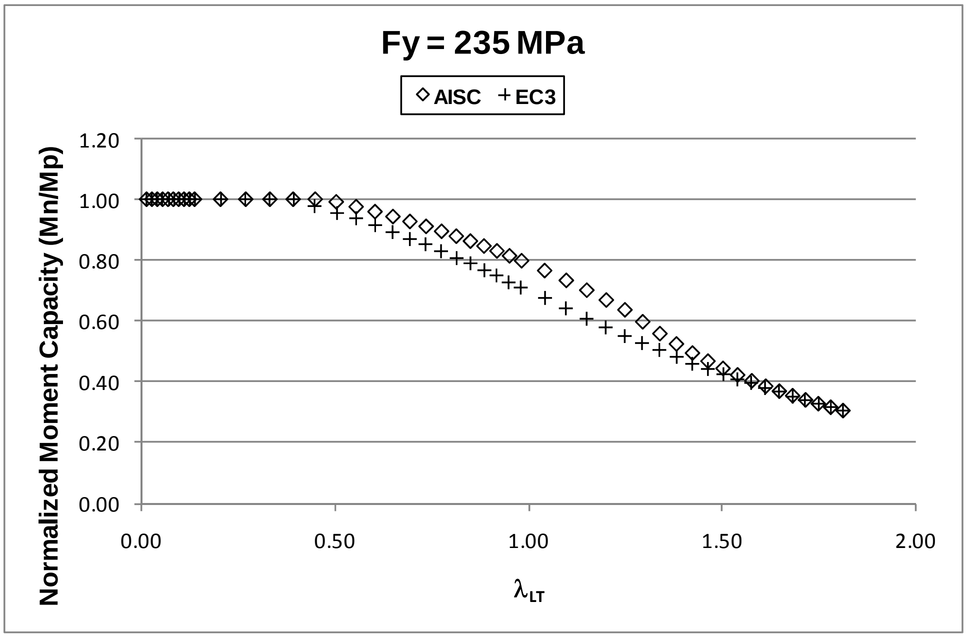


Fig. 5.16: HEB 500- Normalized Moment Capacity vs. Section Slenderness for Fy=235 MPa

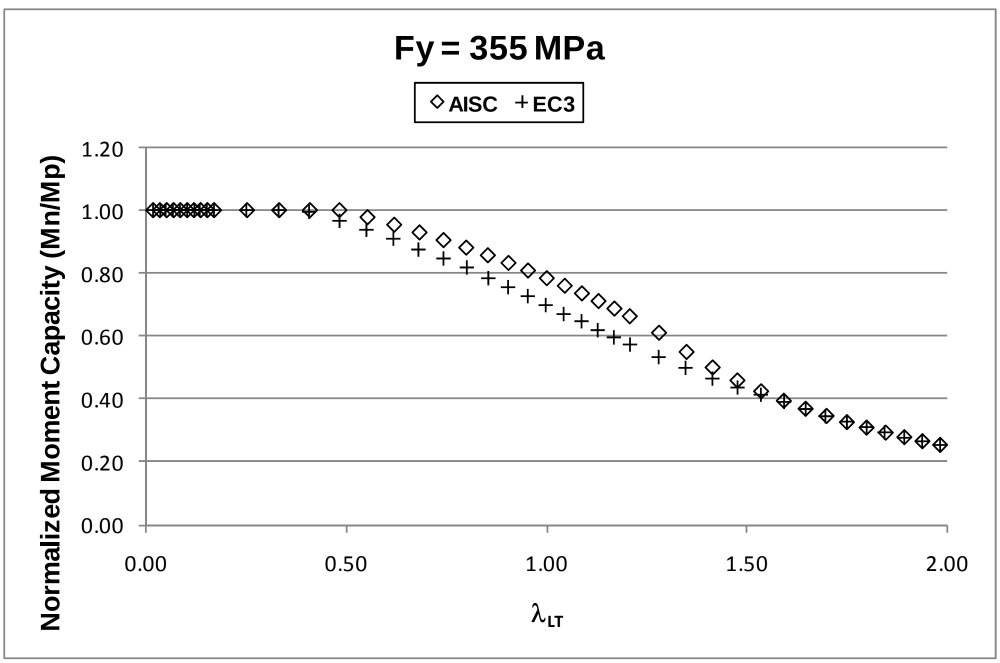


Fig. 5.17: HEB 500- Normalized Moment Capacity vs. Section Slenderness for Fy=355 MPa

EC3 shows the lower reduction for the lateral torsional buckling capacities for rolled I-shaped members if maximum limit value of $\lambda_{LT,O}$ and minimum limit value of β are used. $\lambda_{LT,O}$ and β values were changed to fit the reduction factor slenderness curves. If $\lambda_{LT,O}$ =0.55 and β=0.30 values are used instead the limit values, for IPE 400 section, reduction factor vs. slenderness curve fit exactly for both AISC-360 and EC3 specifications for two yield strengths. Fig. 5.18 and Fig. 5.19 represent these curves.

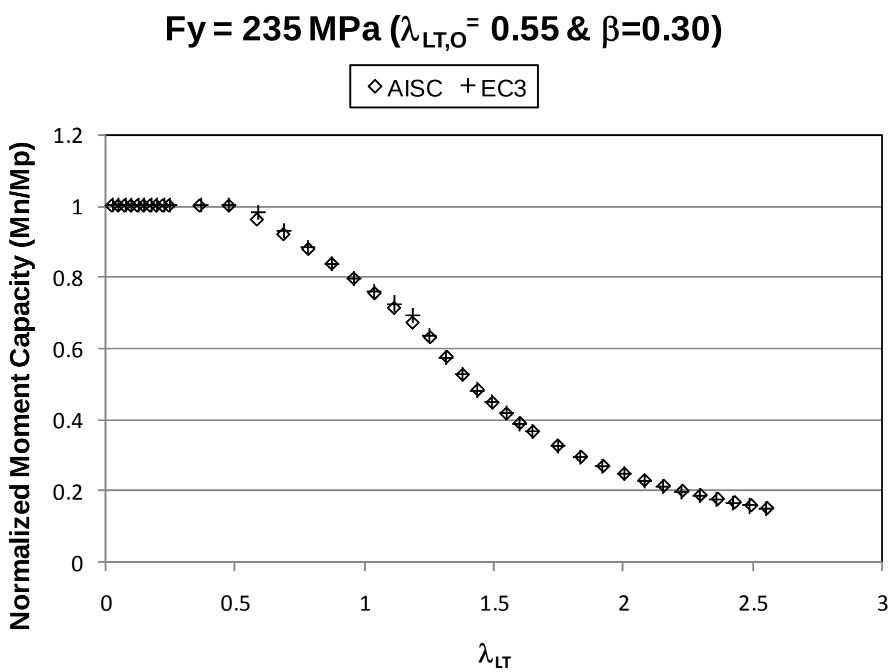


Fig. 5.18: IPE 400- Normalized Moment Capacity vs. Section Slenderness for Fy=235 MPa

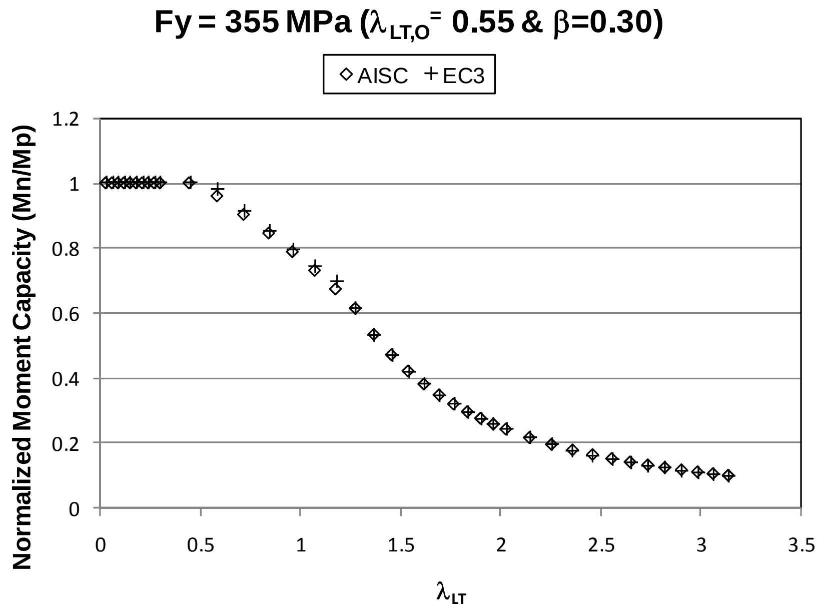


Fig. 5.19: IPE 400- Normalized Moment Capacity vs. Section Slenderness for Fy=355 MPa

If $\lambda_{LT,O}$ =0.50 and β=0.48, normalized moment capacity-slenderness curves fit for HEB 500 section. Fig. 5.20 and Fig. 5.21 show these curves for two different yield strengths.

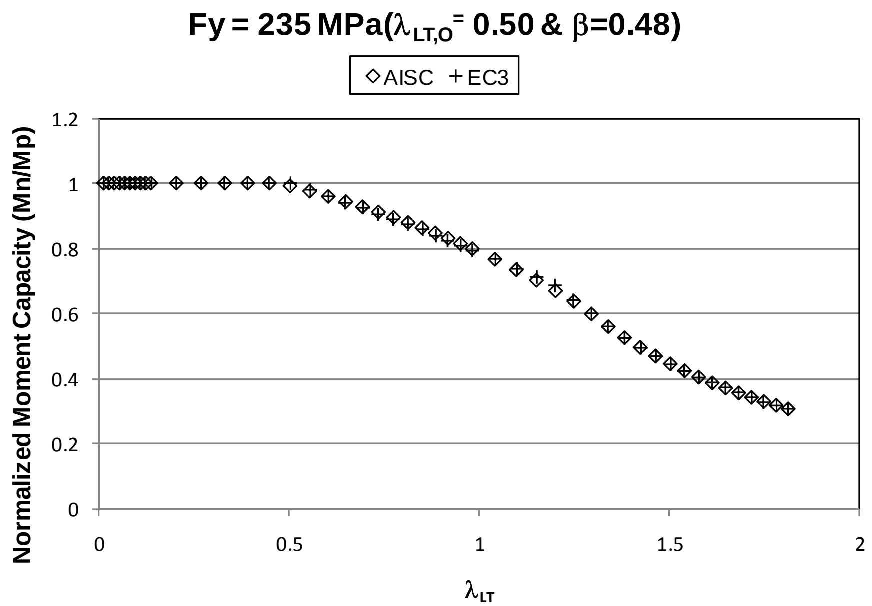


Fig. 5.20: HEB 500- Normalized Moment Capacity vs. Section Slenderness for Fy=235 MPa

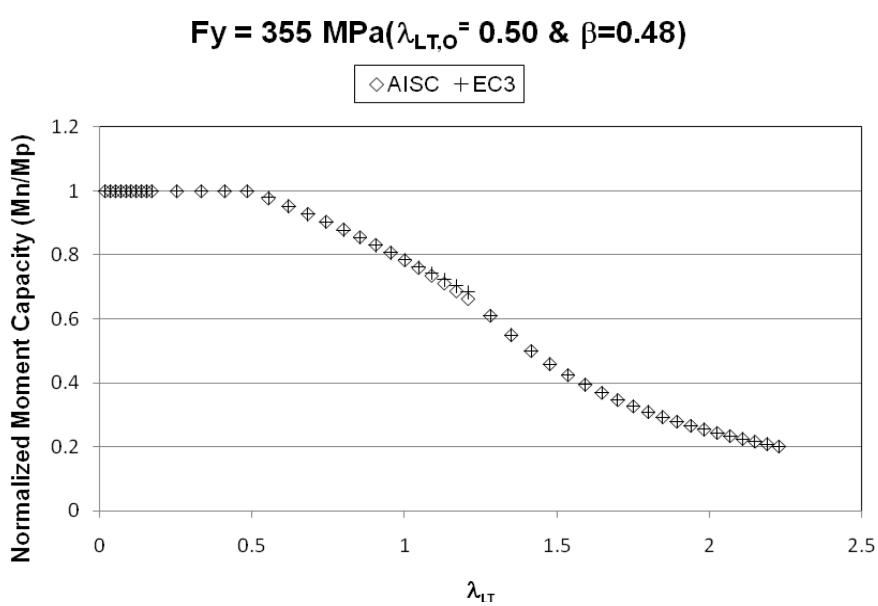


Fig. 5.21: HEB 500- Normalized Moment Capacity vs. Section Slenderness for Fy=355 MPa

CHAPTER 6

DESIGN OF MEMBERS FOR SHEAR

Both specifications consider the limit states of shear yielding and shear buckling for unstiffened and stiffened webs. For unstiffened or stiffened webs the design shear resistance is the sum of the shear resistance contribution of web and shear resistance contribution of flanges for EC3. The main difference between the AISC-360 and EC3 is that AISC-360 presents two methods of calculating shear strengths of sections explicitly. One of them utilizes the post buckling strength of the member, namely tension field action is taken into consideration. However, EC3 does not brief any information about tension field action explicitly. The other method in AISC-360 for shear strength calculation does not take into account the tension field action.

In order to study the shear problem, one has to study the effective area for shear defined in both specifications.

6.1 Definition of Shear Area

In the thesis, load parallel to the web case is considered for design of shear. Hence, shear area for both specifications is determined based on the load parallel to web condition.

Shear area for rolled I sections is defined in Eqn. 6.1 and shown in Fig. 6.1.

$$A_v = A - 2b_f t_f + (t_w + 2r)t_f \qquad (6.1)$$

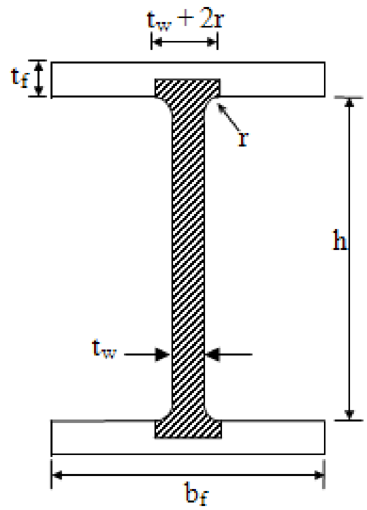


Fig. 6.1: Effective Shear Area for Rolled I Shapes in EC3

The given shear area in Eqn. 6.1 shall not be less than $\eta h t_w$. The value of η is defined in national annexes. However, η=1.20 is recommended for steel grades up to S460 (S460 included). η=1.00 is for higher steel grades. For welded I sections, the shear area is determined as Eqn. 6.4 and shown in Fig. 6.2;

$$A_v = \eta h t_w \tag{6.2}$$

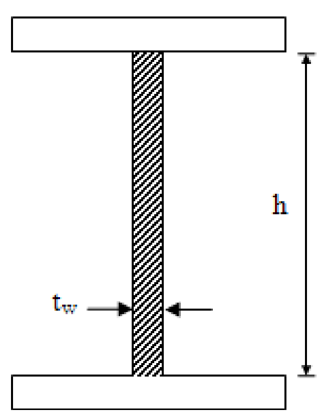


Fig. 6.2: Effective Shear Area for Welded I Shapes in EC3

In AISC-360, the shear area is defined as the multiplication of the overall depth of the section to web thickness. Fig. 6.3 shows the shear area for load parallel condition in AISC-360.

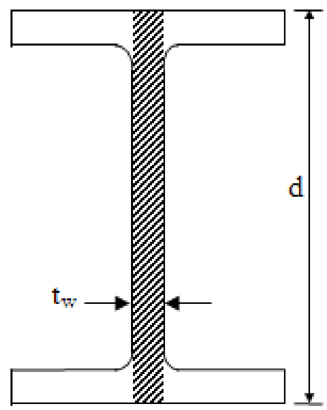


Fig. 6.3: Effective Shear Area for I Shapes in AISC-360

As described above, AISC 360 takes the overall depth for all sections. However, EC3 takes only web height for welded sections. For rolled sections in EC3, radius of sections is included to shear area. Therefore, η factor is used to adjust shear area. In fact, contribution of flanges for shear strength is too small such as deep girders. For these reasons, web height times the web thickness was taken as shear area and η=1.0 to make fair comparison in the thesis. To get consistency, the shear area and nominal shear strength are symbolized as A_w and V_n, respectively.

6.2 Design Strength of Shear

The plastic design shear strength, V_p, is very similar for both specifications.

$$V_p = 0.6 A_w F_y \qquad \text{(AISC-360)} \qquad (6.3)$$

$$V_p = \frac{A_w F_y}{\sqrt{3}} \qquad \text{(EC3)} \qquad (6.4)$$

The nominal shear strength, V_n, of unstiffened and stiffened webs is calculated depending upon the shear strength factor; C_v, in AISC-360. C_v shows three regimes depending upon the cross section web height to thickness ratio.

$$V_n = 0.6 F_y A_w C_v \quad \text{(AISC-360)} \qquad (6.5)$$

For $h / t_w \leq 1.10\sqrt{k_v E / F_y}$

$$C_v = 1.0$$

For $1.10\sqrt{k_v E / F_y} < h / t_w \leq 1.37\sqrt{k_v E / F_y}$

$$C_v = \frac{1.10\sqrt{k_v E / F_y}}{h / t_w}$$

For $h / t_w \geq 1.37\sqrt{k_v E / F_y}$

$$C_v = \frac{1.51 E k_v}{(h / t_w)^2 F_y}$$

Plate buckling coefficient, k_v, varies depending upon the stiffening provided to the web. If the web is unstiffened, k_v is taken as 5. On the contrary, if web is stiffened, k_v is calculated as follow;

$$k_v = 5 + \frac{5}{(a / h)^2}$$

“a” is the distance between transverse stiffeners. If a/h is greater than 3, k_v shall be taken as 5.

When the tension field action (TFA) is permitted, the nominal shear strength does not change if h / t_w is smaller than $1.10\sqrt{k_v E / f_y}$. However, if h / t_w is greater than $1.10\sqrt{k_v E / f_y}$, nominal shear strength shall be considered as;

$$V_n = 0.6F_y A_w \left(C_v + \frac{1 - C_v}{1.15\sqrt{1 + (a/h)^2}} \right) \tag{6.6}$$

In EC3, contribution of web and contribution of flanges for shear strength are considered. A shear resistance factor, χ_w, is taken into account depending upon the h /t_w ratio. Contribution of web for shear strength is;

$$V_n = \frac{\chi_w F_{yw} h t_w}{\sqrt{3}} \tag{6.7}$$

The web shear resistance factor, χ_w, is presented in Table. 6.1.

Table 6.1: Contribution from the Web χ_W to Shear Buckling Resistance in EC3

	Rigid End Post	Non-Rigid End Post
λ_W<0.83/η	η	η
0.83/η<λ_W<1.08	0.83/λ_W	0.83/λ_W
λ_W>1.08	1.37/(0.7+λ_W)	0.83/λ_W

If end portions of the section are stiffened, section is classified as rigid end post (REP) section. If end portions of the section are not stiffened, section is classified as non-rigid end post (NREP) section in EC3.

If transverse stiffeners are at supports only, the slenderness parameter, λ_w, is taken as;

$$\lambda_w = \frac{h_w}{86.4t\varepsilon} \tag{6.8}$$

In addition to support stiffeners, if intermediate transverse and / or longitudinal stiffeners exist, the slenderness parameter is;

$$\lambda_w = \frac{h_w}{37.4t\varepsilon\sqrt{k_\tau}} \tag{6.9}$$

$k_\tau = 5.34 + 4.00(h/a)^2 + k_{\tau st}$ when a / h $\geq$1.00

$k_\tau = 4.00 + 5.34(h/a)^2 + k_{\tau st}$ when a / h <1.00

When the flange resistance is not completely utilized to resist the bending moment, flange contribution for shear strength may be considered as follow;

$$V_n = \frac{b_f t_f^{\,2} F_{yf} t_w}{c}\left(1-\left(\frac{\mathrm{M_{Ed}}}{\mathrm{M_{f,Rd}}}\right)^2\right) \tag{6.10}$$

b_f is not taken larger than $15\varepsilon t_f$.

$$c = \left(0.25 + \frac{1.6 b_f t_f^{\,2} F_{yf}}{t_w h^2 F_{yw}}\right)$$

To investigate the differences between two specifications, 40 cross sections which had constant $M_{Ed}/M_{f,Rd}$ ratio (0.1) were considered for different a/h ratios. For all cases, flange dimensions were 300 mm by 15 mm. Also, web thickness was kept constant as 10 mm and web height increased from 100 mm to 4000 mm. Figs. 6.4, 6.5, 6.6 and 6.7 present normalized shear capacities for 235 MPa yield strength and different a/h ratios.

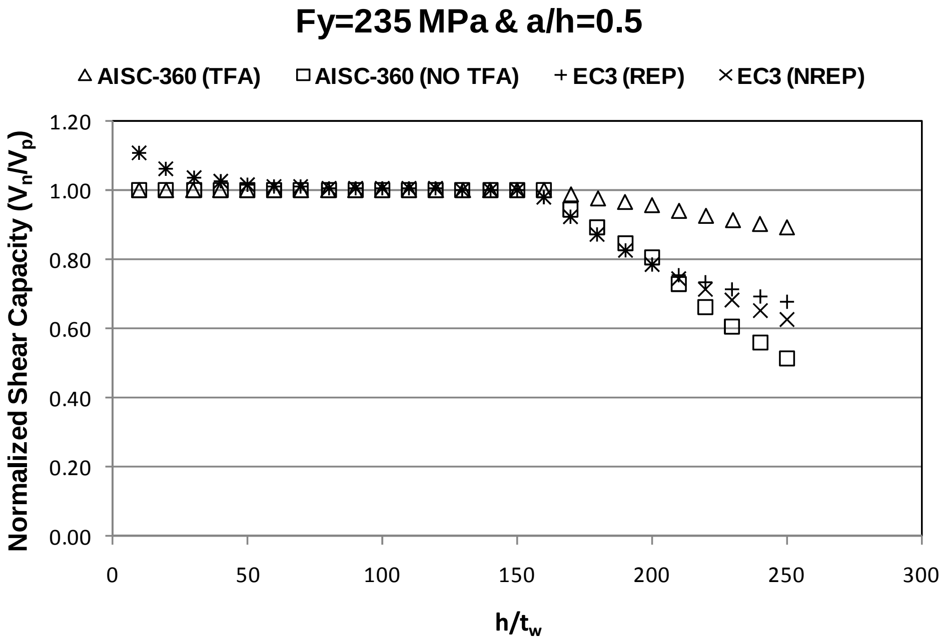


Fig. 6.4: Normalized Shear Capacity for a/h=0.5 and F_y=235 MPa

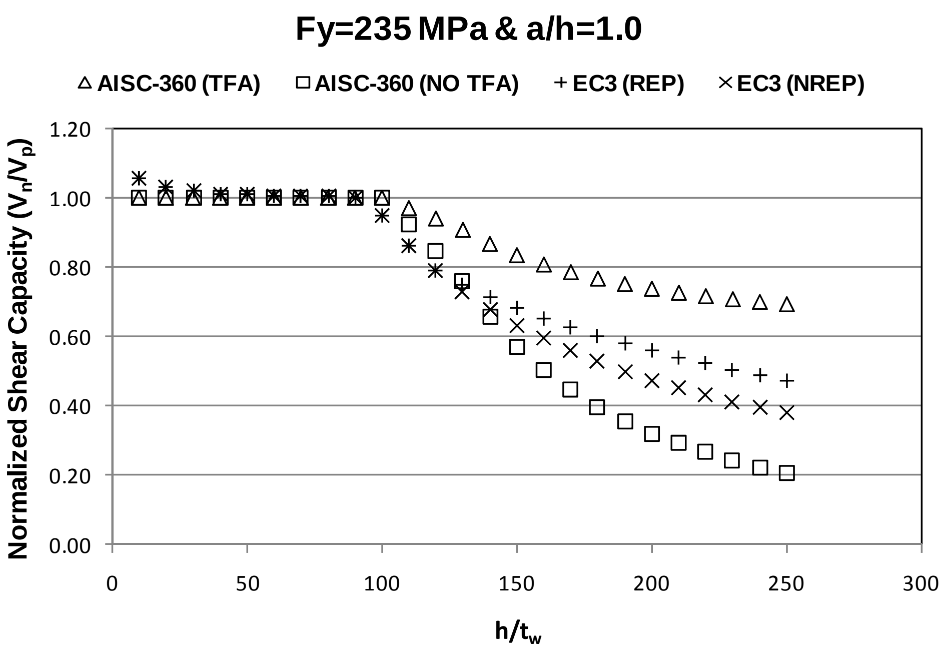


Fig. 6.5: Normalized Shear Capacity for a/h=1.0 and F_y=235 MPa

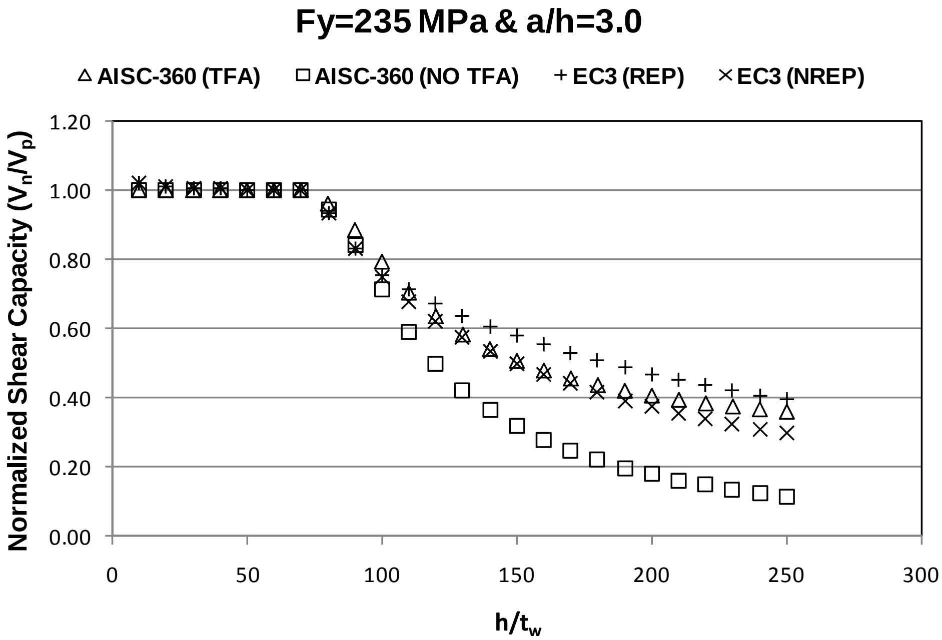


Fig. 6.6: Normalized Shear Capacity for a/h=3.0 and F_y=235 MPa

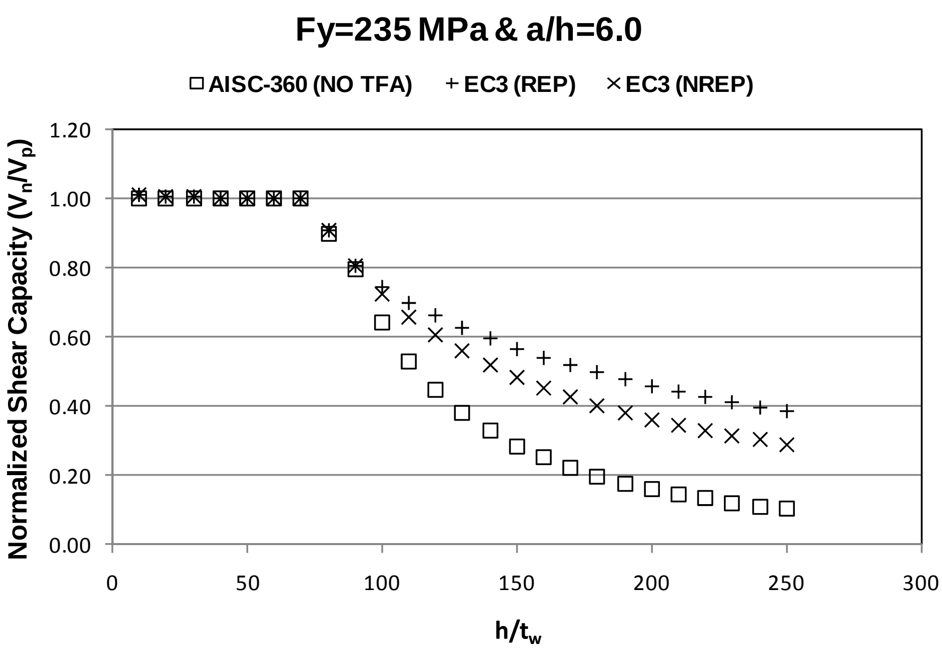


Fig. 6.7: Normalized Shear Capacity for a/h=6.0 and F_y=235 MPa

Figures show that when a/h ratio is too small, tension field action increases the shear resistance capacity of section significantly. Additionally, there is no difference between REP and NREP sections in terms of shear capacity for small a/h ratios according to EC3. EC3 shear resistance capacities are in between AISC-360 values. AISC-360 does not allow using tension field action when a/h ratio exceeds the 3. Therefore, tension field action was not considered for a/h=6 which is presented in Fig. 6.7.

CHAPTER 7

DESIGN OF CONNECTIONS

Welds and bolts were considered to compare AISC-360 and EC3 in terms of connections.

7.1 Welds

Fillet welds, complete joint penetration and partial joint penetration welds were investigated in the thesis.

7.1.1 Fillet Welds

For both specifications, fillet weld resistance is determined by using effective area of weld which is effective throat thickness times the effective length of the weld. AISC-360 and EC3 utilize effective throat thickness, t_e, which is the height of the largest triangle that can be inscribed within the fusion faces and the weld surface, measured perpendicular to the outer side of this triangle to determine the effective area. The minimum throat thickness shall not be less than 3 mm for both AISC-360 and EC3. Fig. 7.1 shows the throat thickness of a fillet weld.

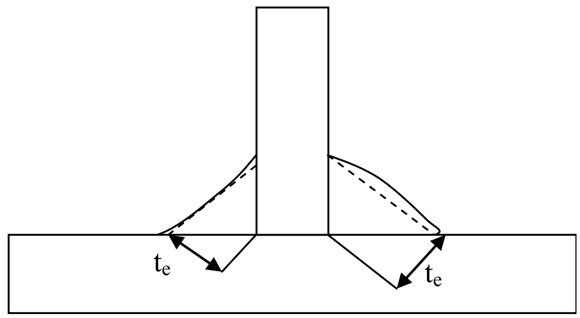


Fig. 7.1: Throat Thickness of a Fillet Weld

Both specifications present two methods for design resistance of fillet weld.

7.1.1.1 Simplified Method

Both AISC-360 and EC3 utilize simplified method for design resistance of fillet weld. In EC3, independent of the orientation of the weld throat plane to the applied force, the design resistance of the fillet weld is determined as follows;

$$R_n = \frac{F_u}{\beta_w \sqrt{3}} A_{wl} \qquad \text{(EC3)} \qquad (7.1)$$

F_u is the nominal ultimate tensile strength of the weaker part joined and β_w is the appropriate correlation factor which varies depending on the parent steel grade. B_w is 0.80 for S235, 0.85 for S275, 0.90 for S355, and 1.00 for S420 and S460.

According to AISC-360, the design resistance of the fillet is determined considering direction the applied load.

$$R_n = F_w A_{wl} \qquad \text{(AISC-360)} \qquad (7.2)$$

$$F_{wl} = 0.60 F_{EXX} \left(1.0 + 0.50 \sin^{1.5} \theta\right)$$

F_{EXX} is the electrode strength and θ is the angle of loading measured from the weld longitudinal axis.

The main difference between AISC-360 and EC3 in terms of simplified method for fillet weld strength is that AISC-360 considers the direction of the loading whereas EC3 does not take into account the direction of loading.

7.1.1.2 Directional Method

Both specifications allow considering the directional method. According to Salmon and Johnson (1996), AISC-360 allows elastic vector analysis to be used. Similarly, EC3 explicitly mentions about the directional method.

The design stresses which occur during transmission of design force on the throat thickness are shown in Fig. 7.2.

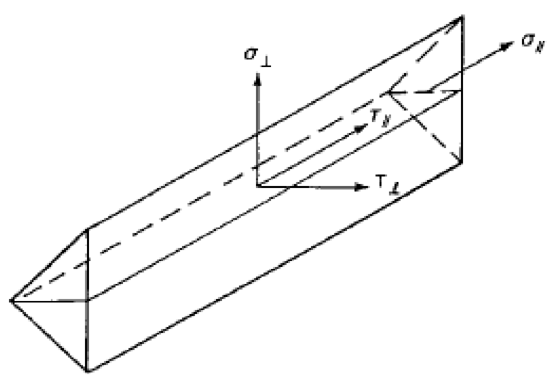


Fig. 7.2: Stresses on the Throat Section of a Fillet Weld

$\sigma_{||}$ is not considered during the calculation of design resistance of the weld.

From elastic vector analysis, AISC-360 considers design resistance of weld as follow;

$$\sigma_r = \sqrt{\sigma^2{}_\perp + \tau^2{}_\perp + \tau^2{}_\parallel} \qquad \text{(AISC-360)} \qquad (7.3)$$

The design stress, $\sigma_{r,}$ is compared to 0.6 times electrode strength F_{EXX}. However, EC3 uses von Mises yield criterion to determine the stress due to applied load. The stress occurred due to applied load is given below considering von Mises yield criteria.

$$\sigma_r = \left[\sigma_\perp{}^2 + 3\left(\tau_\perp{}^2 + \tau_\parallel{}^2\right)\right]^{0.5} \qquad \text{(EC 3)} \qquad (7.4)$$

The fundamental difference between those two directional methods is that AISC-360 directly uses elastic vector analysis. However, EC3 utilizes von Mises yield criteria. Therefore, perpendicular and parallel shear stresses to the weld axis are multiplied by 3. It must be also noticed that, AISC-360 compares the elastic vectoral stresses to the 0.6 times the electrode strength, F_{EXX}. Unlike to AISC-360, EC3 compares the design stress with the parent material ultimate tensile strength.

7.1.2 Complete Joint Penetration Welds

Complete joint penetration is also called as full penetration groove (butt) weld. A full penetration groove weld is that has complete penetration and fusion of weld and parent metal throughout the thickness of the joint. The throat thickness for a full penetration weld is taken as the thickness of thinner parent metal.

In EC3, the design resistance of a complete joint penetration groove weld is considered as equal to the design of the weaker of the parts joined.

According to AISC-360, the design is controlled by the base metal for a complete joint groove weld.

Both specifications consider the base metal strength as a governing control for a complete joint groove weld.

7.1.3 Partial Joint Penetration Welds

Partial joint penetration weld is also called as partial penetration groove (butt) weld. A partial penetration groove weld is that has a penetration thickness less than the thickness of the parent metal. According to AISC-360, the minimum throat thickness is 3 mm if thicker part is less than 6 mm. The throat thickness is 5 mm where the thicker part is in between 6 mm to 13 mm. When the thicker part is in between 13 mm to 19 mm, the throat thickness is 6 mm.

In EC3, the design resistance of a partial penetration butt weld is determined as for a deep penetration fillet weld.

According to AISC-360, the design strength of welds shall be the lower value of the base material and the weld metal strength determined according to the limit states of tensile rupture, shear rupture or yielding as follows;

$R_n = F_y t_e$ (tension and compression) (base material) (AISC-360) (7.5)

$R_n = F_{yw} t_e$ (tension and compression) (weld metal) (AISC-360) (7.6)

$R_n = 0.6 F_y t_e$ (shear) (base material) (AISC-360) (7.7)

$R_n = 0.6 F_{EXX} t_e$ (shear) (weld material) (AISC-360) (7.8)

7.2 Bolts

Each specification has different designations for bolts depending upon bolt quality. Although ASTM (American Society of Testing Material) has lots of specifications about bolts, washers, nuts, and etc., widely accepted ISO 898 (ISO: International Standardization Organization) is the specification for lots of countries as their national bolt specification. EC3 also classifies the bolts according to ISO 898. EC3 represents the bolts with their ultimate tensile and yield strength such as 4.6, 5.6, 8.8, and etc. Multiplication of first number with 100 gives the ultimate tensile strength with the unit of N/mm^2. In addition, multiplication of two numbers and their 10 times gives the yield strength of the bolt. For example, bolt classification 4.6 represents the bolts which have 400 MPa ultimate tensile strength and 240 MPa yield strength. The first number 4 represents the 400 MPa and multiplication of 4 and 6 which is 2.4 represents the 240 MPa yield strength. Unlike to EC3, AISC-360 has different approach to designate the bolts such as A325 and A490 bolts.

Table 7.1 presents the bolt classifications with their ultimate tensile and yield strength according to EC 3.

Table 7.1: Nominal Yield and Ultimate Tensile Strength of Bolts (EC 3)

Bolt Class	4.6	4.8	5.6	5.8	6.8	8.8	10.9	12.9
F_{yb} (MPa	240	320	300	400	480	640	900	1080
F_{ub} (MPa)	400	400	500	500	600	800	1000	1200

Table 7.2 shows the classifications with their ultimate tensile and yield strength in AISC-360.

Table 7.2: Nominal Yield and Ultimate Tensile Strength of Bolts (AISC-360)

Bolt Class	A325	A490
F_{yb} (MPa)	660	940
F_{ub} (MPa)	830	1040

7.2.1 Maximum and Minimum End-Edge Spacings

Differences for both specifications about maximum and minimum end and edge distances are presented in Table 7.3. Fig. 7.3 describes the nomenclature.

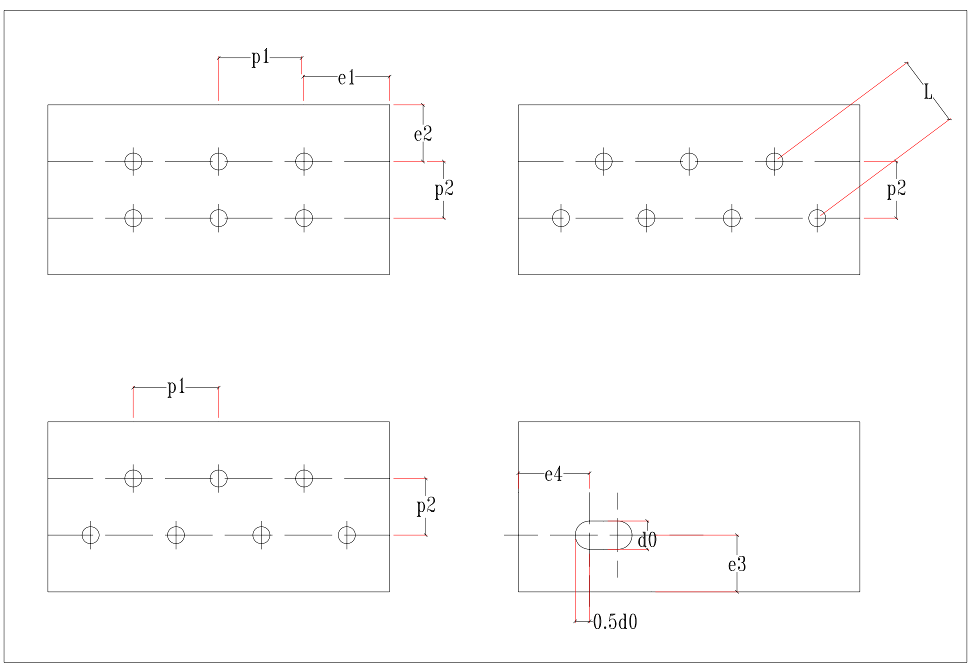


Fig. 7.3: Bolt Orientations

Table 7.3: Maximum. and Minimum End-Edge Distances

(Units in mm)

	AISC-360 MINIMUM END & EDGE DISTANCES					EC3 MINIMUM END & EDGE DISTANCES					RATIO (AISC-360 / EC 3)	
BOLT	SHEARED EDGE DISTANCE	ROLLED EDGE DISTANCE	SPACING			EDGE		SPACING			e1 & e2 (sheared)	e1 & e2 (rolled)
	(e_1 & e_2)	(e_1 & e_2)	p_1	p_2	L	e_1	e_2	p_1	p_2	L		
M16	28.0	22.0	42.7	42.7	42.7	19.2	19.2	35.2	19.2	38.4	1.5	1.1
M20	34.0	26.0	53.3	53.3	53.3	24.0	24.0	44.0	24.0	48.0	1.4	1.1
M22	38.0	28.0	58.7	58.7	58.7	26.4	26.4	48.4	26.4	52.8	1.4	1.1
M24	42.0	30.0	64.0	64.0	64.0	28.8	28.8	52.8	28.8	57.6	1.5	1.0
M27	48.0	34.0	72.0	72.0	72.0	32.4	32.4	59.4	32.4	64.8	1.5	1.0
M30	52.0	38.0	80.0	80.0	80.0	36.0	36.0	66.0	36.0	72.0	1.4	1.1
M36	64.0	46.0	96.0	96.0	96.0	43.2	43.2	79.2	43.2	86.4	1.5	1.1
OVER M36	1.75d	1.25d										

Maximum and minimum end-edge distances and bolt spacings are tabulated in Table 7.2. Since the ratios of p1, p2 and L are constant, only e_1 and e_2 ratios between two specifications were shown in the table. The ratios for p_1, p_2 and L are 1.21, 2.22 and 1.11, respectively.

Both specifications consider bolt tensile, shear, tension and shear failure modes to determine bolt capacity. EC3 categorizes the bolted connections as tension connections and shear connections.

7.2.2 Bolt Tension Capacity

Both specifications consider bolt tension capacity depending upon the bolt ultimate tensile strength, F_{ub}. According to AISC-360, the tensile stress area is the net area through the threads. Therefore, the tensile area of the bolt is equal to 0.75 times the area of unthreaded portion of the bolt. In EC3, the tensile capacity of a bolt is determined by using tensile stress bolt area, ultimate tensile strength of the bolt and a constant k_2 which is equal to 0.9.

$$R_n = 0.75 F_{ub} A_b \qquad \text{(AISC-360)} \qquad (7.9)$$

$$R_n = k_2 F_{ub} A_s \qquad \text{(EC3)} \qquad (7.10)$$

No definition is given for the net tensile area, A_s, in EC3. Engineer is responsible for finding out the net tensile area. It can be found from the manufacturer catalogs.

Between two specifications, there is a 10 percent difference for tensile capacity of bolts.

7.2.3 Bolt Shear Capacity

Depending on the shear plane location which passes through threaded part or unthreaded part, shear strength capacity of bolts in EC3 is;

$$R_n = \alpha_v F_{ub} A_s \qquad \text{(threads included)} \qquad (7.11)$$

$$R_n = \alpha_v F_{ub} A_b \qquad \text{(threads excluded)} \qquad (7.12)$$

α_v varies depending upon the bolt quality and shear plane orientation. When the shear plane passes through the threaded portion of the bolt and for 4.6, 5.6, 8.8 classes α_v=0.6. Additionally, α_v=0.5 for classes 4.8, 5.8, 6.8, 10.9 when threads are not extruded from shear plane.

When the shear plane passes through the unthreaded portion of the bolt α_v=0.6 for all type of grades.

Shear capacity of bolts depending on AISC-360 is calculated by using nominal shear stress capacity, F_{nv}, which is 0.4 times of the ultimate tensile strength when threaded parts are included in the shear plane or 0.5 times of the ultimate tensile strength of the bolt when threaded parts are excluded from the shear plane.

$R_n = 0.4F_{ub}A_b$ (threads included) (7.13)

$R_n = 0.5F_{ub}A_b$ (threads excluded) (7.14)

The main difference between AISC-360 and EC3 in terms of shear capacity of bolts is that EC3 reduces design strength depending upon the shear plane orientation and an extra multiplier α_v but AISC-360 reduces the bolt shear area depending upon the shear plane orientation.

7.2.4 Bolt Combined Tension and Shear Capacity

Combined tension and shear capacity is considered for both specifications. In AISC-360, when both tensile and shear stress occur on a bolt, tension capacity of bolts is reduced because of shear effect. The corresponding tensile capacity of bolts as follows;

$$F'_{nt} = 1.3F_{nt} - \frac{F_{nt}}{\phi F_{nv}} f_v \tag{7.15}$$

F'_{nt}= nominal tensile stress after modified due to effect of shear stress,

F_{nt}= nominal tensile stress capacity

F_{nv}= nominal shear stress capacity

f_v= required shear stress

The above equation can be re-formed as follow;

$$\frac{F'_{nt}}{F_{nt}} - \frac{f_v}{\phi F_{nv}} = 1.3 \tag{7.16}$$

In EC3, tension capacity is determined as follows when both tensile and shear forces exist on bolt.

$$\frac{f_v}{F_{nv}} + \frac{f_t}{1.4F_{nt}} \leq 1.0 \qquad (7.17)$$

To illustrate tension and shear interaction on the bolt, a typical M20 bolt with 8.8 grade was investigated according to both specification. Shear plane was assumed both to pass from the unthreaded portion and threaded portion of the bolt. Fig. 7.4 and Fig.7.5 represent the tension-shear interaction diagram for both threads excluded and threads included cases, respectively.

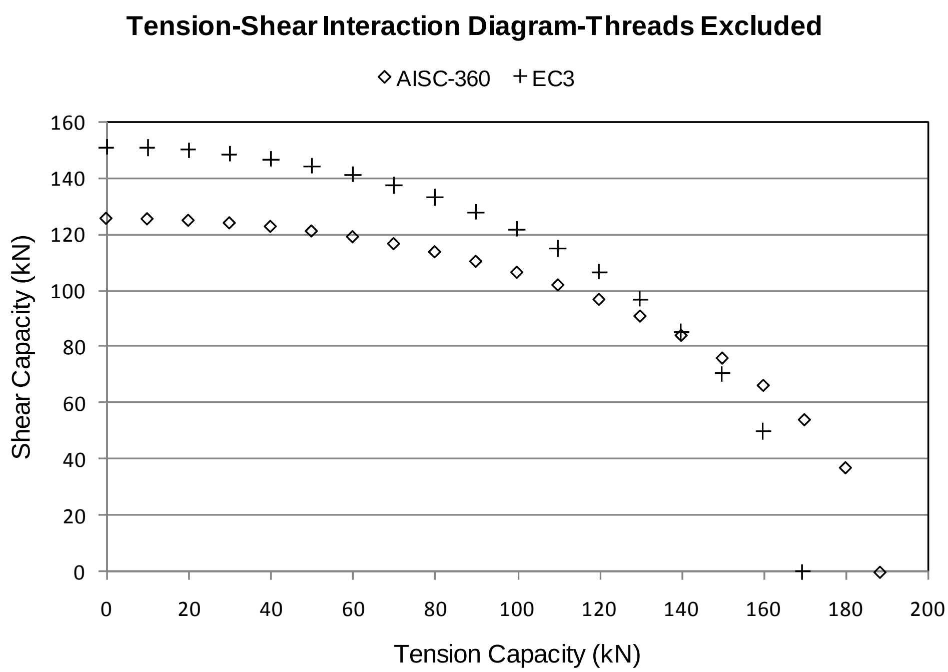


Fig. 7.4: Shear & Tension Interaction Diagram-Threads Excluded

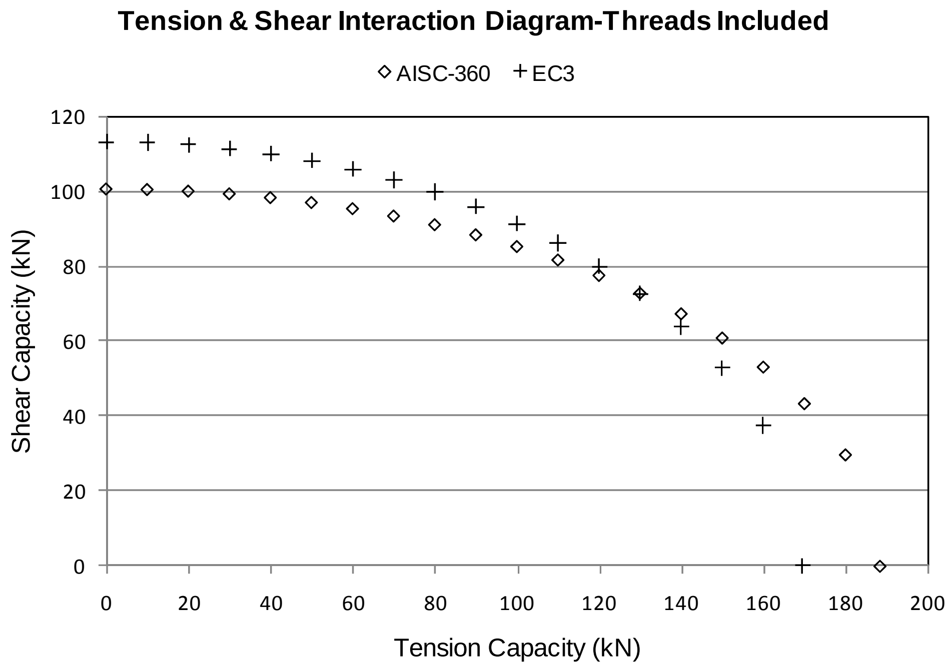


Fig. 7.5: Shear & Tension Interaction Diagram-Threads Included

A_s was considered as 0.75 times the gross cross section area of the bolt for shear and tension capacity of the bolt according to EC3.

CHAPTER 8

CONCLUSIONS

The following conclusions were obtained based on the conducted studies in the thesis.

- It is derived from the study in Chapter 2 that seismically compact sections in AISC-360 match to the Class 1 sections in EC3. Based on the cross section classification, compact, non-compact and slender sections show almost same behavior with Class 2, Class 3 and Class 4 sections, respectively.

- The main difference about tensile capacity between both specifications is the calculation of shear lag factor U. An elaborate treatment is tabulated in AISC-360. However, a less elaborate treatment is given in EC3.

- A single column strength curve is given in AISC-360 whereas five separate curves are presented in EC3 to define the reduction in capacity for compression members. All strength curves (b,c,d) in EC3 give lower capacity values as compared with AISC-360 recommended capacities. Only a_o curve gives higher capacities than AISC-360 curve but the use of this curve is quite limited. The maximum percentage difference between the EC3 curves to AISC-360 curve is 46 percent (difference between curve d and AISC-360).

- For laterally supported flexural members with compact flanges, both specifications allow the member to reach its plastic moment capacity if the web is compact (Class 1 or 2). The nominal moment capacity is between the plastic moment capacity (M_p) and the yield moment (M_y) in AISC-360 when web is non-compact. However, the nominal moment capacity is directly equal to the yield moment in the EC3 for Class 3 sections. For slender webs, a bending strength reduction factor (R_{pg}) is calculated to account for the loss of strength due to the buckling of the web plate in AISC-360. EC3 uses effective cross section properties to account buckling of the web plate for Class 4 sections. In general, AISC-360 gives approximately 10% higher capacity in inelastic region but EC3 gives up to 15% higher capacities in slender portion.

- For laterally supported flexural members with compact webs, the fundamental difference between both specifications is the treatment of flange buckling. In AISC-360, the rotational restraint that is provided by the web to the flange is explicitly taken into account using a k_c factor. In EC3, however, the limiting flange slenderness ratios are not given as a function of the web slenderness. According to both specifications, the member can reach to its plastic moment capacity if the flanges are compact (Class 1 or Class 2). According to the AISC specification, the nominal moment capacity reduces linearly with an increase in the flange slenderness and varies between the plastic moment capacity (M_p) and the yield moment considering residual stresses ($0.7M_y$). On the other hand, the nominal moment capacity is equal to the yield moment for Class 3 sections according to the EC3 specification. For slender flange members the AISC specification utilizes the elastic critical buckling moment approach. In EC3, the post buckling reserve strength approach is utilized. Effective cross-section properties are utilized for this purpose. In general, AISC-360 gives higher capacity in inelastic region (non-compact sections) about 20 percent. However, EC3 gives higher capacities in elastic region (slender sections) about 35 percent according to the sample used sections in the thesis.
- For laterally unsupported flexural members, AISC-360 and EC3 have different treatments. AISC-360 specification identifies three regimes of buckling depending on the unbraced length of the member (L_b). However, EC3 utilizes a reduction factor,(χ_{LT}), approach to treat lateral torsional

buckling problem. In general, flexural capacities according to AISC-360 are higher than those of EC 3 for non-compact sections about 15 percent.

- The fundamental difference between AISC-360 and EC3 regarding to shear resistance capacity is that AISC-360 directly utilizes tension field action with limitations. However, EC3 does not use tension field action consideration for members. Also, there are small differences for the definition of shear area. AISC-360 takes into account the overall depth of the section whereas EC3 uses different approaches for the rolled and welded I-shaped members. In general, shear capacities of both REP and NREP sections in EC3 are in between the shear capacities of with tension field action and without tension field action in AISC-360. When a/h ratio is too small, shear resistance capacities according to EC3 are close to those of without tension field action in AISC-360. When a/h ratio increases up to 3, shear resistance capacities according to EC3 gets close to those of with tension field action in AISC-360. In addition, AISC-360 does not allow including tension field action to the shear resistance capacity if a/h ratio exceeds 3.

- Both specifications utilize simplified and directional methods for weld strength. The main difference between the specifications for simplified method is that AISC-360 considers the angle of loading whereas EC3 does not take into consideration the direction of the loading. For directional methods, AISC-360 uses elastic vector analysis but EC 3 uses the von Mises yield criterion to determine stress occurring during the load application.

- EC3 does not give any information about how the net tensile area is determined. Therefore, engineers are responsible for finding out the net tensile area from the manufacturer catalogs or etc. However, AISC-360 are explicitly consider 0.75 times the gross section area as the net tensile area for coarse threads.

- Tension and shear interaction diagrams for shear plane in threaded portion and unthreaded portion present that EC3 may give the higher shear capacity than that of AISC-360 for pure shear. However, AISC-360 may give higher tensile capacity for pure tension.

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APPENDIX A

Compact flange sections used to compare limit state yielding for laterally supported beams are presented in Appendix A for two different yielding strengths.

Table A.1: Numerical Values of Compact Flange Cross Sections (Fy=235 MPa)

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	5	300	20	100.0	7.5	c	c	806.64	806.64	1.00	Class3	Class1	792.0	806.6	0.98	1.02
500	6	300	20	83.3	7.5	c	c	821.33	821.33	1.00	Class3	Class1	817.8	821.3	1.00	1.00
500	8	300	20	62.5	7.5	c	c	850.70	850.70	1.00	Class1	Class1	850.7	850.7	1.00	1.00
500	10	300	20	50.0	7.5	c	c	880.08	880.08	1.00	Class1	Class1	880.1	880.1	1.00	1.00
500	12	300	20	41.7	7.5	c	c	909.45	909.45	1.00	Class1	Class1	909.5	909.5	1.00	1.00
500	14	300	20	35.7	7.5	c	c	938.83	938.83	1.00	Class1	Class1	938.8	938.8	1.00	1.00
500	15	300	20	33.3	7.5	c	c	953.51	953.51	1.00	Class1	Class1	953.5	953.5	1.00	1.00
500	16	300	20	31.3	7.5	c	c	968.20	968.20	1.00	Class1	Class1	968.2	968.2	1.00	1.00
500	18	300	20	27.8	7.5	c	c	997.58	997.58	1.00	Class1	Class1	997.6	997.6	1.00	1.00
500	20	300	20	25.0	7.5	c	c	1026.95	1026.95	1.00	Class1	Class1	1027.0	1027.0	1.00	1.00
600	5	300	20	120.0	7.5	nc	c	967.75	979.95	0.99	Class3	Class1	944.7	980.0	0.96	1.02
600	6	300	20	100.0	7.5	c	c	1001.10	1001.10	1.00	Class3	Class1	975.7	1001.1	0.97	1.03
600	8	300	20	75.0	7.5	c	c	1043.40	1043.40	1.00	Class2	Class1	1043.4	1043.4	1.00	1.00
600	10	300	20	60.0	7.5	c	c	1085.70	1085.70	1.00	Class1	Class1	1085.7	1085.7	1.00	1.00
600	12	300	20	50.0	7.5	c	c	1128.00	1128.00	1.00	Class1	Class1	1128.0	1128.0	1.00	1.00
600	14	300	20	42.9	7.5	c	c	1170.30	1170.30	1.00	Class1	Class1	1170.3	1170.3	1.00	1.00
600	15	300	20	40.0	7.5	c	c	1191.45	1191.45	1.00	Class1	Class1	1191.5	1191.5	1.00	1.00
600	16	300	20	37.5	7.5	c	c	1212.60	1212.60	1.00	Class1	Class1	1212.6	1212.6	1.00	1.00

Table A.1: Numerical Values of Compact Flange Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	18	300	20	33.3	7.5	c	c	1254.90	1254.90	1.00	Class1	Class1	1254.9	1254.9	1.00	1.00
600	20	300	20	30.0	7.5	c	c	1297.20	1297.20	1.00	Class1	Class1	1297.2	1297.2	1.00	1.00
800	5	300	20	160.0	7.5	nc	c	1258.72	1344.20	0.94	Class4	Class1	1217.6	1344.2	0.91	1.03
800	6	300	20	133.3	7.5	nc	c	1335.89	1381.80	0.97	Class4	Class1	1260.1	1381.8	0.91	1.06
800	8	300	20	100.0	7.5	c	c	1457.00	1457.00	1.00	Class3	Class1	1396.8	1457.0	0.96	1.04
800	10	300	20	80.0	7.5	c	c	1532.20	1532.20	1.00	Class2	Class1	1532.2	1532.2	1.00	1.00
800	12	300	20	66.7	7.5	c	c	1607.40	1607.40	1.00	Class1	Class1	1607.4	1607.4	1.00	1.00
800	14	300	20	57.1	7.5	c	c	1682.60	1682.60	1.00	Class1	Class1	1682.6	1682.6	1.00	1.00
800	15	300	20	53.3	7.5	c	c	1720.20	1720.20	1.00	Class1	Class1	1720.2	1720.2	1.00	1.00
800	16	300	20	50.0	7.5	c	c	1757.80	1757.80	1.00	Class1	Class1	1757.8	1757.8	1.00	1.00
800	18	300	20	44.4	7.5	c	c	1833.00	1833.00	1.00	Class1	Class1	1833.0	1833.0	1.00	1.00
800	20	300	20	40.0	7.5	c	c	1908.20	1908.20	1.00	Class1	Class1	1908.2	1908.2	1.00	1.00
1000	5	300	20	200.0	7.5	s	c	1567.86	1731.95	0.91	Class4	Class1	1519.2	1732.0	0.88	1.03
1000	6	300	20	166.7	7.5	s	c	1636.09	1790.70	0.91	Class4	Class1	1572.8	1790.7	0.88	1.04
1000	8	300	20	125.0	7.5	nc	c	1855.08	1908.20	0.97	Class4	Class1	1706.2	1908.2	0.89	1.09
1000	10	300	20	100.0	7.5	c	c	2025.70	2025.70	1.00	Class3	Class1	1908.2	2025.7	0.94	1.06
1000	12	300	20	83.3	7.5	c	c	2143.20	2143.20	1.00	Class3	Class1	2115.0	2143.2	0.99	1.01
1000	14	300	20	71.4	7.5	c	c	2260.70	2260.70	1.00	Class1	Class1	2260.7	2260.7	1.00	1.00

Table A.1: Numerical Values of Compact Flange Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1000	15	300	20	66.7	7.5	c	c	2319.45	2319.45	1.00	Class1	Class1	2319.5	2319.5	1.00	1.00
1000	16	300	20	62.5	7.5	c	c	2378.20	2378.20	1.00	Class1	Class1	2378.2	2378.2	1.00	1.00
1000	18	300	20	55.6	7.5	c	c	2495.70	2495.70	1.00	Class1	Class1	2495.7	2495.7	1.00	1.00
1000	20	300	20	50.0	7.5	c	c	2613.20	2613.20	1.00	Class1	Class1	2613.2	2613.2	1.00	1.00
1200	5	300	20	240.0	7.5	s	c	1868.78	2143.20	0.87	Class4	Class1	1820.4	2143.2	0.85	1.03
1200	6	300	20	200.0	7.5	s	c	1967.55	2227.80	0.88	Class4	Class1	1885.7	2227.8	0.85	1.04
1200	8	300	20	150.0	7.5	nc	c	2206.19	2397.00	0.92	Class4	Class1	2048.1	2397.0	0.85	1.08
1200	10	300	20	120.0	7.5	nc	c	2506.46	2566.20	0.98	Class3	Class1	2284.2	2566.2	0.89	1.10
1200	12	300	20	100.0	7.5	c	c	2735.40	2735.40	1.00	Class3	Class1	2532.4	2735.4	0.93	1.08
1200	14	300	20	85.7	7.5	c	c	2904.60	2904.60	1.00	Class3	Class1	2825.6	2904.6	0.97	1.03
1200	15	300	20	80.0	7.5	c	c	2989.20	2989.20	1.00	Class2	Class1	2989.2	2989.2	1.00	1.00
1200	16	300	20	75.0	7.5	c	c	3073.80	3073.80	1.00	Class2	Class1	3073.8	3073.8	1.00	1.00
1200	18	300	20	66.7	7.5	c	c	3243.00	3243.00	1.00	Class1	Class1	3243.0	3243.0	1.00	1.00
1200	20	300	20	60.0	7.5	c	c	3412.20	3412.20	1.00	Class1	Class1	3412.2	3412.2	1.00	1.00
1400	5	300	20	280.0	7.5	s	c	2146.63	2577.95	0.83	Class4	Class1	2121.3	2578.0	0.82	1.01
1400	6	300	20	233.3	7.5	s	c	2281.85	2693.10	0.85	Class4	Class1	2198.8	2693.1	0.82	1.04
1400	8	300	20	175.0	7.5	s	c	2547.70	2923.40	0.87	Class4	Class1	2391.6	2923.4	0.82	1.07
1400	10	300	20	140.0	7.5	nc	c	2921.83	3153.70	0.93	Class4	Class1	2629.7	3153.7	0.83	1.11

Table A.1: Numerical Values of Compact Flange Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	tf	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1400	12	300	20	116.7	7.5	nc	c	3320.64	3384.00	0.98	Class3	Class1	2949.7	3384.0	0.87	1.13
1400	14	300	20	100.0	7.5	c	c	3614.30	3614.30	1.00	Class3	Class1	3291.9	3614.3	0.91	1.10
1400	15	300	20	93.3	7.5	c	c	3729.45	3729.45	1.00	Class3	Class1	3482.7	3729.5	0.93	1.07
1400	16	300	20	87.5	7.5	c	c	3844.60	3844.60	1.00	Class3	Class1	3686.7	3844.6	0.96	1.04
1400	18	300	20	77.8	7.5	c	c	4074.90	4074.90	1.00	Class2	Class1	4074.9	4074.9	1.00	1.00
1400	20	300	20	70.0	7.5	c	c	4305.20	4305.20	1.00	Class1	Class1	4305.2	4305.2	1.00	1.00
1600	5	300	20	320.0	7.5	s	c	2393.77	3036.20	0.79	Class4	Class1	2422.0	3036.2	0.80	0.99
1600	6	300	20	266.7	7.5	s	c	2571.45	3186.60	0.81	Class4	Class1	2512.2	3186.6	0.79	1.02
1600	8	300	20	200.0	7.5	s	c	2920.13	3487.40	0.84	Class4	Class1	2736.8	3487.4	0.78	1.07
1600	10	300	20	160.0	7.5	nc	c	3296.05	3788.20	0.87	Class4	Class1	3014.0	3788.2	0.80	1.09
1600	12	300	20	133.3	7.5	nc	c	3813.78	4089.00	0.93	Class4	Class1	3338.5	4089.0	0.82	1.14
1600	14	300	20	114.3	7.5	nc	c	4327.77	4389.80	0.99	Class3	Class1	3758.1	4389.8	0.86	1.15
1600	15	300	20	106.7	7.5	c	c	4540.20	4540.20	1.00	Class3	Class1	3976.2	4540.2	0.88	1.14
1600	16	300	20	100.0	7.5	c	c	4690.60	4690.60	1.00	Class3	Class1	4209.3	4690.6	0.90	1.11
1600	18	300	20	88.9	7.5	c	c	4991.40	4991.40	1.00	Class3	Class1	4720.7	4991.4	0.95	1.06
1600	20	300	20	80.0	7.5	c	c	5292.20	5292.20	1.00	Class2	Class1	5292.2	5292.2	1.00	1.00
1800	5	300	20	360.0	7.5	s	c	2602.70	3517.95	0.74	Class4	Class1	2722.6	3518.0	0.77	0.96
1800	6	300	20	300.0	7.5	s	c	2829.01	3708.30	0.76	Class4	Class1	2825.9	3708.3	0.76	1.00

Table A.1: Numerical Values of Compact Flange Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	tw	bf	tf	h/tw	$bf/2t_f$	Class of Web	Class of Flange	Mn (kN.m)	Mp (kN.m)	Mn / Mp	Class of Web	Class of Flange	Mn (kN.m)	Mp (kN.m)	Mn / Mp	AISC-360/EC3
1800	8	300	20	225.0	7.5	s	c	3272.26	4089.00	0.80	Class4	Class1	3083.7	4089.0	0.75	1.06
1800	10	300	20	180.0	7.5	s	c	3705.67	4469.70	0.83	Class4	Class1	3401.8	4469.7	0.76	1.09
1800	12	300	20	150.0	7.5	nc	c	4264.66	4850.40	0.88	Class4	Class1	3773.7	4850.4	0.78	1.13
1800	14	300	20	128.6	7.5	nc	c	4912.56	5231.10	0.94	Class4	Class1	4195.4	5231.1	0.80	1.17
1800	15	300	20	120.0	7.5	nc	c	5235.46	5421.45	0.97	Class3	Class1	4469.7	5421.5	0.82	1.17
1800	16	300	20	112.5	7.5	nc	c	5557.83	5611.80	0.99	Class3	Class1	4732.0	5611.8	0.84	1.17
1800	18	300	20	100.0	7.5	c	c	5992.50	5992.50	1.00	Class3	Class1	5307.2	5992.5	0.89	1.13
1800	20	300	20	90.0	7.5	c	c	6373.20	6373.20	1.00	Class3	Class1	5950.2	6373.2	0.93	1.07
2000	6	300	20	333.3	7.5	s	c	3047.33	4258.20	0.72	Class4	Class1	3140.0	4258.2	0.74	0.97
2000	8	300	20	250.0	7.5	s	c	3597.09	4728.20	0.76	Class4	Class1	3432.3	4728.2	0.73	1.05
2000	10	300	20	200.0	7.5	s	c	4133.70	5198.20	0.80	Class4	Class1	3792.8	5198.2	0.73	1.09
2000	12	300	20	166.7	7.5	s	c	4660.46	5668.20	0.82	Class4	Class1	4214.1	5668.2	0.74	1.11
2000	14	300	20	142.9	7.5	nc	c	5453.95	6138.20	0.89	Class4	Class1	4691.2	6138.2	0.76	1.16
2000	15	300	20	133.3	7.5	nc	c	5851.43	6373.20	0.92	Class4	Class1	4949.7	6373.2	0.78	1.18
2000	16	300	20	125.0	7.5	nc	c	6248.32	6608.20	0.95	Class4	Class1	5221.2	6608.2	0.79	1.20
2000	18	300	20	111.1	7.5	nc	c	7040.72	7078.20	0.99	Class3	Class1	5893.8	7078.2	0.83	1.19
2000	20	300	20	100.0	7.5	c	c	7548.20	7548.20	1.00	Class3	Class1	6608.2	7548.2	0.88	1.14

Table A.2: Numerical Values of Compact Flange Cross Sections (Fy=355 MPa)

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	5	300	20	100.0	7.5	nc	c	1199.04	1218.54	0.98	Class3	Class2	1179.8	1218.5	0.97	1.02
500	6	300	20	83.3	7.5	c	c	1240.73	1240.73	1.00	Class3	Class2	1211.6	1240.7	0.98	1.02
500	8	300	20	62.5	7.5	c	c	1285.10	1285.10	1.00	Class2	Class2	1285.1	1285.1	1.00	1.00
500	10	300	20	50.0	7.5	c	c	1329.48	1329.48	1.00	Class1	Class2	1329.5	1329.5	1.00	1.00
500	12	300	20	41.7	7.5	c	c	1373.85	1373.85	1.00	Class1	Class2	1373.9	1373.9	1.00	1.00
500	14	300	20	35.7	7.5	c	c	1418.23	1418.23	1.00	Class1	Class2	1418.2	1418.2	1.00	1.00
500	15	300	20	33.3	7.5	c	c	1440.41	1440.41	1.00	Class1	Class2	1440.4	1440.4	1.00	1.00
500	16	300	20	31.3	7.5	c	c	1462.60	1462.60	1.00	Class1	Class2	1462.6	1462.6	1.00	1.00
500	18	300	20	27.8	7.5	c	c	1506.98	1506.98	1.00	Class1	Class2	1507.0	1507.0	1.00	1.00
500	20	300	20	25.0	7.5	c	c	1551.35	1551.35	1.00	Class1	Class2	1551.4	1551.4	1.00	1.00
600	5	300	20	120.0	7.5	nc	c	1412.78	1480.35	0.95	Class4	Class2	1360.7	1480.4	0.92	1.04
600	6	300	20	100.0	7.5	nc	c	1485.87	1512.30	0.98	Class3	Class2	1445.4	1512.3	0.96	1.03
600	8	300	20	75.0	7.5	c	c	1576.20	1576.20	1.00	Class3	Class2	1542.4	1576.2	0.98	1.02
600	10	300	20	60.0	7.5	c	c	1640.10	1640.10	1.00	Class2	Class2	1640.1	1640.1	1.00	1.00
600	12	300	20	50.0	7.5	c	c	1704.00	1704.00	1.00	Class1	Class2	1704.0	1704.0	1.00	1.00
600	14	300	20	42.9	7.5	c	c	1767.90	1767.90	1.00	Class1	Class2	1767.9	1767.9	1.00	1.00
600	15	300	20	40.0	7.5	c	c	1799.85	1799.85	1.00	Class1	Class2	1799.9	1799.9	1.00	1.00
600	16	300	20	37.5	7.5	c	c	1831.80	1831.80	1.00	Class1	Class2	1831.8	1831.8	1.00	1.00

Table A.2: Numerical Values of Compact Flange Cross Sections (Fy=355 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	18	300	20	33.3	7.5	c	c	1895.70	1895.70	1.00	Class1	Class2	1895.7	1895.7	1.00	1.00
600	20	300	20	30.0	7.5	c	c	1959.60	1959.60	1.00	Class1	Class2	1959.6	1959.6	1.00	1.00
800	5	300	20	160.0	7.5	s	c	1863.15	2030.60	0.92	Class4	Class2	1809.8	2030.6	0.89	1.03
800	6	300	20	133.3	7.5	nc	c	1928.46	2087.40	0.92	Class4	Class2	1862.1	2087.4	0.89	1.04
800	8	300	20	100.0	7.5	nc	c	2152.54	2201.00	0.98	Class3	Class2	2042.4	2201.0	0.93	1.05
800	10	300	20	80.0	7.5	c	c	2314.60	2314.60	1.00	Class3	Class2	2208.7	2314.6	0.95	1.05
800	12	300	20	66.7	7.5	c	c	2428.20	2428.20	1.00	Class2	Class2	2428.2	2428.2	1.00	1.00
800	14	300	20	57.1	7.5	c	c	2541.80	2541.80	1.00	Class1	Class2	2541.8	2541.8	1.00	1.00
800	15	300	20	53.3	7.5	c	c	2598.60	2598.60	1.00	Class1	Class2	2598.6	2598.6	1.00	1.00
800	16	300	20	50.0	7.5	c	c	2655.40	2655.40	1.00	Class1	Class2	2655.4	2655.4	1.00	1.00
800	18	300	20	44.4	7.5	c	c	2769.00	2769.00	1.00	Class1	Class2	2769.0	2769.0	1.00	1.00
800	20	300	20	40.0	7.5	c	c	2882.60	2882.60	1.00	Class1	Class2	2882.6	2882.6	1.00	1.00
1000	5	300	20	200.0	7.5	s	c	2325.46	2616.35	0.89	Class4	Class2	2257.9	2616.4	0.86	1.03
1000	6	300	20	166.7	7.5	s	c	2420.46	2705.10	0.89	Class4	Class2	2324.2	2705.1	0.86	1.04
1000	8	300	20	125.0	7.5	nc	c	2652.26	2882.60	0.92	Class4	Class2	2490.3	2882.6	0.86	1.07
1000	10	300	20	100.0	7.5	nc	c	2975.94	3060.10	0.97	Class3	Class2	2750.3	3060.1	0.90	1.08
1000	12	300	20	83.3	7.5	c	c	3237.60	3237.60	1.00	Class3	Class2	3004.4	3237.6	0.93	1.08
1000	14	300	20	71.4	7.5	c	c	3415.10	3415.10	1.00	Class3	Class2	3304.8	3415.1	0.97	1.03

Table A.2: Numerical Values of Compact Flange Cross Sections (Fy=355 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1000	15	300	20	66.7	7.5	c	c	3503.85	3503.85	1.00	Class2	Class2	3503.9	3503.9	1.00	1.00
1000	16	300	20	62.5	7.5	c	c	3592.60	3592.60	1.00	Class2	Class2	3592.6	3592.6	1.00	1.00
1000	18	300	20	55.6	7.5	c	c	3770.10	3770.10	1.00	Class1	Class2	3770.1	3770.1	1.00	1.00
1000	20	300	20	50.0	7.5	c	c	3947.60	3947.60	1.00	Class1	Class2	3947.6	3947.6	1.00	1.00
1200	5	300	20	240.0	7.5	s	c	2761.70	3237.60	0.85	Class4	Class2	2705.0	3237.6	0.84	1.02
1200	6	300	20	200.0	7.5	s	c	2899.51	3365.40	0.86	Class4	Class2	2786.0	3365.4	0.83	1.04
1200	8	300	20	150.0	7.5	s	c	3171.25	3621.00	0.88	Class4	Class2	2989.3	3621.0	0.83	1.06
1200	10	300	20	120.0	7.5	nc	c	3545.73	3876.60	0.91	Class4	Class2	3242.1	3876.6	0.84	1.09
1200	12	300	20	100.0	7.5	nc	c	3995.32	4132.20	0.97	Class3	Class2	3596.8	4132.2	0.87	1.11
1200	14	300	20	85.7	7.5	c	c	4387.80	4387.80	1.00	Class3	Class2	3957.3	4387.8	0.90	1.11
1200	15	300	20	80.0	7.5	c	c	4515.60	4515.60	1.00	Class3	Class2	4158.3	4515.6	0.92	1.09
1200	16	300	20	75.0	7.5	c	c	4643.40	4643.40	1.00	Class3	Class2	4373.2	4643.4	0.94	1.06
1200	18	300	20	66.7	7.5	c	c	4899.00	4899.00	1.00	Class2	Class2	4899.0	4899.0	1.00	1.00
1200	20	300	20	60.0	7.5	c	c	5154.60	5154.60	1.00	Class2	Class2	5154.6	5154.6	1.00	1.00
1400	5	300	20	280.0	7.5	s	c	3160.06	3894.35	0.81	Class4	Class2	3151.4	3894.4	0.81	1.00
1400	6	300	20	233.3	7.5	s	c	3349.05	4068.30	0.82	Class4	Class2	3247.7	4068.3	0.80	1.03
1400	8	300	20	175.0	7.5	s	c	3720.96	4416.20	0.84	Class4	Class2	3490.1	4416.2	0.79	1.07
1400	10	300	20	140.0	7.5	s	c	4086.29	4764.10	0.86	Class4	Class2	3791.4	4764.1	0.80	1.08

Table A.2: Numerical Values of Compact Flange Cross Sections (Fy=355 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1400	12	300	20	116.7	7.5	nc	c	4649.62	5112.00	0.91	Class4	Class2	4145.5	5112.0	0.81	1.12
1400	14	300	20	100.0	7.5	nc	c	5249.97	5459.90	0.96	Class3	Class2	4609.7	5459.9	0.84	1.14
1400	15	300	20	93.3	7.5	nc	c	5548.63	5633.85	0.98	Class3	Class2	4844.3	5633.9	0.86	1.15
1400	16	300	20	87.5	7.5	c	c	5807.80	5807.80	1.00	Class3	Class2	5095.0	5807.8	0.88	1.14
1400	18	300	20	77.8	7.5	c	c	6155.70	6155.70	1.00	Class3	Class2	5644.9	6155.7	0.92	1.09
1400	20	300	20	70.0	7.5	c	c	6503.60	6503.60	1.00	Class3	Class2	6259.5	6503.6	0.96	1.04
1600	5	300	20	320.0	7.5	s	c	3509.01	4586.60	0.77	Class4	Class2	3597.2	4586.6	0.78	0.98
1600	6	300	20	266.7	7.5	s	c	3757.75	4813.80	0.78	Class4	Class2	3709.5	4813.8	0.77	1.01
1600	8	300	20	200.0	7.5	s	c	4246.29	5268.20	0.81	Class4	Class2	3992.7	5268.2	0.76	1.06
1600	10	300	20	160.0	7.5	s	c	4725.28	5722.60	0.83	Class4	Class2	4344.9	5722.6	0.76	1.09
1600	12	300	20	133.3	7.5	nc	c	5224.14	6177.00	0.85	Class4	Class2	4758.5	6177.0	0.77	1.10
1600	14	300	20	114.3	7.5	nc	c	6003.84	6631.40	0.91	Class4	Class2	5228.5	6631.4	0.79	1.15
1600	15	300	20	106.7	7.5	nc	c	6391.94	6858.60	0.93	Class4	Class2	5483.5	6858.6	0.80	1.17
1600	16	300	20	100.0	7.5	nc	c	6779.18	7085.80	0.96	Class3	Class2	5816.7	7085.8	0.82	1.17
1600	18	300	20	88.9	7.5	c	c	7540.20	7540.20	1.00	Class3	Class2	6445.2	7540.2	0.85	1.17
1600	20	300	20	80.0	7.5	c	c	7994.60	7994.60	1.00	Class3	Class2	7147.7	7994.6	0.89	1.12
1800	5	300	20	360.0	7.5	s	c	3797.28	5314.35	0.71	Class4	Class2	4042.5	5314.4	0.76	0.94
1800	6	300	20	300.0	7.5	s	c	4114.60	5601.90	0.73	Class4	Class2	4171.4	5601.9	0.74	0.99

Table A.2: Numerical Values of Compact Flange Cross Sections (Fy=355 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1800	8	300	20	225.0	7.5	s	c	4736.52	6177.00	0.77	Class4	Class2	4497.1	6177.0	0.73	1.05
1800	10	300	20	180.0	7.5	s	c	5345.12	6752.10	0.79	Class4	Class2	4902.5	6752.1	0.73	1.09
1800	12	300	20	150.0	7.5	s	c	5943.56	7327.20	0.81	Class4	Class2	5378.3	7327.2	0.73	1.11
1800	14	300	20	128.6	7.5	nc	c	6670.47	7902.30	0.84	Class4	Class2	5918.4	7902.3	0.75	1.13
1800	15	300	20	120.0	7.5	nc	c	7159.71	8189.85	0.87	Class4	Class2	6211.2	8189.9	0.76	1.15
1800	16	300	20	112.5	7.5	nc	c	7647.97	8477.40	0.90	Class4	Class2	6518.8	8477.4	0.77	1.17
1800	18	300	20	100.0	7.5	nc	c	8622.21	9052.50	0.95	Class3	Class2	7245.6	9052.5	0.80	1.19
1800	20	300	20	90.0	7.5	nc	c	9594.15	9627.60	1.00	Class3	Class2	8035.8	9627.6	0.83	1.19
2000	6	300	20	333.3	7.5	s	c	4408.76	6432.60	0.69	Class4	Class2	4633.6	6432.6	0.72	0.95
2000	8	300	20	250.0	7.5	s	c	5181.13	7142.60	0.73	Class4	Class2	5003.4	7142.6	0.70	1.04
2000	10	300	20	200.0	7.5	s	c	5935.50	7852.60	0.76	Class4	Class2	5464.0	7852.6	0.70	1.09
2000	12	300	20	166.7	7.5	s	c	6676.37	8562.60	0.78	Class4	Class2	6004.6	8562.6	0.70	1.11
2000	14	300	20	142.9	7.5	s	c	7406.84	9272.60	0.80	Class4	Class2	6617.6	9272.6	0.71	1.12
2000	15	300	20	133.3	7.5	nc	c	7821.11	9627.60	0.81	Class4	Class2	6949.8	9627.6	0.72	1.13
2000	16	300	20	125.0	7.5	nc	c	8422.09	9982.60	0.84	Class4	Class2	7298.6	9982.6	0.73	1.15
2000	18	300	20	111.1	7.5	nc	c	9621.49	10692.60	0.90	Class4	Class2	8044.2	10692.6	0.75	1.20
2000	20	300	20	100.0	7.5	nc	c	10818.35	11402.60	0.95	Class3	Class2	8923.9	11402.6	0.78	1.21

APPENDIX B

Compact web sections used to compare limit state yielding for laterally supported beams are presented in Appendix B for two different yielding strengths.

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	8	300	20	62.50	7.50	c	c	850.70	850.70	1.00	Class1	Class1	850.70	850.70	1.00	1.00
500	10	300	20	50.00	7.50	c	c	880.08	880.08	1.00	Class1	Class1	880.08	880.08	1.00	1.00
500	12	300	20	41.67	7.50	c	c	909.45	909.45	1.00	Class1	Class1	909.45	909.45	1.00	1.00
500	15	300	20	33.33	7.50	c	c	953.51	953.51	1.00	Class1	Class1	953.51	953.51	1.00	1.00
500	16	300	20	31.25	7.50	c	c	968.20	968.20	1.00	Class1	Class1	968.20	968.20	1.00	1.00
500	18	300	20	27.78	7.50	c	c	997.58	997.58	1.00	Class1	Class1	997.58	997.58	1.00	1.00
500	20	300	20	25.00	7.50	c	c	1026.95	1026.95	1.00	Class1	Class1	1026.95	1026.95	1.00	1.00
600	10	300	20	60.00	7.50	c	c	1085.70	1085.70	1.00	Class1	Class1	1085.70	1085.70	1.00	1.00
600	12	300	20	50.00	7.50	c	c	1128.00	1128.00	1.00	Class1	Class1	1128.00	1128.00	1.00	1.00
600	15	300	20	40.00	7.50	c	c	1191.45	1191.45	1.00	Class1	Class1	1191.45	1191.45	1.00	1.00
600	16	300	20	37.50	7.50	c	c	1212.60	1212.60	1.00	Class1	Class1	1212.60	1212.60	1.00	1.00
600	18	300	20	33.33	7.50	c	c	1254.90	1254.90	1.00	Class1	Class1	1254.90	1254.90	1.00	1.00
600	20	300	20	30.00	7.50	c	c	1297.20	1297.20	1.00	Class1	Class1	1297.20	1297.20	1.00	1.00
800	12	300	20	66.67	7.50	c	c	1607.40	1607.40	1.00	Class1	Class1	1607.40	1607.40	1.00	1.00
600	15	300	20	40.00	7.50	c	c	1191.45	1191.45	1.00	Class1	Class1	1191.45	1191.45	1.00	1.00
600	16	300	20	37.50	7.50	c	c	1212.60	1212.60	1.00	Class1	Class1	1212.60	1212.60	1.00	1.00
600	18	300	20	33.33	7.50	c	c	1254.90	1254.90	1.00	Class1	Class1	1254.90	1254.90	1.00	1.00
800	20	300	20	40.00	7.50	c	c	1908.20	1908.20	1.00	Class1	Class1	1908.20	1908.20	1.00	1.00

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1000	15	300	20	66.67	7.50	c	c	2319.45	2319.45	1.00	Class1	Class1	2319.45	2319.45	1.00	1.00
1000	16	300	20	62.50	7.50	c	c	2378.20	2378.20	1.00	Class1	Class1	2378.20	2378.20	1.00	1.00
1000	18	300	20	55.56	7.50	c	c	2495.70	2495.70	1.00	Class1	Class1	2495.70	2495.70	1.00	1.00
1000	20	300	20	50.00	7.50	c	c	2613.20	2613.20	1.00	Class1	Class1	2613.20	2613.20	1.00	1.00
500	8	300	15	62.50	10.00	c	c	662.11	662.11	1.00	Class1	Class2	662.11	662.11	1.00	1.00
500	10	300	15	50.00	10.00	c	c	691.49	691.49	1.00	Class1	Class2	691.49	691.49	1.00	1.00
500	12	300	15	41.67	10.00	c	c	720.86	720.86	1.00	Class1	Class2	720.86	720.86	1.00	1.00
500	15	300	15	33.33	10.00	c	c	764.93	764.93	1.00	Class1	Class2	764.93	764.93	1.00	1.00
500	16	300	15	31.25	10.00	c	c	779.61	779.61	1.00	Class1	Class2	779.61	779.61	1.00	1.00
500	18	300	15	27.78	10.00	c	c	808.99	808.99	1.00	Class1	Class2	808.99	808.99	1.00	1.00
500	20	300	15	25.00	10.00	c	c	838.36	838.36	1.00	Class1	Class2	838.36	838.36	1.00	1.00
600	10	300	15	60.00	10.00	c	c	861.86	861.86	1.00	Class1	Class2	861.86	861.86	1.00	1.00
600	12	300	15	50.00	10.00	c	c	904.16	904.16	1.00	Class1	Class2	904.16	904.16	1.00	1.00
600	15	300	15	40.00	10.00	c	c	967.61	967.61	1.00	Class1	Class2	967.61	967.61	1.00	1.00
600	16	300	15	37.50	10.00	c	c	988.76	988.76	1.00	Class1	Class2	988.76	988.76	1.00	1.00
600	18	300	15	33.33	10.00	c	c	1031.06	1031.06	1.00	Class1	Class2	1031.06	1031.06	1.00	1.00
600	20	300	15	30.00	10.00	c	c	1073.36	1073.36	1.00	Class1	Class2	1073.36	1073.36	1.00	1.00
800	12	300	15	66.67	10.00	c	c	1313.06	1313.06	1.00	Class1	Class2	1313.06	1313.06	1.00	1.00

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	15	300	15	40.00	10.00	c	c	967.61	967.61	1.00	Class1	Class2	967.61	967.61	1.00	1.00
600	16	300	15	37.50	10.00	c	c	988.76	988.76	1.00	Class1	Class2	988.76	988.76	1.00	1.00
600	18	300	15	33.33	10.00	c	c	1031.06	1031.06	1.00	Class1	Class2	1031.06	1031.06	1.00	1.00
800	20	300	15	40.00	10.00	c	c	1613.86	1613.86	1.00	Class1	Class2	1613.86	1613.86	1.00	1.00
1000	15	300	15	66.67	10.00	c	c	1954.61	1954.61	1.00	Class1	Class2	1954.61	1954.61	1.00	1.00
1000	16	300	15	62.50	10.00	c	c	2013.36	2013.36	1.00	Class1	Class2	2013.36	2013.36	1.00	1.00
1000	18	300	15	55.56	10.00	c	c	2130.86	2130.86	1.00	Class1	Class2	2130.86	2130.86	1.00	1.00
1000	20	300	15	50.00	10.00	c	c	2248.36	2248.36	1.00	Class1	Class2	2248.36	2248.36	1.00	1.00
500	8	300	12	62.50	12.50	c	nc	527.75	550.65	0.96	Class1	Class3	497.98	550.65	0.90	1.06
500	10	300	12	50.00	12.50	c	nc	557.69	580.03	0.96	Class1	Class3	516.66	580.03	0.89	1.08
500	12	300	12	41.67	12.50	c	nc	587.26	609.40	0.96	Class1	Class3	535.35	609.40	0.88	1.10
500	15	300	12	33.33	12.50	c	nc	631.24	653.46	0.97	Class1	Class3	563.38	653.46	0.86	1.12
500	16	300	12	31.25	12.50	c	nc	645.83	668.15	0.97	Class1	Class3	572.72	668.15	0.86	1.13
500	18	300	12	27.78	12.50	c	nc	674.96	697.53	0.97	Class1	Class3	591.41	697.53	0.85	1.14
500	20	300	12	25.00	12.50	c	nc	703.07	726.90	0.97	Class1	Class3	610.10	726.90	0.84	1.15
600	10	300	12	60.00	12.50	c	nc	698.24	729.25	0.96	Class1	Class3	643.37	729.25	0.88	1.09
600	12	300	12	50.00	12.50	c	nc	740.64	771.55	0.96	Class1	Class3	670.49	771.55	0.87	1.10
600	15	300	12	40.00	12.50	c	nc	803.75	835.00	0.96	Class1	Class3	711.16	835.00	0.85	1.13

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	16	300	12	37.50	12.50	c	nc	824.70	856.15	0.96	Class1	Class3	724.72	856.15	0.85	1.14
600	18	300	12	33.33	12.50	c	nc	866.53	898.45	0.96	Class1	Class3	751.83	898.45	0.84	1.15
600	20	300	12	30.00	12.50	c	nc	908.27	940.75	0.97	Class1	Class3	778.95	940.75	0.83	1.17
800	12	300	12	66.67	12.50	c	nc	1084.40	1138.15	0.95	Class1	Class3	968.99	1138.15	0.85	1.12
600	15	300	12	40.00	12.50	c	nc	803.75	835.00	0.96	Class1	Class3	711.16	835.00	0.85	1.13
600	16	300	12	37.50	12.50	c	nc	824.70	856.15	0.96	Class1	Class3	724.72	856.15	0.85	1.14
600	18	300	12	33.33	12.50	c	nc	866.53	898.45	0.96	Class1	Class3	751.83	898.45	0.84	1.15
800	20	300	12	40.00	12.50	c	nc	1381.08	1438.95	0.96	Class1	Class3	1163.68	1438.95	0.81	1.19
1000	15	300	12	66.67	12.50	c	nc	1650.50	1737.40	0.95	Class1	Class3	1419.85	1737.40	0.82	1.16
1000	16	300	12	62.50	12.50	c	nc	1708.25	1796.15	0.95	Class1	Class3	1458.10	1796.15	0.81	1.17
1000	18	300	12	55.56	12.50	c	nc	1823.58	1913.65	0.95	Class1	Class3	1534.60	1913.65	0.80	1.19
1000	20	300	12	50.00	12.50	c	nc	1938.76	2031.15	0.95	Class1	Class3	1611.09	2031.15	0.79	1.20
500	8	300	10	62.50	15.00	c	nc	421.37	477.05	0.88	Class1	Class4	413.34	477.05	0.87	1.02
500	10	300	10	50.00	15.00	c	nc	451.60	506.43	0.89	Class1	Class4	432.48	506.43	0.85	1.04
500	12	300	10	41.67	15.00	c	nc	481.00	535.80	0.90	Class1	Class4	451.57	535.80	0.84	1.07
500	15	300	10	33.33	15.00	c	nc	524.27	579.86	0.90	Class1	Class4	480.13	579.86	0.83	1.09
500	16	300	10	31.25	15.00	c	nc	538.55	594.55	0.91	Class1	Class4	489.63	594.55	0.82	1.10
500	18	300	10	27.78	15.00	c	nc	567.00	623.93	0.91	Class1	Class4	508.63	623.93	0.82	1.11

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	20	300	10	25.00	15.00	c	nc	592.88	653.30	0.91	Class1	Class4	527.60	653.30	0.81	1.12
600	10	300	10	60.00	15.00	c	nc	564.65	641.55	0.88	Class1	Class4	542.68	641.55	0.85	1.04
600	12	300	10	50.00	15.00	c	nc	606.56	683.85	0.89	Class1	Class4	570.28	683.85	0.83	1.06
600	15	300	10	40.00	15.00	c	nc	668.32	747.30	0.89	Class1	Class4	611.58	747.30	0.82	1.09
600	16	300	10	37.50	15.00	c	nc	688.74	768.45	0.90	Class1	Class4	625.33	768.45	0.81	1.10
600	18	300	10	33.33	15.00	c	nc	729.40	810.75	0.90	Class1	Class4	652.81	810.75	0.81	1.12
600	20	300	10	30.00	15.00	c	nc	769.90	853.05	0.90	Class1	Class4	680.27	853.05	0.80	1.13
800	12	300	10	66.67	15.00	c	nc	885.74	1022.25	0.87	Class1	Class4	836.03	1022.25	0.82	1.06
600	15	300	10	40.00	15.00	c	nc	668.32	747.30	0.89	Class1	Class4	611.58	747.30	0.82	1.09
600	16	300	10	37.50	15.00	c	nc	688.74	768.45	0.90	Class1	Class4	625.33	768.45	0.81	1.10
600	18	300	10	33.33	15.00	c	nc	729.40	810.75	0.90	Class1	Class4	652.81	810.75	0.81	1.12
800	20	300	10	40.00	15.00	c	nc	1172.76	1323.05	0.89	Class1	Class4	1032.69	1323.05	0.78	1.14
1000	15	300	10	66.67	15.00	c	nc	1367.95	1593.30	0.86	Class1	Class4	1255.24	1593.30	0.79	1.09
1000	16	300	10	62.50	15.00	c	nc	1423.52	1652.05	0.86	Class1	Class4	1293.78	1652.05	0.78	1.10
1000	18	300	10	55.56	15.00	c	nc	1534.30	1769.55	0.87	Class1	Class4	1370.84	1769.55	0.77	1.12
1000	20	300	10	50.00	15.00	c	nc	1644.77	1887.05	0.87	Class1	Class4	1447.86	1887.05	0.77	1.14
500	8	400	20	62.50	10.00	c	c	1095.10	1095.10	1.00	Class1	Class2	1095.10	1095.10	1.00	1.00
500	10	400	20	50.00	10.00	c	c	1124.48	1124.48	1.00	Class1	Class2	1124.48	1124.48	1.00	1.00

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	12	400	20	41.67	10.00	c	c	1153.85	1153.85	1.00	Class1	Class2	1153.85	1153.85	1.00	1.00
500	15	400	20	33.33	10.00	c	c	1197.91	1197.91	1.00	Class1	Class2	1197.91	1197.91	1.00	1.00
500	16	400	20	31.25	10.00	c	c	1212.60	1212.60	1.00	Class1	Class2	1212.60	1212.60	1.00	1.00
500	18	400	20	27.78	10.00	c	c	1241.98	1241.98	1.00	Class1	Class2	1241.98	1241.98	1.00	1.00
500	20	400	20	25.00	10.00	c	c	1271.35	1271.35	1.00	Class1	Class2	1271.35	1271.35	1.00	1.00
600	10	400	20	60.00	10.00	c	c	1377.10	1377.10	1.00	Class1	Class2	1377.10	1377.10	1.00	1.00
600	12	400	20	50.00	10.00	c	c	1419.40	1419.40	1.00	Class1	Class2	1419.40	1419.40	1.00	1.00
600	15	400	20	40.00	10.00	c	c	1482.85	1482.85	1.00	Class1	Class2	1482.85	1482.85	1.00	1.00
600	16	400	20	37.50	10.00	c	c	1504.00	1504.00	1.00	Class1	Class2	1504.00	1504.00	1.00	1.00
600	18	400	20	33.33	10.00	c	c	1546.30	1546.30	1.00	Class1	Class2	1546.30	1546.30	1.00	1.00
600	20	400	20	30.00	10.00	c	c	1588.60	1588.60	1.00	Class1	Class2	1588.60	1588.60	1.00	1.00
800	12	400	20	66.67	10.00	c	c	1992.80	1992.80	1.00	Class1	Class2	1992.80	1992.80	1.00	1.00
600	15	400	20	40.00	10.00	c	c	1482.85	1482.85	1.00	Class1	Class2	1482.85	1482.85	1.00	1.00
600	16	400	20	37.50	10.00	c	c	1504.00	1504.00	1.00	Class1	Class2	1504.00	1504.00	1.00	1.00
600	18	400	20	33.33	10.00	c	c	1546.30	1546.30	1.00	Class1	Class2	1546.30	1546.30	1.00	1.00
800	20	400	20	40.00	10.00	c	c	2293.60	2293.60	1.00	Class1	Class2	2293.60	2293.60	1.00	1.00
1000	15	400	20	66.67	10.00	c	c	2798.85	2798.85	1.00	Class1	Class2	2798.85	2798.85	1.00	1.00
1000	16	400	20	62.50	10.00	c	c	2857.60	2857.60	1.00	Class1	Class2	2857.60	2857.60	1.00	1.00

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1000	18	400	20	55.56	10.00	c	c	2975.10	2975.10	1.00	Class1	Class2	2975.10	2975.10	1.00	1.00
1000	20	400	20	50.00	10.00	c	c	3092.60	3092.60	1.00	Class1	Class2	3092.60	3092.60	1.00	1.00
500	8	400	15	62.50	13.33	c	nc	789.97	843.65	0.94	Class1	Class3	779.50	843.65	0.92	1.01
500	10	400	15	50.00	13.33	c	nc	821.92	873.03	0.94	Class1	Class3	797.97	873.03	0.91	1.03
500	12	400	15	41.67	13.33	c	nc	852.79	902.40	0.95	Class1	Class3	816.45	902.40	0.90	1.04
500	15	400	15	33.33	13.33	c	nc	897.99	946.46	0.95	Class1	Class3	844.16	946.46	0.89	1.06
500	16	400	15	31.25	13.33	c	nc	912.87	961.15	0.95	Class1	Class3	853.40	961.15	0.89	1.07
500	18	400	15	27.78	13.33	c	nc	942.44	990.53	0.95	Class1	Class3	871.87	990.53	0.88	1.08
500	20	400	15	25.00	13.33	c	nc	969.79	1019.90	0.95	Class1	Class3	890.35	1019.90	0.87	1.09
600	10	400	15	60.00	13.33	c	nc	1009.36	1078.65	0.94	Class1	Class3	980.79	1078.65	0.91	1.03
600	12	400	15	50.00	13.33	c	nc	1053.40	1120.95	0.94	Class1	Class3	1007.65	1120.95	0.90	1.05
600	15	400	15	40.00	13.33	c	nc	1117.99	1184.40	0.94	Class1	Class3	1047.93	1184.40	0.88	1.07
600	16	400	15	37.50	13.33	c	nc	1139.27	1205.55	0.95	Class1	Class3	1061.36	1205.55	0.88	1.07
600	18	400	15	33.33	13.33	c	nc	1181.58	1247.85	0.95	Class1	Class3	1088.22	1247.85	0.87	1.09
600	20	400	15	30.00	13.33	c	nc	1223.64	1290.15	0.95	Class1	Class3	1115.08	1290.15	0.86	1.10
800	12	400	15	66.67	13.33	c	nc	1487.49	1600.35	0.93	Class1	Class3	1418.31	1600.35	0.89	1.05
600	15	400	15	40.00	13.33	c	nc	1117.99	1184.40	0.94	Class1	Class3	1047.93	1184.40	0.88	1.07
600	16	400	15	37.50	13.33	c	nc	1139.27	1205.55	0.95	Class1	Class3	1061.36	1205.55	0.88	1.07

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	18	400	15	33.33	13.33	c	nc	1181.58	1247.85	0.95	Class1	Class3	1088.22	1247.85	0.87	1.09
800	20	400	15	40.00	13.33	c	nc	1787.27	1901.15	0.94	Class1	Class3	1611.60	1901.15	0.85	1.11
1000	15	400	15	66.67	13.33	c	nc	2140.40	2312.40	0.93	Class1	Class3	1980.70	2312.40	0.86	1.08
1000	16	400	15	62.50	13.33	c	nc	2198.56	2371.15	0.93	Class1	Class3	2018.72	2371.15	0.85	1.09
1000	18	400	15	55.56	13.33	c	nc	2314.32	2488.65	0.93	Class1	Class3	2094.77	2488.65	0.84	1.10
1000	20	400	15	50.00	13.33	c	nc	2429.54	2606.15	0.93	Class1	Class3	2170.83	2606.15	0.83	1.12
500	8	400	12	62.50	16.67	c	nc	584.24	695.04	0.84	Class1	Class4	579.98	695.04	0.83	1.01
500	10	400	12	50.00	16.67	c	nc	617.87	724.41	0.85	Class1	Class4	599.74	724.41	0.83	1.03
500	12	400	12	41.67	16.67	c	nc	649.43	753.79	0.86	Class1	Class4	619.36	753.79	0.82	1.05
500	15	400	12	33.33	16.67	c	nc	694.69	797.85	0.87	Class1	Class4	648.58	797.85	0.81	1.07
500	16	400	12	31.25	16.67	c	nc	709.43	812.54	0.87	Class1	Class4	658.28	812.54	0.81	1.08
500	18	400	12	27.78	16.67	c	nc	738.54	841.91	0.88	Class1	Class4	677.62	841.91	0.80	1.09
500	20	400	12	25.00	16.67	c	nc	762.92	871.29	0.88	Class1	Class4	696.89	871.29	0.80	1.09
600	10	400	12	60.00	16.67	c	nc	755.71	901.84	0.84	Class1	Class4	744.03	901.84	0.83	1.02
600	12	400	12	50.00	16.67	c	nc	800.33	944.14	0.85	Class1	Class4	772.31	944.14	0.82	1.04
600	15	400	12	40.00	16.67	c	nc	864.46	1007.59	0.86	Class1	Class4	814.45	1007.59	0.81	1.06
600	16	400	12	37.50	16.67	c	nc	885.37	1028.74	0.86	Class1	Class4	828.44	1028.74	0.81	1.07
600	18	400	12	33.33	16.67	c	nc	926.73	1071.04	0.87	Class1	Class4	856.34	1071.04	0.80	1.08

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	20	400	12	30.00	16.67	c	nc	967.64	1113.34	0.87	Class1	Class4	884.15	1113.34	0.79	1.09
800	12	400	12	66.67	16.67	c	nc	1122.26	1367.14	0.82	Class1	Class4	1107.03	1367.14	0.81	1.01
600	15	400	12	40.00	16.67	c	nc	864.46	1007.59	0.86	Class1	Class4	814.45	1007.59	0.81	1.06
600	16	400	12	37.50	16.67	c	nc	885.37	1028.74	0.86	Class1	Class4	828.44	1028.74	0.81	1.07
600	18	400	12	33.33	16.67	c	nc	926.73	1071.04	0.87	Class1	Class4	856.34	1071.04	0.80	1.08
800	20	400	12	40.00	16.67	c	nc	1413.57	1667.94	0.85	Class1	Class4	1306.15	1667.94	0.78	1.08
1000	15	400	12	66.67	16.67	c	nc	1639.27	2022.79	0.81	Class1	Class4	1597.06	2022.79	0.79	1.03
1000	16	400	12	62.50	16.67	c	nc	1695.30	2081.54	0.81	Class1	Class4	1635.99	2081.54	0.79	1.04
1000	18	400	12	55.56	16.67	c	nc	1806.36	2199.04	0.82	Class1	Class4	1713.69	2199.04	0.78	1.05
1000	20	400	12	50.00	16.67	c	nc	1916.44	2316.54	0.83	Class1	Class4	1791.23	2316.54	0.77	1.07
500	8	400	10	62.50	20.00	c	nc	443.25	596.90	0.74	Class1	Class4	449.46	596.90	0.75	0.99
500	10	400	10	50.00	20.00	c	nc	477.21	626.28	0.76	Class1	Class4	470.17	626.28	0.75	1.01
500	12	400	10	41.67	20.00	c	nc	508.51	655.65	0.78	Class1	Class4	490.61	655.65	0.75	1.04
500	15	400	10	33.33	20.00	c	nc	552.79	699.71	0.79	Class1	Class4	520.88	699.71	0.74	1.06
500	16	400	10	31.25	20.00	c	nc	567.10	714.40	0.79	Class1	Class4	530.88	714.40	0.74	1.07
500	18	400	10	27.78	20.00	c	nc	595.29	743.78	0.80	Class1	Class4	550.79	743.78	0.74	1.08
500	20	400	10	25.00	20.00	c	nc	616.72	773.15	0.80	Class1	Class4	570.58	773.15	0.74	1.08
600	10	400	10	60.00	20.00	c	nc	578.50	784.90	0.74	Class1	Class4	589.38	784.90	0.75	0.98

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	12	400	10	50.00	20.00	c	nc	622.41	827.20	0.75	Class1	Class4	618.64	827.20	0.75	1.01
600	15	400	10	40.00	20.00	c	nc	684.72	890.65	0.77	Class1	Class4	662.02	890.65	0.74	1.03
600	16	400	10	37.50	20.00	c	nc	704.90	911.80	0.77	Class1	Class4	676.37	911.80	0.74	1.04
600	18	400	10	33.33	20.00	c	nc	744.70	954.10	0.78	Class1	Class4	704.93	954.10	0.74	1.06
600	20	400	10	30.00	20.00	c	nc	783.94	996.40	0.79	Class1	Class4	733.34	996.40	0.74	1.07
800	12	400	10	66.67	20.00	c	nc	858.44	1212.60	0.71	Class1	Class4	903.81	1212.60	0.75	0.95
600	15	400	10	40.00	20.00	c	nc	684.72	890.65	0.77	Class1	Class4	662.02	890.65	0.74	1.03
600	16	400	10	37.50	20.00	c	nc	704.90	911.80	0.77	Class1	Class4	676.37	911.80	0.74	1.04
600	18	400	10	33.33	20.00	c	nc	744.70	954.10	0.78	Class1	Class4	704.93	954.10	0.74	1.06
800	20	400	10	40.00	20.00	c	nc	1136.82	1513.40	0.75	Class1	Class4	1106.53	1513.40	0.73	1.03
1000	15	400	10	66.67	20.00	c	nc	1263.79	1830.65	0.69	Class1	Class4	1346.42	1830.65	0.74	0.94
1000	16	400	10	62.50	20.00	c	nc	1316.90	1889.40	0.70	Class1	Class4	1385.88	1889.40	0.73	0.95
1000	18	400	10	55.56	20.00	c	nc	1421.88	2006.90	0.71	Class1	Class4	1464.54	2006.90	0.73	0.97
1000	20	400	10	50.00	20.00	c	nc	1525.69	2124.40	0.72	Class1	Class4	1542.94	2124.40	0.73	0.99
500	8	500	20	62.50	12.50	c	nc	1286.79	1339.50	0.96	Class1	Class3	1249.27	1339.50	0.93	1.03
500	10	500	20	50.00	12.50	c	nc	1319.61	1368.88	0.96	Class1	Class3	1267.40	1368.88	0.93	1.04
500	12	500	20	41.67	12.50	c	nc	1351.23	1398.25	0.97	Class1	Class3	1285.54	1398.25	0.92	1.05
500	15	500	20	33.33	12.50	c	nc	1397.41	1442.31	0.97	Class1	Class3	1312.74	1442.31	0.91	1.06

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	16	500	20	31.25	12.50	c	nc	1412.59	1457.00	0.97	Class1	Class3	1321.80	1457.00	0.91	1.07
500	18	500	20	27.78	12.50	c	nc	1442.73	1486.38	0.97	Class1	Class3	1339.94	1486.38	0.90	1.08
500	20	500	20	25.00	12.50	c	nc	1470.83	1515.75	0.97	Class1	Class3	1358.07	1515.75	0.90	1.08
600	10	500	20	60.00	12.50	c	nc	1603.12	1668.50	0.96	Class1	Class3	1543.66	1668.50	0.93	1.04
600	12	500	20	50.00	12.50	c	nc	1648.24	1710.80	0.96	Class1	Class3	1570.09	1710.80	0.92	1.05
600	15	500	20	40.00	12.50	c	nc	1714.24	1774.25	0.97	Class1	Class3	1609.75	1774.25	0.91	1.06
600	16	500	20	37.50	12.50	c	nc	1735.96	1795.40	0.97	Class1	Class3	1622.97	1795.40	0.90	1.07
600	18	500	20	33.33	12.50	c	nc	1779.10	1837.70	0.97	Class1	Class3	1649.41	1837.70	0.90	1.08
600	20	500	20	30.00	12.50	c	nc	1821.95	1880.00	0.97	Class1	Class3	1675.84	1880.00	0.89	1.09
800	12	500	20	66.67	12.50	c	nc	2277.57	2378.20	0.96	Class1	Class3	2167.60	2378.20	0.91	1.05
600	15	500	20	40.00	12.50	c	nc	1714.24	1774.25	0.97	Class1	Class3	1609.75	1774.25	0.91	1.06
600	16	500	20	37.50	12.50	c	nc	1735.96	1795.40	0.97	Class1	Class3	1622.97	1795.40	0.90	1.07
600	18	500	20	33.33	12.50	c	nc	1779.10	1837.70	0.97	Class1	Class3	1649.41	1837.70	0.90	1.08
800	20	500	20	40.00	12.50	c	nc	2583.71	2679.00	0.96	Class1	Class3	2358.58	2679.00	0.88	1.10
1000	15	500	20	66.67	12.50	c	nc	3133.64	3278.25	0.96	Class1	Class3	2915.81	3278.25	0.89	1.07
1000	16	500	20	62.50	12.50	c	nc	3193.09	3337.00	0.96	Class1	Class3	2953.47	3337.00	0.89	1.08
1000	18	500	20	55.56	12.50	c	nc	3311.33	3454.50	0.96	Class1	Class3	3028.79	3454.50	0.88	1.09
1000	20	500	20	50.00	12.50	c	nc	3428.91	3572.00	0.96	Class1	Class3	3104.11	3572.00	0.87	1.10

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	8	500	15	62.50	16.67	c	nc	865.92	1025.19	0.84	Class1	Class4	860.92	1025.19	0.84	1.01
500	10	500	15	50.00	16.67	c	nc	904.22	1054.56	0.86	Class1	Class4	880.76	1054.56	0.84	1.03
500	12	500	15	41.67	16.67	c	nc	939.13	1083.94	0.87	Class1	Class4	900.47	1083.94	0.83	1.04
500	15	500	15	33.33	16.67	c	nc	987.98	1128.00	0.88	Class1	Class4	929.84	1128.00	0.82	1.06
500	16	500	15	31.25	16.67	c	nc	1003.67	1142.69	0.88	Class1	Class4	939.58	1142.69	0.82	1.07
500	18	500	15	27.78	16.67	c	nc	1034.43	1172.06	0.88	Class1	Class4	959.00	1172.06	0.82	1.08
500	20	500	15	25.00	16.67	c	nc	1058.80	1201.44	0.88	Class1	Class4	978.34	1201.44	0.81	1.08
600	10	500	15	60.00	16.67	c	nc	1093.25	1295.44	0.84	Class1	Class4	1081.34	1295.44	0.83	1.01
600	12	500	15	50.00	16.67	c	nc	1142.30	1337.74	0.85	Class1	Class4	1109.80	1337.74	0.83	1.03
600	15	500	15	40.00	16.67	c	nc	1211.17	1401.19	0.86	Class1	Class4	1152.20	1401.19	0.82	1.05
600	16	500	15	37.50	16.67	c	nc	1233.33	1422.34	0.87	Class1	Class4	1166.26	1422.34	0.82	1.06
600	18	500	15	33.33	16.67	c	nc	1276.84	1464.64	0.87	Class1	Class4	1194.30	1464.64	0.82	1.07
600	20	500	15	30.00	16.67	c	nc	1319.55	1506.94	0.88	Class1	Class4	1222.23	1506.94	0.81	1.08
800	12	500	15	66.67	16.67	c	nc	1565.98	1887.64	0.83	Class1	Class4	1557.70	1887.64	0.83	1.01
600	15	500	15	40.00	16.67	c	nc	1211.17	1401.19	0.86	Class1	Class4	1152.20	1401.19	0.82	1.05
600	16	500	15	37.50	16.67	c	nc	1233.33	1422.34	0.87	Class1	Class4	1166.26	1422.34	0.82	1.06
600	18	500	15	33.33	16.67	c	nc	1276.84	1464.64	0.87	Class1	Class4	1194.30	1464.64	0.82	1.07
800	20	500	15	40.00	16.67	c	nc	1872.82	2188.44	0.86	Class1	Class4	1757.95	2188.44	0.80	1.07

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1000	15	500	15	66.67	16.67	c	nc	2191.91	2670.19	0.82	Class1	Class4	2162.16	2670.19	0.81	1.01
1000	16	500	15	62.50	16.67	c	nc	2250.74	2728.94	0.82	Class1	Class4	2201.30	2728.94	0.81	1.02
1000	18	500	15	55.56	16.67	c	nc	2366.58	2846.44	0.83	Class1	Class4	2279.38	2846.44	0.80	1.04
1000	20	500	15	50.00	16.67	c	nc	2480.62	2963.94	0.84	Class1	Class4	2357.23	2963.94	0.80	1.05
500	8	500	12	62.50	20.83	c	nc	610.25	839.42	0.73	Class1	Class4	616.04	839.42	0.73	0.99
500	10	500	12	50.00	20.83	c	nc	650.54	868.80	0.75	Class1	Class4	637.41	868.80	0.73	1.02
500	12	500	12	41.67	20.83	c	nc	686.24	898.17	0.76	Class1	Class4	658.48	898.17	0.73	1.04
500	15	500	12	33.33	20.83	c	nc	735.08	942.23	0.78	Class1	Class4	689.63	942.23	0.73	1.07
500	16	500	12	31.25	20.83	c	nc	750.56	956.92	0.78	Class1	Class4	699.91	956.92	0.73	1.07
500	18	500	12	27.78	20.83	c	nc	780.72	986.30	0.79	Class1	Class4	720.34	986.30	0.73	1.08
500	20	500	12	25.00	20.83	c	nc	801.40	1015.67	0.79	Class1	Class4	740.60	1015.67	0.73	1.08
600	10	500	12	60.00	20.83	c	nc	777.74	1074.42	0.72	Class1	Class4	790.77	1074.42	0.74	0.98
600	12	500	12	50.00	20.83	c	nc	827.42	1116.72	0.74	Class1	Class4	820.92	1116.72	0.74	1.01
600	15	500	12	40.00	20.83	c	nc	895.63	1180.17	0.76	Class1	Class4	865.50	1180.17	0.73	1.03
600	16	500	12	37.50	20.83	c	nc	917.30	1201.32	0.76	Class1	Class4	880.22	1201.32	0.73	1.04
600	18	500	12	33.33	20.83	c	nc	959.60	1243.62	0.77	Class1	Class4	909.46	1243.62	0.73	1.06
600	20	500	12	30.00	20.83	c	nc	1000.84	1285.92	0.78	Class1	Class4	938.50	1285.92	0.73	1.07
800	12	500	12	66.67	20.83	c	nc	1111.19	1596.12	0.70	Class1	Class4	1175.69	1596.12	0.74	0.95

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	15	500	12	40.00	20.83	c	nc	895.63	1180.17	0.76	Class1	Class4	865.50	1180.17	0.73	1.03
600	16	500	12	37.50	20.83	c	nc	917.30	1201.32	0.76	Class1	Class4	880.22	1201.32	0.73	1.04
600	18	500	12	33.33	20.83	c	nc	959.60	1243.62	0.77	Class1	Class4	909.46	1243.62	0.73	1.06
800	20	500	12	40.00	20.83	c	nc	1407.27	1896.92	0.74	Class1	Class4	1382.70	1896.92	0.73	1.02
1000	15	500	12	66.67	20.83	c	nc	1567.46	2308.17	0.68	Class1	Class4	1691.21	2308.17	0.73	0.93
1000	16	500	12	62.50	20.83	c	nc	1623.61	2366.92	0.69	Class1	Class4	1731.38	2366.92	0.73	0.94
1000	18	500	12	55.56	20.83	c	nc	1733.53	2484.42	0.70	Class1	Class4	1811.34	2484.42	0.73	0.96
1000	20	500	12	50.00	20.83	c	nc	1841.12	2601.92	0.71	Class1	Class4	1890.86	2601.92	0.73	0.97
500	8	500	10	62.50	25.00	c	s	411.14	716.75	0.57	Class1	Class4	473.45	716.75	0.66	0.87
500	10	500	10	50.00	25.00	c	s	472.72	746.13	0.63	Class1	Class4	495.67	746.13	0.66	0.95
500	12	500	10	41.67	25.00	c	nc	510.95	775.50	0.66	Class1	Class4	517.47	775.50	0.67	0.99
500	15	500	10	33.33	25.00	c	nc	558.52	819.56	0.68	Class1	Class4	549.53	819.56	0.67	1.02
500	16	500	10	31.25	25.00	c	nc	573.46	834.25	0.69	Class1	Class4	560.07	834.25	0.67	1.02
500	18	500	10	27.78	25.00	c	nc	602.45	863.63	0.70	Class1	Class4	580.98	863.63	0.67	1.04
500	20	500	10	25.00	25.00	c	nc	619.45	893.00	0.69	Class1	Class4	601.68	893.00	0.67	1.03
600	10	500	10	60.00	25.00	c	s	532.64	928.25	0.57	Class1	Class4	621.46	928.25	0.67	0.86
600	12	500	10	50.00	25.00	c	s	602.40	970.55	0.62	Class1	Class4	652.47	970.55	0.67	0.92
600	15	500	10	40.00	25.00	c	nc	671.87	1034.00	0.65	Class1	Class4	698.10	1034.00	0.68	0.96

Table B.1: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	16	500	10	37.50	25.00	c	nc	692.62	1055.15	0.66	Class1	Class4	713.12	1055.15	0.68	0.97
600	18	500	10	33.33	25.00	c	nc	732.94	1097.45	0.67	Class1	Class4	742.92	1097.45	0.68	0.99
600	20	500	10	30.00	25.00	c	nc	772.07	1139.75	0.68	Class1	Class4	772.44	1139.75	0.68	1.00
800	12	500	10	66.67	25.00	c	s	740.64	1402.95	0.53	Class1	Class4	952.56	1402.95	0.68	0.78
600	15	500	10	40.00	25.00	c	nc	671.87	1034.00	0.65	Class1	Class4	698.10	1034.00	0.68	0.96
600	16	500	10	37.50	25.00	c	nc	692.62	1055.15	0.66	Class1	Class4	713.12	1055.15	0.68	0.97
600	18	500	10	33.33	25.00	c	nc	732.94	1097.45	0.67	Class1	Class4	742.92	1097.45	0.68	0.99
800	20	500	10	40.00	25.00	c	nc	1062.39	1703.75	0.62	Class1	Class4	1162.44	1703.75	0.68	0.91
1000	15	500	10	66.67	25.00	c	s	1051.33	2068.00	0.51	Class1	Class4	1414.97	2068.00	0.68	0.74
1000	16	500	10	62.50	25.00	c	s	1109.62	2126.75	0.52	Class1	Class4	1455.55	2126.75	0.68	0.76
1000	18	500	10	55.56	25.00	c	s	1227.44	2244.25	0.55	Class1	Class4	1536.23	2244.25	0.68	0.80
1000	20	500	10	50.00	25.00	c	s	1347.08	2361.75	0.57	Class1	Class4	1616.40	2361.75	0.68	0.83

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=355 MPa)

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	8	300	20	62.50	7.50	c	c	1285.10	1285.10	1.00	Class2	Class2	1285.10	1285.10	1.00	1.00
500	10	300	20	50.00	7.50	c	c	1329.48	1329.48	1.00	Class1	Class2	1329.48	1329.48	1.00	1.00
500	12	300	20	41.67	7.50	c	c	1373.85	1373.85	1.00	Class1	Class2	1373.85	1373.85	1.00	1.00
500	15	300	20	33.33	7.50	c	c	1440.41	1440.41	1.00	Class1	Class2	1440.41	1440.41	1.00	1.00
500	16	300	20	31.25	7.50	c	c	1462.60	1462.60	1.00	Class1	Class2	1462.60	1462.60	1.00	1.00
500	18	300	20	27.78	7.50	c	c	1506.98	1506.98	1.00	Class1	Class2	1506.98	1506.98	1.00	1.00
500	20	300	20	25.00	7.50	c	c	1551.35	1551.35	1.00	Class1	Class2	1551.35	1551.35	1.00	1.00
600	10	300	20	60.00	7.50	c	c	1640.10	1640.10	1.00	Class2	Class2	1640.10	1640.10	1.00	1.00
600	12	300	20	50.00	7.50	c	c	1704.00	1704.00	1.00	Class1	Class2	1704.00	1704.00	1.00	1.00
600	15	300	20	40.00	7.50	c	c	1799.85	1799.85	1.00	Class1	Class2	1799.85	1799.85	1.00	1.00
600	16	300	20	37.50	7.50	c	c	1831.80	1831.80	1.00	Class1	Class2	1831.80	1831.80	1.00	1.00
600	18	300	20	33.33	7.50	c	c	1895.70	1895.70	1.00	Class1	Class2	1895.70	1895.70	1.00	1.00
600	20	300	20	30.00	7.50	c	c	1959.60	1959.60	1.00	Class1	Class2	1959.60	1959.60	1.00	1.00
800	12	300	20	66.67	7.50	c	c	2428.20	2428.20	1.00	Class2	Class2	2428.20	2428.20	1.00	1.00
600	15	300	20	40.00	7.50	c	c	1799.85	1799.85	1.00	Class1	Class2	1799.85	1799.85	1.00	1.00
600	16	300	20	37.50	7.50	c	c	1831.80	1831.80	1.00	Class1	Class2	1831.80	1831.80	1.00	1.00
600	18	300	20	33.33	7.50	c	c	1895.70	1895.70	1.00	Class1	Class2	1895.70	1895.70	1.00	1.00
800	20	300	20	40.00	7.50	c	c	2882.60	2882.60	1.00	Class1	Class2	2882.60	2882.60	1.00	1.00

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=355 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1000	15	300	20	66.67	7.50	c	c	3503.85	3503.85	1.00	Class2	Class2	3503.85	3503.85	1.00	1.00
1000	16	300	20	62.50	7.50	c	c	3592.60	3592.60	1.00	Class2	Class2	3592.60	3592.60	1.00	1.00
1000	18	300	20	55.56	7.50	c	c	3770.10	3770.10	1.00	Class1	Class2	3770.10	3770.10	1.00	1.00
1000	20	300	20	50.00	7.50	c	c	3947.60	3947.60	1.00	Class1	Class2	3947.60	3947.60	1.00	1.00
500	8	300	15	62.50	10.00	c	nc	965.20	1000.21	0.96	Class2	Class3	911.06	1000.21	0.91	1.06
500	10	300	15	50.00	10.00	c	nc	1010.84	1044.59	0.97	Class1	Class3	938.97	1044.59	0.90	1.08
500	12	300	15	41.67	10.00	c	nc	1055.83	1088.96	0.97	Class1	Class3	966.88	1088.96	0.89	1.09
500	15	300	15	33.33	10.00	c	nc	1122.68	1155.53	0.97	Class1	Class3	1008.74	1155.53	0.87	1.11
500	16	300	15	31.25	10.00	c	nc	1144.85	1177.71	0.97	Class1	Class3	1022.70	1177.71	0.87	1.12
500	18	300	15	27.78	10.00	c	nc	1189.09	1222.09	0.97	Class1	Class3	1050.61	1222.09	0.86	1.13
500	20	300	15	25.00	10.00	c	nc	1231.82	1266.46	0.97	Class1	Class3	1078.52	1266.46	0.85	1.14
600	10	300	15	60.00	10.00	c	nc	1255.67	1301.96	0.96	Class2	Class3	1161.93	1301.96	0.89	1.08
600	12	300	15	50.00	10.00	c	nc	1320.19	1365.86	0.97	Class1	Class3	1202.50	1365.86	0.88	1.10
600	15	300	15	40.00	10.00	c	nc	1416.11	1461.71	0.97	Class1	Class3	1263.36	1461.71	0.86	1.12
600	16	300	15	37.50	10.00	c	nc	1447.94	1493.66	0.97	Class1	Class3	1283.64	1493.66	0.86	1.13
600	18	300	15	33.33	10.00	c	nc	1511.47	1557.56	0.97	Class1	Class3	1324.21	1557.56	0.85	1.14
600	20	300	15	30.00	10.00	c	nc	1574.85	1621.46	0.97	Class1	Class3	1364.78	1621.46	0.84	1.15
800	12	300	15	66.67	10.00	c	nc	1905.67	1983.56	0.96	Class2	Class3	1716.41	1983.56	0.87	1.11

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=355 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	15	300	15	40.00	10.00	c	nc	1416.11	1461.71	0.97	Class1	Class3	1263.36	1461.71	0.86	1.12
600	16	300	15	37.50	10.00	c	nc	1447.94	1493.66	0.97	Class1	Class3	1283.64	1493.66	0.86	1.13
600	18	300	15	33.33	10.00	c	nc	1511.47	1557.56	0.97	Class1	Class3	1324.21	1557.56	0.85	1.14
800	20	300	15	40.00	10.00	c	nc	2356.45	2437.96	0.97	Class1	Class3	2008.39	2437.96	0.82	1.17
1000	15	300	15	66.67	10.00	c	nc	2830.10	2952.71	0.96	Class2	Class3	2459.50	2952.71	0.83	1.15
1000	16	300	15	62.50	10.00	c	nc	2917.87	3041.46	0.96	Class2	Class3	2516.94	3041.46	0.83	1.16
1000	18	300	15	55.56	10.00	c	nc	3093.10	3218.96	0.96	Class1	Class3	2631.83	3218.96	0.82	1.18
1000	20	300	15	50.00	10.00	c	nc	3268.03	3396.46	0.96	Class1	Class3	2746.72	3396.46	0.81	1.19
500	8	300	12	62.50	12.50	c	nc	727.18	831.84	0.87	Class2	Class4	716.57	831.84	0.86	1.01
500	10	300	12	50.00	12.50	c	nc	774.17	876.21	0.88	Class1	Class4	745.52	876.21	0.85	1.04
500	12	300	12	41.67	12.50	c	nc	819.43	920.59	0.89	Class1	Class4	774.36	920.59	0.84	1.06
500	15	300	12	33.33	12.50	c	nc	885.59	987.15	0.90	Class1	Class4	817.46	987.15	0.83	1.08
500	16	300	12	31.25	12.50	c	nc	907.36	1009.34	0.90	Class1	Class4	831.80	1009.34	0.82	1.09
500	18	300	12	27.78	12.50	c	nc	950.61	1053.71	0.90	Class1	Class4	860.43	1053.71	0.82	1.10
500	20	300	12	25.00	12.50	c	nc	989.18	1098.09	0.90	Class1	Class4	889.01	1098.09	0.81	1.11
600	10	300	12	60.00	12.50	c	nc	959.93	1101.64	0.87	Class2	Class4	930.59	1101.64	0.84	1.03
600	12	300	12	50.00	12.50	c	nc	1024.31	1165.54	0.88	Class1	Class4	972.30	1165.54	0.83	1.05
600	15	300	12	40.00	12.50	c	nc	1118.57	1261.39	0.89	Class1	Class4	1034.65	1261.39	0.82	1.08

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	16	300	12	37.50	12.50	c	nc	1149.62	1293.34	0.89	Class1	Class4	1055.39	1293.34	0.82	1.09
600	18	300	12	33.33	12.50	c	nc	1211.36	1357.24	0.89	Class1	Class4	1096.82	1357.24	0.81	1.10
600	20	300	12	30.00	12.50	c	nc	1272.74	1421.14	0.90	Class1	Class4	1138.20	1421.14	0.80	1.12
800	12	300	12	66.67	12.50	c	nc	1473.73	1719.34	0.86	Class2	Class4	1411.12	1719.34	0.82	1.04
600	15	300	12	40.00	12.50	c	nc	1118.57	1261.39	0.89	Class1	Class4	1034.65	1261.39	0.82	1.08
600	16	300	12	37.50	12.50	c	nc	1149.62	1293.34	0.89	Class1	Class4	1055.39	1293.34	0.82	1.09
600	18	300	12	33.33	12.50	c	nc	1211.36	1357.24	0.89	Class1	Class4	1096.82	1357.24	0.81	1.10
800	20	300	12	40.00	12.50	c	nc	1909.29	2173.74	0.88	Class1	Class4	1707.82	2173.74	0.79	1.12
1000	15	300	12	66.67	12.50	c	nc	2227.48	2624.59	0.85	Class2	Class4	2081.79	2624.59	0.79	1.07
1000	16	300	12	62.50	12.50	c	nc	2311.68	2713.34	0.85	Class2	Class4	2139.95	2713.34	0.79	1.08
1000	18	300	12	55.56	12.50	c	nc	2479.28	2890.84	0.86	Class1	Class4	2256.19	2890.84	0.78	1.10
1000	20	300	12	50.00	12.50	c	nc	2646.17	3068.34	0.86	Class1	Class4	2372.32	3068.34	0.77	1.12
500	8	300	10	62.50	15.00	c	nc	562.69	720.65	0.78	Class2	Class4	563.40	720.65	0.78	1.00
500	10	300	10	50.00	15.00	c	nc	609.51	765.03	0.80	Class1	Class4	593.61	765.03	0.78	1.03
500	12	300	10	41.67	15.00	c	nc	653.94	809.40	0.81	Class1	Class4	623.53	809.40	0.77	1.05
500	15	300	10	33.33	15.00	c	nc	718.25	875.96	0.82	Class1	Class4	668.00	875.96	0.76	1.08
500	16	300	10	31.25	15.00	c	nc	739.30	898.15	0.82	Class1	Class4	682.74	898.15	0.76	1.08
500	18	300	10	27.78	15.00	c	nc	781.05	942.53	0.83	Class1	Class4	712.11	942.53	0.76	1.10

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=355 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	20	300	10	25.00	15.00	c	nc	815.50	986.90	0.83	Class1	Class4	741.37	986.90	0.75	1.10
600	10	300	10	60.00	15.00	c	nc	751.01	969.15	0.77	Class2	Class4	749.33	969.15	0.77	1.00
600	12	300	10	50.00	15.00	c	nc	813.79	1033.05	0.79	Class1	Class4	792.33	1033.05	0.77	1.03
600	15	300	10	40.00	15.00	c	nc	904.86	1128.90	0.80	Class1	Class4	856.29	1128.90	0.76	1.06
600	16	300	10	37.50	15.00	c	nc	934.72	1160.85	0.81	Class1	Class4	877.50	1160.85	0.76	1.07
600	18	300	10	33.33	15.00	c	nc	993.97	1224.75	0.81	Class1	Class4	919.79	1224.75	0.75	1.08
600	20	300	10	30.00	15.00	c	nc	1052.78	1288.65	0.82	Class1	Class4	961.94	1288.65	0.75	1.09
800	12	300	10	66.67	15.00	c	nc	1157.00	1544.25	0.75	Class2	Class4	1173.20	1544.25	0.76	0.99
600	15	300	10	40.00	15.00	c	nc	904.86	1128.90	0.80	Class1	Class4	856.29	1128.90	0.76	1.06
600	16	300	10	37.50	15.00	c	nc	934.72	1160.85	0.81	Class1	Class4	877.50	1160.85	0.76	1.07
600	18	300	10	33.33	15.00	c	nc	993.97	1224.75	0.81	Class1	Class4	919.79	1224.75	0.75	1.08
800	20	300	10	40.00	15.00	c	nc	1572.32	1998.65	0.79	Class1	Class4	1474.54	1998.65	0.74	1.07
1000	15	300	10	66.67	15.00	c	nc	1767.64	2406.90	0.73	Class2	Class4	1788.58	2406.90	0.74	0.99
1000	16	300	10	62.50	15.00	c	nc	1847.35	2495.65	0.74	Class2	Class4	1847.43	2495.65	0.74	1.00
1000	18	300	10	55.56	15.00	c	nc	2005.78	2673.15	0.75	Class1	Class4	1964.91	2673.15	0.74	1.02
1000	20	300	10	50.00	15.00	c	nc	2163.36	2850.65	0.76	Class1	Class4	2082.17	2850.65	0.73	1.04
500	8	400	20	62.50	10.00	c	nc	1598.07	1654.30	0.97	Class2	Class3	1531.67	1654.30	0.93	1.04
500	10	400	20	50.00	10.00	c	nc	1645.75	1698.68	0.97	Class1	Class3	1559.06	1698.68	0.92	1.06

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	12	400	20	41.67	10.00	c	nc	1692.20	1743.05	0.97	Class1	Class3	1586.46	1743.05	0.91	1.07
500	15	400	20	33.33	10.00	c	nc	1760.61	1809.61	0.97	Class1	Class3	1627.54	1809.61	0.90	1.08
500	16	400	20	31.25	10.00	c	nc	1783.20	1831.80	0.97	Class1	Class3	1641.24	1831.80	0.90	1.09
500	18	400	20	27.78	10.00	c	nc	1828.16	1876.18	0.97	Class1	Class3	1668.63	1876.18	0.89	1.10
500	20	400	20	25.00	10.00	c	nc	1870.88	1920.55	0.97	Class1	Class3	1696.02	1920.55	0.88	1.10
600	10	400	20	60.00	10.00	c	nc	2009.57	2080.30	0.97	Class2	Class3	1905.46	2080.30	0.92	1.05
600	12	400	20	50.00	10.00	c	nc	2076.02	2144.20	0.97	Class1	Class3	1945.40	2144.20	0.91	1.07
600	15	400	20	40.00	10.00	c	nc	2174.00	2240.05	0.97	Class1	Class3	2005.31	2240.05	0.90	1.08
600	16	400	20	37.50	10.00	c	nc	2206.37	2272.00	0.97	Class1	Class3	2025.28	2272.00	0.89	1.09
600	18	400	20	33.33	10.00	c	nc	2270.83	2335.90	0.97	Class1	Class3	2065.21	2335.90	0.88	1.10
600	20	400	20	30.00	10.00	c	nc	2334.99	2399.80	0.97	Class1	Class3	2105.15	2399.80	0.88	1.11
800	12	400	20	66.67	10.00	c	nc	2899.24	3010.40	0.96	Class2	Class3	2706.11	3010.40	0.90	1.07
600	15	400	20	40.00	10.00	c	nc	2174.00	2240.05	0.97	Class1	Class3	2005.31	2240.05	0.90	1.08
600	16	400	20	37.50	10.00	c	nc	2206.37	2272.00	0.97	Class1	Class3	2025.28	2272.00	0.89	1.09
600	18	400	20	33.33	10.00	c	nc	2270.83	2335.90	0.97	Class1	Class3	2065.21	2335.90	0.88	1.10
800	20	400	20	40.00	10.00	c	nc	3356.71	3464.80	0.97	Class1	Class3	2994.62	3464.80	0.86	1.12
1000	15	400	20	66.67	10.00	c	nc	4064.52	4228.05	0.96	Class2	Class3	3694.46	4228.05	0.87	1.10
1000	16	400	20	62.50	10.00	c	nc	4153.49	4316.80	0.96	Class2	Class3	3751.35	4316.80	0.87	1.11

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1000	18	400	20	55.56	10.00	c	nc	4330.76	4494.30	0.96	Class1	Class3	3865.13	4494.30	0.86	1.12
1000	20	400	20	50.00	10.00	c	nc	4507.40	4671.80	0.96	Class1	Class3	3978.91	4671.80	0.85	1.13
500	8	400	15	62.50	13.33	c	nc	1083.14	1274.45	0.85	Class2	Class4	1074.98	1274.45	0.84	1.01
500	10	400	15	50.00	13.33	c	nc	1136.70	1318.83	0.86	Class1	Class4	1104.56	1318.83	0.84	1.03
500	12	400	15	41.67	13.33	c	nc	1186.40	1363.20	0.87	Class1	Class4	1133.96	1363.20	0.83	1.05
500	15	400	15	33.33	13.33	c	nc	1257.03	1429.76	0.88	Class1	Class4	1177.77	1429.76	0.82	1.07
500	16	400	15	31.25	13.33	c	nc	1279.90	1451.95	0.88	Class1	Class4	1192.31	1451.95	0.82	1.07
500	18	400	15	27.78	13.33	c	nc	1324.97	1496.33	0.89	Class1	Class4	1221.31	1496.33	0.82	1.08
500	20	400	15	25.00	13.33	c	nc	1362.14	1540.70	0.88	Class1	Class4	1250.20	1540.70	0.81	1.09
600	10	400	15	60.00	13.33	c	nc	1382.52	1629.45	0.85	Class2	Class4	1362.09	1629.45	0.84	1.02
600	12	400	15	50.00	13.33	c	nc	1452.63	1693.35	0.86	Class1	Class4	1404.56	1693.35	0.83	1.03
600	15	400	15	40.00	13.33	c	nc	1552.53	1789.20	0.87	Class1	Class4	1467.86	1789.20	0.82	1.06
600	16	400	15	37.50	13.33	c	nc	1584.95	1821.15	0.87	Class1	Class4	1488.87	1821.15	0.82	1.06
600	18	400	15	33.33	13.33	c	nc	1648.89	1885.05	0.87	Class1	Class4	1530.77	1885.05	0.81	1.08
600	20	400	15	30.00	13.33	c	nc	1711.95	1948.95	0.88	Class1	Class4	1572.54	1948.95	0.81	1.09
800	12	400	15	66.67	13.33	c	nc	2015.38	2417.55	0.83	Class2	Class4	1989.48	2417.55	0.82	1.01
600	15	400	15	40.00	13.33	c	nc	1552.53	1789.20	0.87	Class1	Class4	1467.86	1789.20	0.82	1.06
600	16	400	15	37.50	13.33	c	nc	1584.95	1821.15	0.87	Class1	Class4	1488.87	1821.15	0.82	1.06

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	18	400	15	33.33	13.33	c	nc	1648.89	1885.05	0.87	Class1	Class4	1530.77	1885.05	0.81	1.08
800	20	400	15	40.00	13.33	c	nc	2466.15	2871.95	0.86	Class1	Class4	2289.17	2871.95	0.80	1.08
1000	15	400	15	66.67	13.33	c	nc	2880.27	3493.20	0.82	Class2	Class4	2808.84	3493.20	0.80	1.03
1000	16	400	15	62.50	13.33	c	nc	2966.92	3581.95	0.83	Class2	Class4	2867.49	3581.95	0.80	1.03
1000	18	400	15	55.56	13.33	c	nc	3138.23	3759.45	0.83	Class1	Class4	2984.54	3759.45	0.79	1.05
1000	20	400	15	50.00	13.33	c	nc	3307.60	3936.95	0.84	Class1	Class4	3101.32	3936.95	0.79	1.07
500	8	400	12	62.50	16.67	c	nc	768.06	1049.95	0.73	Class2	Class4	777.98	1049.95	0.74	0.99
500	10	400	12	50.00	16.67	c	nc	823.27	1094.32	0.75	Class1	Class4	809.63	1094.32	0.74	1.02
500	12	400	12	41.67	16.67	c	nc	873.22	1138.70	0.77	Class1	Class4	840.83	1138.70	0.74	1.04
500	15	400	12	33.33	16.67	c	nc	942.82	1205.26	0.78	Class1	Class4	886.99	1205.26	0.74	1.06
500	16	400	12	31.25	16.67	c	nc	965.13	1227.45	0.79	Class1	Class4	902.23	1227.45	0.74	1.07
500	18	400	12	27.78	16.67	c	nc	1008.84	1271.82	0.79	Class1	Class4	932.53	1271.82	0.73	1.08
500	20	400	12	25.00	16.67	c	nc	1040.51	1316.20	0.79	Class1	Class4	962.61	1316.20	0.73	1.08
600	10	400	12	60.00	16.67	c	nc	990.60	1362.35	0.73	Class2	Class4	1010.03	1362.35	0.74	0.98
600	12	400	12	50.00	16.67	c	nc	1060.40	1426.25	0.74	Class1	Class4	1054.71	1426.25	0.74	1.01
600	15	400	12	40.00	16.67	c	nc	1157.97	1522.10	0.76	Class1	Class4	1120.83	1522.10	0.74	1.03
600	16	400	12	37.50	16.67	c	nc	1189.32	1554.05	0.77	Class1	Class4	1142.68	1554.05	0.74	1.04
600	18	400	12	33.33	16.67	c	nc	1250.83	1617.95	0.77	Class1	Class4	1186.12	1617.95	0.73	1.05

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	20	400	12	30.00	16.67	c	nc	1311.19	1681.85	0.78	Class1	Class4	1229.30	1681.85	0.73	1.07
800	12	400	12	66.67	16.67	c	nc	1442.26	2065.25	0.70	Class2	Class4	1526.93	2065.25	0.74	0.94
600	15	400	12	40.00	16.67	c	nc	1157.97	1522.10	0.76	Class1	Class4	1120.83	1522.10	0.74	1.03
600	16	400	12	37.50	16.67	c	nc	1189.32	1554.05	0.77	Class1	Class4	1142.68	1554.05	0.74	1.04
600	18	400	12	33.33	16.67	c	nc	1250.83	1617.95	0.77	Class1	Class4	1186.12	1617.95	0.73	1.05
800	20	400	12	40.00	16.67	c	nc	1872.52	2519.65	0.74	Class1	Class4	1835.11	2519.65	0.73	1.02
1000	15	400	12	66.67	16.67	c	nc	2079.99	3055.70	0.68	Class2	Class4	2238.69	3055.70	0.73	0.93
1000	16	400	12	62.50	16.67	c	nc	2161.84	3144.45	0.69	Class2	Class4	2298.61	3144.45	0.73	0.94
1000	18	400	12	55.56	16.67	c	nc	2322.94	3321.95	0.70	Class1	Class4	2417.99	3321.95	0.73	0.96
1000	20	400	12	50.00	16.67	c	nc	2481.57	3499.45	0.71	Class1	Class4	2536.85	3499.45	0.72	0.98
500	8	400	10	62.50	20.00	c	s	528.52	901.70	0.59	Class2	Class4	604.73	901.70	0.67	0.87
500	10	400	10	50.00	20.00	c	nc	605.15	946.08	0.64	Class1	Class4	637.47	946.08	0.67	0.95
500	12	400	10	41.67	20.00	c	nc	653.92	990.45	0.66	Class1	Class4	669.60	990.45	0.68	0.98
500	15	400	10	33.33	20.00	c	nc	720.98	1057.01	0.68	Class1	Class4	716.91	1057.01	0.68	1.01
500	16	400	10	31.25	20.00	c	nc	742.32	1079.20	0.69	Class1	Class4	732.48	1079.20	0.68	1.01
500	18	400	10	27.78	20.00	c	nc	783.99	1123.58	0.70	Class1	Class4	763.39	1123.58	0.68	1.03
500	20	400	10	25.00	20.00	c	nc	810.19	1167.95	0.69	Class1	Class4	794.03	1167.95	0.68	1.02
600	10	400	10	60.00	20.00	c	s	692.79	1185.70	0.58	Class2	Class4	804.40	1185.70	0.68	0.86

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	12	400	10	50.00	20.00	c	nc	781.24	1249.60	0.63	Class1	Class4	850.15	1249.60	0.68	0.92
600	15	400	10	40.00	20.00	c	nc	874.48	1345.45	0.65	Class1	Class4	917.58	1345.45	0.68	0.95
600	16	400	10	37.50	20.00	c	nc	904.22	1377.40	0.66	Class1	Class4	939.80	1377.40	0.68	0.96
600	18	400	10	33.33	20.00	c	nc	962.39	1441.30	0.67	Class1	Class4	983.94	1441.30	0.68	0.98
600	20	400	10	30.00	20.00	c	nc	1019.30	1505.20	0.68	Class1	Class4	1027.73	1505.20	0.68	0.99
800	12	400	10	66.67	20.00	c	s	980.86	1831.80	0.54	Class2	Class4	1255.87	1831.80	0.69	0.78
600	15	400	10	40.00	20.00	c	nc	874.48	1345.45	0.65	Class1	Class4	917.58	1345.45	0.68	0.95
600	16	400	10	37.50	20.00	c	nc	904.22	1377.40	0.66	Class1	Class4	939.80	1377.40	0.68	0.96
600	18	400	10	33.33	20.00	c	nc	962.39	1441.30	0.67	Class1	Class4	983.94	1441.30	0.68	0.98
800	20	400	10	40.00	20.00	c	nc	1424.95	2286.20	0.62	Class1	Class4	1567.60	2286.20	0.69	0.91
1000	15	400	10	66.67	20.00	c	s	1422.23	2765.45	0.51	Class2	Class4	1903.01	2765.45	0.69	0.75
1000	16	400	10	62.50	20.00	c	s	1506.08	2854.20	0.53	Class2	Class4	1963.43	2854.20	0.69	0.77
1000	18	400	10	55.56	20.00	c	s	1676.36	3031.70	0.55	Class1	Class4	2083.72	3031.70	0.69	0.80
1000	20	400	10	50.00	20.00	c	nc	1839.91	3209.20	0.57	Class1	Class4	2203.39	3209.20	0.69	0.84
500	8	500	20	62.50	12.50	c	nc	1782.65	2023.50	0.88	Class2	Class4	1781.45	2023.50	0.88	1.00
500	10	500	20	50.00	12.50	c	nc	1842.77	2067.88	0.89	Class1	Class4	1810.11	2067.88	0.88	1.02
500	12	500	20	41.67	12.50	c	nc	1897.40	2112.25	0.90	Class1	Class4	1838.68	2112.25	0.87	1.03
500	15	500	20	33.33	12.50	c	nc	1973.65	2178.81	0.91	Class1	Class4	1881.37	2178.81	0.86	1.05

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	16	500	20	31.25	12.50	c	nc	1998.09	2201.00	0.91	Class1	Class4	1895.56	2201.00	0.86	1.05
500	18	500	20	27.78	12.50	c	nc	2045.96	2245.38	0.91	Class1	Class4	1923.89	2245.38	0.86	1.06
500	20	500	20	25.00	12.50	c	nc	2084.50	2289.75	0.91	Class1	Class4	1952.16	2289.75	0.85	1.07
600	10	500	20	60.00	12.50	c	nc	2221.76	2520.50	0.88	Class2	Class4	2207.62	2520.50	0.88	1.01
600	12	500	20	50.00	12.50	c	nc	2298.53	2584.40	0.89	Class1	Class4	2249.11	2584.40	0.87	1.02
600	15	500	20	40.00	12.50	c	nc	2406.04	2680.25	0.90	Class1	Class4	2311.11	2680.25	0.86	1.04
600	16	500	20	37.50	12.50	c	nc	2440.58	2712.20	0.90	Class1	Class4	2331.71	2712.20	0.86	1.05
600	18	500	20	33.33	12.50	c	nc	2508.34	2776.10	0.90	Class1	Class4	2372.86	2776.10	0.85	1.06
600	20	500	20	30.00	12.50	c	nc	2574.75	2840.00	0.91	Class1	Class4	2413.91	2840.00	0.85	1.07
800	12	500	20	66.67	12.50	c	nc	3132.81	3592.60	0.87	Class2	Class4	3113.87	3592.60	0.87	1.01
600	15	500	20	40.00	12.50	c	nc	2406.04	2680.25	0.90	Class1	Class4	2311.11	2680.25	0.86	1.04
600	16	500	20	37.50	12.50	c	nc	2440.58	2712.20	0.90	Class1	Class4	2331.71	2712.20	0.86	1.05
600	18	500	20	33.33	12.50	c	nc	2508.34	2776.10	0.90	Class1	Class4	2372.86	2776.10	0.85	1.06
800	20	500	20	40.00	12.50	c	nc	3611.61	4047.00	0.89	Class1	Class4	3409.69	4047.00	0.84	1.06
1000	15	500	20	66.67	12.50	c	nc	4291.48	4952.25	0.87	Class2	Class4	4211.48	4952.25	0.85	1.02
1000	16	500	20	62.50	12.50	c	nc	4383.43	5041.00	0.87	Class2	Class4	4269.58	5041.00	0.85	1.03
1000	18	500	20	55.56	12.50	c	nc	4564.30	5218.50	0.87	Class1	Class4	4385.58	5218.50	0.84	1.04
1000	20	500	20	50.00	12.50	c	nc	4742.17	5396.00	0.88	Class1	Class4	4501.37	5396.00	0.83	1.05

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
500	8	500	15	62.50	16.67	c	nc	1143.49	1548.69	0.74	Class2	Class4	1142.61	1548.69	0.74	1.00
500	10	500	15	50.00	16.67	c	nc	1210.59	1593.06	0.76	Class1	Class4	1174.89	1593.06	0.74	1.03
500	12	500	15	41.67	16.67	c	nc	1269.04	1637.44	0.78	Class1	Class4	1206.75	1637.44	0.74	1.05
500	15	500	15	33.33	16.67	c	nc	1347.79	1704.00	0.79	Class1	Class4	1253.89	1704.00	0.74	1.07
500	16	500	15	31.25	16.67	c	nc	1372.51	1726.19	0.80	Class1	Class4	1269.44	1726.19	0.74	1.08
500	18	500	15	27.78	16.67	c	nc	1420.42	1770.56	0.80	Class1	Class4	1300.36	1770.56	0.73	1.09
500	20	500	15	25.00	16.67	c	nc	1452.06	1814.94	0.80	Class1	Class4	1331.03	1814.94	0.73	1.09
600	10	500	15	60.00	16.67	c	nc	1442.57	1956.94	0.74	Class2	Class4	1448.96	1956.94	0.74	1.00
600	12	500	15	50.00	16.67	c	nc	1523.63	2020.84	0.75	Class1	Class4	1494.65	2020.84	0.74	1.02
600	15	500	15	40.00	16.67	c	nc	1633.25	2116.69	0.77	Class1	Class4	1562.22	2116.69	0.74	1.05
600	16	500	15	37.50	16.67	c	nc	1667.77	2148.64	0.78	Class1	Class4	1584.52	2148.64	0.74	1.05
600	18	500	15	33.33	16.67	c	nc	1734.77	2212.54	0.78	Class1	Class4	1628.85	2212.54	0.74	1.07
600	20	500	15	30.00	16.67	c	nc	1799.71	2276.44	0.79	Class1	Class4	1672.84	2276.44	0.73	1.08
800	12	500	15	66.67	16.67	c	nc	2033.20	2851.54	0.71	Class2	Class4	2116.18	2851.54	0.74	0.96
600	15	500	15	40.00	16.67	c	nc	1633.25	2116.69	0.77	Class1	Class4	1562.22	2116.69	0.74	1.05
600	16	500	15	37.50	16.67	c	nc	1667.77	2148.64	0.78	Class1	Class4	1584.52	2148.64	0.74	1.05
600	18	500	15	33.33	16.67	c	nc	1734.77	2212.54	0.78	Class1	Class4	1628.85	2212.54	0.74	1.07
800	20	500	15	40.00	16.67	c	nc	2502.98	3305.94	0.76	Class1	Class4	2430.33	3305.94	0.74	1.03

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
1000	15	500	15	66.67	16.67	c	nc	2816.91	4033.69	0.70	Class2	Class4	2982.28	4033.69	0.74	0.94
1000	16	500	15	62.50	16.67	c	nc	2905.87	4122.44	0.70	Class2	Class4	3043.27	4122.44	0.74	0.95
1000	18	500	15	55.56	16.67	c	nc	3079.13	4299.94	0.72	Class1	Class4	3164.60	4299.94	0.74	0.97
1000	20	500	15	50.00	16.67	c	nc	3247.83	4477.44	0.73	Class1	Class4	3285.20	4477.44	0.73	0.99
500	8	500	12	62.50	20.83	c	s	696.59	1268.06	0.55	Class2	Class4	818.29	1268.06	0.65	0.85
500	10	500	12	50.00	20.83	c	s	797.46	1312.44	0.61	Class1	Class4	852.43	1312.44	0.65	0.94
500	12	500	12	41.67	20.83	c	nc	879.91	1356.81	0.65	Class1	Class4	885.92	1356.81	0.65	0.99
500	15	500	12	33.33	20.83	c	nc	957.22	1423.37	0.67	Class1	Class4	935.13	1423.37	0.66	1.02
500	16	500	12	31.25	20.83	c	nc	981.20	1445.56	0.68	Class1	Class4	951.31	1445.56	0.66	1.03
500	18	500	12	27.78	20.83	c	nc	1027.35	1489.94	0.69	Class1	Class4	983.36	1489.94	0.66	1.04
500	20	500	12	25.00	20.83	c	nc	1052.15	1534.31	0.69	Class1	Class4	1015.07	1534.31	0.66	1.04
600	10	500	12	60.00	20.83	c	s	894.83	1623.06	0.55	Class2	Class4	1063.84	1623.06	0.66	0.84
600	12	500	12	50.00	20.83	c	s	1007.30	1686.96	0.60	Class1	Class4	1111.49	1686.96	0.66	0.91
600	15	500	12	40.00	20.83	c	nc	1142.51	1782.81	0.64	Class1	Class4	1181.53	1782.81	0.66	0.97
600	16	500	12	37.50	20.83	c	nc	1175.65	1814.76	0.65	Class1	Class4	1204.55	1814.76	0.66	0.98
600	18	500	12	33.33	20.83	c	nc	1239.54	1878.66	0.66	Class1	Class4	1250.20	1878.66	0.67	0.99
600	20	500	12	30.00	20.83	c	nc	1301.05	1942.56	0.67	Class1	Class4	1295.38	1942.56	0.67	1.00
800	12	500	12	66.67	20.83	c	s	1227.92	2411.16	0.51	Class2	Class4	1608.90	2411.16	0.67	0.76

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	15	500	12	40.00	20.83	c	nc	1142.51	1782.81	0.64	Class1	Class4	1181.53	1782.81	0.66	0.97
600	16	500	12	37.50	20.83	c	nc	1175.65	1814.76	0.65	Class1	Class4	1204.55	1814.76	0.66	0.98
600	18	500	12	33.33	20.83	c	nc	1239.54	1878.66	0.66	Class1	Class4	1250.20	1878.66	0.67	0.99
800	20	500	12	40.00	20.83	c	nc	1763.72	2865.56	0.62	Class1	Class4	1930.08	2865.56	0.67	0.91
1000	15	500	12	66.67	20.83	c	s	1715.22	3486.81	0.49	Class2	Class4	2354.89	3486.81	0.68	0.73
1000	16	500	12	62.50	20.83	c	s	1805.62	3575.56	0.50	Class2	Class4	2416.89	3575.56	0.68	0.75
1000	18	500	12	55.56	20.83	c	s	1987.60	3753.06	0.53	Class1	Class4	2540.05	3753.06	0.68	0.78
1000	20	500	12	50.00	20.83	c	s	2171.48	3930.56	0.55	Class1	Class4	2662.26	3930.56	0.68	0.82
500	8	500	10	62.50	25.00	c	s	411.14	1082.75	0.38	Class2	Class4	632.43	1082.75	0.58	0.65
500	10	500	10	50.00	25.00	c	s	472.72	1127.13	0.42	Class1	Class4	667.50	1127.13	0.59	0.71
500	12	500	10	41.67	25.00	c	s	532.14	1171.50	0.45	Class1	Class4	701.74	1171.50	0.60	0.76
500	15	500	10	33.33	25.00	c	s	618.93	1238.06	0.50	Class1	Class4	751.85	1238.06	0.61	0.82
500	16	500	10	31.25	25.00	c	s	647.49	1260.25	0.51	Class1	Class4	768.28	1260.25	0.61	0.84
500	18	500	10	27.78	25.00	c	s	704.28	1304.63	0.54	Class1	Class4	800.78	1304.63	0.61	0.88
500	20	500	10	25.00	25.00	c	s	722.80	1349.00	0.54	Class1	Class4	832.88	1349.00	0.62	0.87
600	10	500	10	60.00	25.00	c	s	532.64	1402.25	0.38	Class2	Class4	842.76	1402.25	0.60	0.63
600	12	500	10	50.00	25.00	c	s	602.40	1466.15	0.41	Class1	Class4	891.24	1466.15	0.61	0.68
600	15	500	10	40.00	25.00	c	s	705.23	1562.00	0.45	Class1	Class4	962.24	1562.00	0.62	0.73

Table B.2: Numerical Values of Compact Web Cross Sections (Fy=235 MPa)-continued

SECTION DIMENSIONAL PROPERTIES						AISC-360					EC3					RATIO
h	t_w	b_f	t_f	h/t_w	$b_f/2t_f$	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	Class of Web	Class of Flange	M_n (kN.m)	M_p (kN.m)	M_n / M_p	AISC-360/EC3
600	16	500	10	37.50	25.00	c	s	739.28	1593.95	0.46	Class1	Class4	985.53	1593.95	0.62	0.75
600	18	500	10	33.33	25.00	c	s	807.30	1657.85	0.49	Class1	Class4	1031.65	1657.85	0.62	0.78
600	20	500	10	30.00	25.00	c	s	875.39	1721.75	0.51	Class1	Class4	1077.23	1721.75	0.63	0.81
800	12	500	10	66.67	25.00	c	s	740.64	2119.35	0.35	Class2	Class4	1316.48	2119.35	0.62	0.56
600	15	500	10	40.00	25.00	c	s	705.23	1562.00	0.45	Class1	Class4	962.24	1562.00	0.62	0.73
600	16	500	10	37.50	25.00	c	s	739.28	1593.95	0.46	Class1	Class4	985.53	1593.95	0.62	0.75
600	18	500	10	33.33	25.00	c	s	807.30	1657.85	0.49	Class1	Class4	1031.65	1657.85	0.62	0.78
800	20	500	10	40.00	25.00	c	s	1107.80	2573.75	0.43	Class1	Class4	1639.78	2573.75	0.64	0.68
1000	15	500	10	66.67	25.00	c	s	1051.33	3124.00	0.34	Class2	Class4	1991.10	3124.00	0.64	0.53
1000	16	500	10	62.50	25.00	c	s	1109.62	3212.75	0.35	Class2	Class4	2053.35	3212.75	0.64	0.54
1000	18	500	10	55.56	25.00	c	s	1227.44	3390.25	0.36	Class1	Class4	2176.93	3390.25	0.64	0.56
1000	20	500	10	50.00	25.00	c	s	1347.08	3567.75	0.38	Class1	Class4	2299.51	3567.75	0.64	0.59

APPENDIX C

Normalized moment capacity values for IPE 400 and HEB 500 sections are presented in Appendix C for two different yielding strengths to compare compact I-shaped members in terms of lateral torsional buckling.

Table C.1: Numerical Values of IPE 400 Section (Fy= 235 MPa)

SECTION	LENGTH	AISC-360			EC3			RATIO
	Lb (m)	Mn (kN.m)	χ_{LT}	λ_{LT}	Mn (kN.m)	χ_{LT}	λ_{LT}	
IPE 400	0.1	307.15	1.00	0.02	307.15	1.00	0.02	1.00
	0.2	307.15	1.00	0.05	307.15	1.00	0.05	1.00
	0.3	307.15	1.00	0.07	307.15	1.00	0.07	1.00
	0.4	307.15	1.00	0.10	307.15	1.00	0.10	1.00
	0.5	307.15	1.00	0.12	307.15	1.00	0.12	1.00
	0.6	307.15	1.00	0.15	307.15	1.00	0.15	1.00
	0.7	307.15	1.00	0.17	307.15	1.00	0.17	1.00
	0.8	307.15	1.00	0.20	307.15	1.00	0.20	1.00
	0.9	307.15	1.00	0.22	307.15	1.00	0.22	1.00
	1	307.15	1.00	0.24	307.15	1.00	0.24	1.00
	1.5	307.15	1.00	0.36	307.15	1.00	0.36	1.00
	2	307.15	1.00	0.48	293.96	0.96	0.48	1.04
	2.5	295.19	0.96	0.58	274.89	0.89	0.58	1.07
	3	282.53	0.92	0.69	256.12	0.83	0.69	1.10
	3.5	269.87	0.88	0.78	237.87	0.77	0.78	1.13
	4	257.21	0.84	0.87	220.44	0.72	0.87	1.17
	4.5	244.55	0.80	0.96	204.16	0.66	0.96	1.20
	5	231.88	0.75	1.04	189.24	0.62	1.04	1.23
	5.5	219.22	0.71	1.11	175.75	0.57	1.11	1.25
	6	206.56	0.67	1.19	163.67	0.53	1.19	1.26
	6.5	193.90	0.63	1.25	152.90	0.50	1.25	1.27
	7	177.22	0.58	1.32	143.32	0.47	1.32	1.24
	7.5	161.79	0.53	1.38	134.78	0.44	1.38	1.20
	8	148.85	0.48	1.44	127.16	0.41	1.44	1.17
	8.5	137.85	0.45	1.49	120.33	0.39	1.49	1.15
	9	128.38	0.42	1.55	114.19	0.37	1.55	1.12
	9.5	120.16	0.39	1.60	108.65	0.35	1.60	1.11
	10	112.95	0.37	1.65	103.62	0.34	1.65	1.09
	11	100.90	0.33	1.74	94.88	0.31	1.74	1.06
	12	91.23	0.30	1.84	87.53	0.28	1.84	1.04
	13	83.30	0.27	1.92	81.27	0.26	1.92	1.02
	14	76.67	0.25	2.00	75.88	0.25	2.00	1.01
	15	71.04	0.23	2.08	71.03	0.23	2.08	1.00
	16	66.20	0.22	2.15	66.19	0.22	2.15	1.00
	17	61.99	0.20	2.23	61.98	0.20	2.23	1.00
	18	58.29	0.19	2.30	58.29	0.19	2.30	1.00
	19	55.03	0.18	2.36	55.02	0.18	2.36	1.00
	20	52.11	0.17	2.43	52.11	0.17	2.43	1.00
	21	49.50	0.16	2.49	49.49	0.16	2.49	1.00
	22	47.13	0.15	2.55	47.13	0.15	2.55	1.00

Table C.2: Numerical Values of IPE 400 Section (Fy= 355 MPa)

SECTION	LENGTH	AISC-360			EC3			RATIO
	Lb (m)	Mn (kN.m)	χ_{LT}	λ_{LT}	Mn (kN.m)	χ_{LT}	λ_{LT}	
IPE 400	0.1	463.99	1.00	0.03	463.99	1.00	0.03	1.00
	0.2	463.99	1.00	0.06	463.99	1.00	0.06	1.00
	0.3	463.99	1.00	0.09	463.99	1.00	0.09	1.00
	0.4	463.99	1.00	0.12	463.99	1.00	0.12	1.00
	0.5	463.99	1.00	0.15	463.99	1.00	0.15	1.00
	0.6	463.99	1.00	0.18	463.99	1.00	0.18	1.00
	0.7	463.99	1.00	0.21	463.99	1.00	0.21	1.00
	0.8	463.99	1.00	0.24	463.99	1.00	0.24	1.00
	0.9	463.99	1.00	0.27	463.99	1.00	0.27	1.00
	1	463.99	1.00	0.30	463.99	1.00	0.30	1.00
	1.5	463.99	1.00	0.45	451.98	0.97	0.45	1.03
	2	445.42	0.96	0.59	414.93	0.89	0.59	1.07
	2.5	418.88	0.90	0.72	377.86	0.81	0.72	1.11
	3	392.35	0.85	0.84	341.54	0.74	0.84	1.15
	3.5	365.81	0.79	0.96	307.29	0.66	0.96	1.19
	4	339.28	0.73	1.07	276.28	0.60	1.07	1.23
	4.5	312.74	0.67	1.18	249.05	0.54	1.18	1.26
	5	285.25	0.61	1.28	225.59	0.49	1.28	1.26
	5.5	247.88	0.53	1.37	205.54	0.44	1.37	1.21
	6	218.91	0.47	1.46	188.41	0.41	1.46	1.16
	6.5	195.89	0.42	1.54	173.75	0.37	1.54	1.13
	7	177.22	0.38	1.62	161.12	0.35	1.62	1.10
	7.5	161.79	0.35	1.69	150.17	0.32	1.69	1.08
	8	148.85	0.32	1.77	140.62	0.30	1.77	1.06
	8.5	137.85	0.30	1.84	132.22	0.28	1.84	1.04
	9	128.38	0.28	1.90	124.79	0.27	1.90	1.03
	9.5	120.16	0.26	1.97	118.17	0.25	1.97	1.02
	10	112.95	0.24	2.03	112.24	0.24	2.03	1.01
	11	100.90	0.22	2.14	100.87	0.22	2.14	1.00
	12	91.23	0.20	2.26	91.21	0.20	2.26	1.00
	13	83.30	0.18	2.36	83.28	0.18	2.36	1.00
	14	76.67	0.17	2.46	76.65	0.17	2.46	1.00
	15	71.04	0.15	2.56	71.03	0.15	2.56	1.00
	16	66.20	0.14	2.65	66.19	0.14	2.65	1.00
	17	61.99	0.13	2.74	61.98	0.13	2.74	1.00
	18	58.29	0.13	2.82	58.29	0.13	2.82	1.00
	19	55.03	0.12	2.90	55.02	0.12	2.90	1.00
	20	52.11	0.11	2.98	52.11	0.11	2.98	1.00
	21	49.50	0.11	3.06	49.49	0.11	3.06	1.00
	22	47.13	0.10	3.14	47.13	0.10	3.14	1.00

Table C.3: Numerical Values of HEB 500 Section (Fy= 235 MPa)

	LENGTH	AISC-LRFD			EC3		
SECTION	Lb (m)	Mn (kN.m)	χ_{LT}	λ_{LT}	Mn (kN.m)	χ_{LT}	λ_{LT}
HEB 500	0.1	1131.53	1.00	0.01	1131.53	1.00	0.01
	0.2	1131.53	1.00	0.03	1131.53	1.00	0.03
	0.3	1131.53	1.00	0.04	1131.53	1.00	0.04
	0.4	1131.53	1.00	0.06	1131.53	1.00	0.06
	0.5	1131.53	1.00	0.07	1131.53	1.00	0.07
	0.6	1131.53	1.00	0.08	1131.53	1.00	0.08
	0.7	1131.53	1.00	0.10	1131.53	1.00	0.10
	0.8	1131.53	1.00	0.11	1131.53	1.00	0.11
	0.9	1131.53	1.00	0.12	1131.53	1.00	0.12
	1	1131.53	1.00	0.14	1131.53	1.00	0.14
	1.5	1131.53	1.00	0.20	1131.53	1.00	0.20
	2	1131.53	1.00	0.27	1131.53	1.00	0.27
	2.5	1131.53	1.00	0.33	1131.53	1.00	0.33
	3	1131.53	1.00	0.39	1131.53	1.00	0.39
	3.5	1131.53	1.00	0.45	1109.69	0.98	0.45
	4	1121.76	0.99	0.50	1084.88	0.96	0.50
	4.5	1103.49	0.98	0.55	1060.32	0.94	0.55
	5	1085.23	0.96	0.60	1035.95	0.92	0.60
	5.5	1066.96	0.94	0.65	1011.71	0.89	0.65
	6	1048.69	0.93	0.69	987.60	0.87	0.69
	6.5	1030.42	0.91	0.74	963.64	0.85	0.74
	7	1012.16	0.89	0.78	939.86	0.83	0.78
	7.5	993.89	0.88	0.81	916.31	0.81	0.81
	8	975.62	0.86	0.85	893.06	0.79	0.85
	8.5	957.35	0.85	0.88	870.17	0.77	0.88
	9	939.09	0.83	0.92	847.69	0.75	0.92
	9.5	920.82	0.81	0.95	825.70	0.73	0.95
	10	902.55	0.80	0.98	804.25	0.71	0.98
	11	866.02	0.77	1.04	763.11	0.67	1.04
	12	829.48	0.73	1.10	724.51	0.64	1.10
	13	792.95	0.70	1.15	688.54	0.61	1.15
	14	756.41	0.67	1.20	655.18	0.58	1.20
	15	719.88	0.64	1.25	624.34	0.55	1.25
	16	675.32	0.60	1.29	595.85	0.53	1.29
	17	631.38	0.56	1.34	569.55	0.50	1.34
	18	592.96	0.52	1.38	545.27	0.48	1.38
	19	559.04	0.49	1.42	522.81	0.46	1.42
	20	528.89	0.47	1.46	502.02	0.44	1.46
	21	501.89	0.44	1.50	482.74	0.43	1.50
	22	477.58	0.42	1.54	464.83	0.41	1.54

Table C.3: Numerical Values of HEB 500 Section (Fy= 235 MPa)-continued

	LENGTH	AISC-LRFD			EC3		
SECTION	Lb (m)	Mn (kN.m)	χ_{LT}	λ_{LT}	Mn (kN.m)	χ_{LT}	λ_{LT}
HEB 500	23	455.55	0.40	1.58	448.16	0.40	1.58
	24	435.51	0.38	1.61	432.61	0.38	1.61
	25	417.19	0.37	1.65	417.22	0.37	1.65
	26	400.37	0.35	1.68	400.40	0.35	1.68
	27	384.88	0.34	1.71	384.91	0.34	1.71
	28	370.57	0.33	1.75	370.59	0.33	1.75
	29	357.29	0.32	1.78	357.32	0.32	1.78
	30	344.95	0.30	1.81	344.97	0.30	1.81

Table C.4: Numerical Values of HEB 500 Section (Fy= 355 MPa)

	LENGTH	AISC-LRFD			EC3		
SECTION	Lb (m)	Mn (kN.m)	χ_{LT}	λ_{LT}	Mn (kN.m)	χ_{LT}	λ_{LT}
HEB 500	0.1	1709.33	1.00	0.02	1709.33	1.00	0.02
	0.2	1709.33	1.00	0.03	1709.33	1.00	0.03
	0.3	1709.33	1.00	0.05	1709.33	1.00	0.05
	0.4	1709.33	1.00	0.07	1709.33	1.00	0.07
	0.5	1709.33	1.00	0.09	1709.33	1.00	0.09
	0.6	1709.33	1.00	0.10	1709.33	1.00	0.10
	0.7	1709.33	1.00	0.12	1709.33	1.00	0.12
	0.8	1709.33	1.00	0.14	1709.33	1.00	0.14
	0.9	1709.33	1.00	0.15	1709.33	1.00	0.15
	1	1709.33	1.00	0.17	1709.33	1.00	0.17
	1.5	1709.33	1.00	0.25	1709.33	1.00	0.25
	2	1709.33	1.00	0.33	1709.33	1.00	0.33
	2.5	1709.33	1.00	0.41	1703.66	1.00	0.41
	3	1709.33	1.00	0.48	1653.78	0.97	0.48
	3.5	1671.03	0.98	0.55	1603.68	0.94	0.55
	4	1629.68	0.95	0.62	1553.05	0.91	0.62
	4.5	1588.32	0.93	0.68	1501.82	0.88	0.68
	5	1546.97	0.91	0.74	1450.09	0.85	0.74
	5.5	1505.61	0.88	0.80	1398.13	0.82	0.80
	6	1464.26	0.86	0.85	1346.34	0.79	0.85
	6.5	1422.91	0.83	0.90	1295.16	0.76	0.90
	7	1381.55	0.81	0.95	1245.04	0.73	0.95
	7.5	1340.20	0.78	1.00	1196.39	0.70	1.00
	8	1298.84	0.76	1.04	1149.53	0.67	1.04
	8.5	1257.49	0.74	1.09	1104.70	0.65	1.09
	9	1216.13	0.71	1.13	1062.04	0.62	1.13
	9.5	1174.78	0.69	1.17	1021.63	0.60	1.17
	10	1133.42	0.66	1.21	983.45	0.58	1.21
	11	1043.73	0.61	1.28	913.61	0.53	1.28
	12	940.05	0.55	1.35	851.82	0.50	1.35
	13	855.54	0.50	1.41	797.17	0.47	1.41
	14	785.34	0.46	1.48	748.71	0.44	1.48
	15	726.06	0.42	1.53	705.60	0.41	1.53
	16	675.32	0.40	1.59	667.07	0.39	1.59
	17	631.38	0.37	1.65	631.40	0.37	1.65
	18	592.96	0.35	1.70	592.97	0.35	1.70
	19	559.04	0.33	1.75	559.06	0.33	1.75
	20	528.89	0.31	1.80	528.91	0.31	1.80
	21	501.89	0.29	1.85	501.92	0.29	1.85
	22	477.58	0.28	1.89	477.60	0.28	1.89

Table C.4: Numerical Values of HEB 500 Section (Fy= 355 MPa)-continued

	LENGTH	AISC-LRFD			EC3		
SECTION	Lb (m)	Mn (kN.m)	χ_{LT}	λ_{LT}	Mn (kN.m)	χ_{LT}	λ_{LT}
HEB 500	23	455.55	0.27	1.94	455.58	0.27	1.94
	24	435.51	0.25	1.98	435.54	0.25	1.98
	25	417.19	0.24	2.02	417.22	0.24	2.02
	26	400.37	0.23	2.07	400.40	0.23	2.07
	27	384.88	0.23	2.11	384.91	0.23	2.11
	28	370.57	0.22	2.15	370.59	0.22	2.15
	29	357.29	0.21	2.19	357.32	0.21	2.19
	30	344.95	0.20	2.23	344.97	0.20	2.23