Table 5.9 Universal beams subject to bending, steel grade 43: buckling resistance moment M_b(kN m) (abstracted from the *Steelwork Design Guide to BS 5950: Part 1*, published by the Steel Construction Institute)

Designation serial size: mass/metre and capacity	Slenderness correction factor n	Effective length L_E 2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0
457 × 191 × 82	0.4	503	503	503	503	503	503	496	472	451	431	413	395	379
$M_{cx} = 503$	0.6	503	503	500	478	457	436	417	379	346	317	291	269	249
Plastic	0.8	503	480	449	419	389	361	335	289	252	223	199	180	164
	1.0	478	437	396	357	321	289	261	217	184	159	140	126	114
457 × 191 × 74	0.4	456	456	456	456	456	456	446	424	403	384	366	349	333
$M_{cx} = 456$	0.6	456	456	451	430	410	391	372	337	305	277	253	232	214
Plastic	0.8	456	433	404	375	348	321	296	253	219	192	171	154	140
	1.0	431	393	355	319	285	255	230	189	159	137	120	107	96
457 × 191 × 67	0.4	404	404	404	404	404	402	391	370	350	332	314	298	283
$M_{cx} = 404$	0.6	404	404	397	378	359	341	323	290	260	234	212	194	178
Plastic	0.8	404	381	354	328	302	277	254	215	184	160	142	127	114
	1.0	380	345	310	277	246	219	195	159	132	113	98	87	78
457 × 152 × 82	0.4	477	477	477	477	475	462	450	427	407	388	370	0	0
$M_{cx} = 477$	0.6	477	471	447	424	402	381	362	327	297	272	250	0	0
Plastic	0.8	457	422	388	356	326	300	277	238	208	185	167	0	0
	1.0	416	370	327	290	257	231	208	174	149	131	116	0	0
457 × 152 × 74	0.4	429	429	429	429	423	411	399	377	357	339	322	0	0
$M_{cx} = 429$	0.6	429	421	398	376	355	335	317	284	256	232	212	0	0
Plastic	0.8	409	375	343	313	285	260	239	204	177	156	140	0	0
	1.0	371	328	288	252	223	198	178	147	125	109	97	0	0
457 × 152 × 67	0.4	396	396	396	396	384	372	360	338	318	299	283	0	0
$M_{cx} = 396$	0.6	396	383	361	339	318	299	280	247	220	198	179	0	0
Plastic	0.8	372	340	308	278	251	227	207	174	149	130	116	0	0
	1.0	336	294	255	221	193	170	152	124	105	90	79	0	0
457 × 152 × 60	0.4	352	352	352	351	339	328	317	296	276	259	243	0	0
$M_{cx} = 352$	0.6	352	340	319	299	280	261	244	213	188	167	151	0	0
Plastic	0.8	330	301	272	244	219	197	178	148	126	109	96	0	0
	1.0	298	260	224	193	168	147	130	105	87	75	66	0	0
457 × 152 × 52	0.4	300	300	300	295	284	274	263	243	225	208	194	0	0
$M_{cx} = 300$	0.6	300	286	267	249	231	214	198	170	148	130	116	0	0
Plastic	0.8	278	251	225	200	178	158	142	116	97	83	73	0	0
	1.0	249	215	183	156	134	116	102	81	67	57	50	0	0
406 × 178 × 74	0.4	412	412	412	412	412	412	404	386	369	354	339	326	313
$M_{cx} = 412$	0.6	412	412	405	387	370	354	338	309	283	260	240	223	208
Plastic	0.8	412	388	362	337	313	291	270	235	206	183	165	150	137
	1.0	385	351	317	286	257	232	210	175	150	131	116	105	95
406 × 178 × 67	0.4	371	371	371	371	371	370	360	343	327	312	298	285	273
$M_{cx} = 371$	0.6	371	371	363	346	330	314	299	271	246	225	206	190	176
Plastic	0.8	371	347	323	300	277	256	236	203	177	156	139	126	115
	1.0	345	313	282	252	226	202	182	151	128	111	97	87	79

M_b is obtained using an equivalent slenderness $= nuvL_e/r_y$.

Values have not been given for values of slenderness greater than 300.

The section classification given applies to members subject to bending only.

Check lateral torsional buckling:

$$\bar{M} = mM_A \leqslant M_b = p_b S_x$$

The magnitude of the UDL in this example is significant, and it will therefore be necessary to consider the beam to be loaded between lateral restraints. By reference to Table 5.8, for members not subject to destabilizing loads, m is 1.0 and n should be obtained from BS 5950 Table 16, which is cross-referenced with Table 17.

First we have

$$\bar{M} = mM_A = 1.0 \times 380 = 380\,\text{kN m}$$

We now need to find M_b. The bending strength p_b has to be obtained from Table 5.5 in relation to p_y and λ_{LT}. We have $p_y = 275\,\text{N/mm}^2$ and

$$\lambda_{LT} = nuv\lambda$$

The slenderness correction factor n is obtained from BS 5950 Table 16 in relation to the ratios γ and β for the length of beam between lateral restraints. In this instance that length would be from a support to the central point load. The ratios γ and β are obtained as follows. First, $\gamma = M/M_o$. The larger end moment $M = 380\,\text{kN m}$. M_o is the mid-span moment on a simply supported span equal to the unrestrained length, that is $M_o = WL/8$. The UDL on unrestrained length is $W = 40/2 = 20\,\text{kN}$, and the unrestrained length $L = \text{span}/2 = 4\,\text{m}$. Hence

$$M_o = \frac{WL}{8} = \frac{20 \times 4}{8} = 10\,\text{kNm}$$

The equivalent bending moment diagram, for the unrestrained length, corresponding to these values is shown in Figure 5.14. Thus

$$\gamma = \frac{M}{M_o} = \frac{380}{10} = 38$$

Secondly,

$$\beta = \frac{\text{smaller end moment}}{\text{larger end moment}} = \frac{0}{380} = 0$$

Therefore, by interpolation from BS 5950 Table 16, $n = 0.782$.

From section tables, $u = 0.877$.

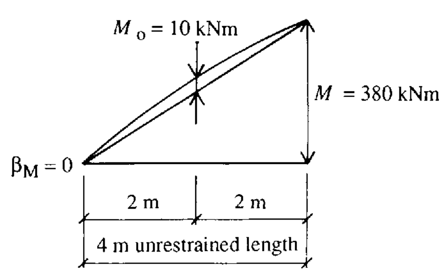

Figure 5.14 *Equivalent bending moment diagram for the unrestrained length*