CELLBEAM PROGRAM DESIGN GUIDE

&

SECTION PROPERTY TABLES

This section is intended to be used in conjunction with the CELLBEAM software written by the Steel Construction Institute (UK), which can be obtained free of charge from Macsteel Trading. Its aim is to provide guidance on the choice of suitable parent sections and cell data, and to illustrate the various steps adopted in the design of cellular beams

Macsteel Trading Advisory Engineers are available to help, Including a full design service, free of charge

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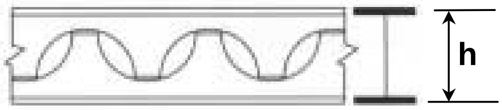
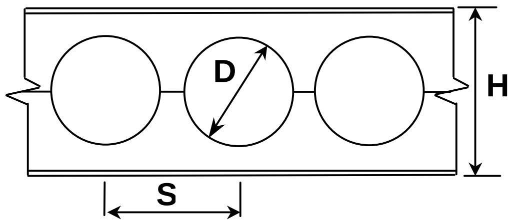
CHOOSING CELL DATA

Choosing the optimum cell data for a particular application is vital for efficient and economic design. The geometry and properties of a cellular beam are **completely variable**.





D min = 0.7h
Smin = 1.08 D

D max = 1.3h
S max = 1.6D

Outside this range - consult Macsteel Trading

Step 1 Initial Cell data Selection

The following table can be used:

Initial Cell Data Selection Table		
Application	**Cell Diameter (D)**	**Cell Pitch (S)**
Simply Supported Rafter	**1.05h**	**1.25D**
Continuous Rafter and Non-composite Floor Beam	**h**	**1.5D**
Spine Beam	**S/1.5**	**1.5D**
Composite Floor Beam – symmetric	**h**	**1.5D**
asymmetric	**hmin**	**1.5D**

(**hmin** =original depth of the shallower section making up the asymmetric beam)

FLOOR BEAMS

COMPOSITE DESIGN

Step 1
Choose a parent section - as a guide use a span/depth ratio of 26 for secondary beams and 20 for primary beams.

Start with a symmetric section initially. Weight savings can be achieved later on in the design process by adopting an asymmetric section.

Step 2
Choose cell data based on the guidance given in section 1.

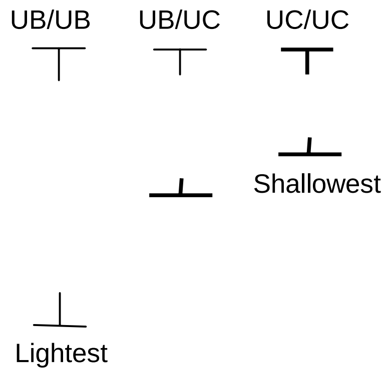
Step 3
Analyse the beam and adjust the parent section size until a unity factor of between 0.8 to 0.9 in global bending is obtained. Don't worry about secondary failures at this stage.

For the lightest cellular beam follow steps 4 and 5. For restricted depth applications jump to step 6.

Step 4
For the lightest section reduce the weight of the top tee by around 30 %, and re-configure the cell data based on the section depth of the top tee.

Step 5
Re-analyse and adjust the cell data to control the secondary forces as necessary.

Step 6
Substitute the UB bottom tee for a UC section of similar weight and re-configure the cell data based on the section depth of the UC.



Step 7
Re-analyse and adjust the cell data to control the secondary forces.

Step 8
Try reducing the top tee section by one or two weights. In very shallow floors a UC top tee may be required.

NON-COMPOSITE DESIGN

Step 1
Choose a parent section from the floor beam section tables as appropriate.

Step 2
Choose cell data based on the guidance given in section 1.

Step 3
Analyse the beam and adjust the cell data as required

Note: The beam design should not be governed by deflection considerations under dead loads as cellular beams are pre-cambered at no cost.

ROOF BEAMS

SIMPLY-SUPPORTED

Step 1 - Choose a parent section from the floor/roof beam section tables as appropriate.

Step 2 - Choose cell data based on the guidance given in section 1.
Step 3 - Analyse the beam and adjust the cell data as required.

PORTAL FRAMES

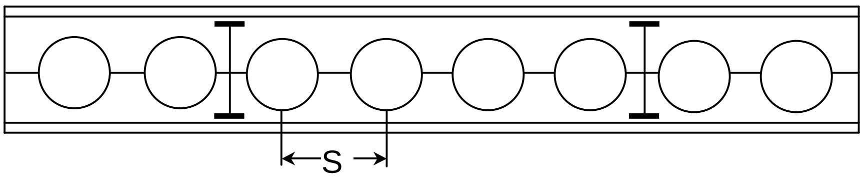
Step 1 - Design a simply supported beam for the rafter span and centers. (see above)

Step 2 - Use the inertia and area of the cellular section in a frame analysis.
Step 3 - Revise the cellular beam design using the resulting end fixity moments, and re-analyse the frame using the new properties of the cellular beam.

Step 4 - When assessing deflections, to take account of shear deflection in the cellular beam pro-rata the deflections from the frame analysis for cellular beam by the ratio of "additional deflection due to cells/total deflection " taken from CELLBEAM.

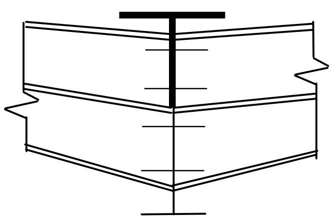
SPINE BEAMS

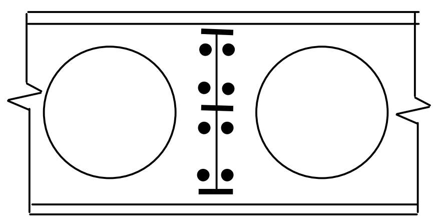
Step 1 - Choose a parent section from the **floor beam** section tables.
Step 2 - Choose cell data based on the guidance in section 1, but also making the cell pitch (S) a multiple of the secondary beam centers, in order to avoid infills.



Step 3 - Analyses the beam and adjust the cell data as required.

Note (i) Where lateral torsional buckling governs the design, consider the use of an asymmetric section with a wide flanged top tee.



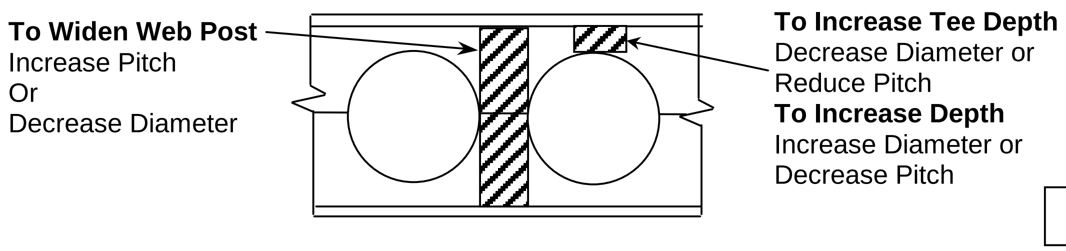


Note (ii) To simplify connection details, make the spine beam deeper than the incoming secondary member.

SECONDARY EFFECTS

The overall bending of the section produces secondary effects local to the cells. The table below illustrates these secondary effects, and offers guidance on how to control them by re-configuring the cell data:-

SECONDARY EFFECT	CONTROL MECHANISM	CELL-DATA RECONFIGURATION
Midspan Vierendeel Behaviour Global bending action results in compressive and tensile forces in the top and bottom tees, which are at a maximum at midspan for a simply supported beam. Failure occurs when these forces exceed the axial capacity of the tee.	**Increase the lever arm (i.e. section depth) between top and bottom tees (works for failures up to a unity factor of ~ 1.07)**	**Increase cell diameter or Decrease cell pitch (less effective)**
End-span Vierendeel Behaviour The shear force across a cell induces secondary bending moments in the top and bottom tees. Failure occurs when the moment capacity of the tee is exceeded.	**Increase the depth of the tees. (works for failures upto a unity factor of ~1.3)**	**Decrease cell diameter**
Vertical Shear Close to supports or point loads the shear becomes critical in the web of the top and bottom tees.	**Increase the depth of the tees.(works for failures upto a unity factor of ~1.05)**	**Decrease cell diameter**
Horizontal Shear The change in bending moment across a cell generates a horizontal shearing force across each web post which is greatest at points of high moment gradient.	**Increase the width of the web post. (works for failures upto a unity factor of ~1.10)**	**Increase cell pitch**
Web-post Flexure and Buckling Web-post flexure results from the horizontal shear generated in the web-post under global bending action.	**Increase the web-post width or decrease web post slederness. (works for failures up to a unity factor of ~ 3.0)**	**Increase cell pitch or Decrease cell diameter**



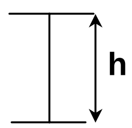
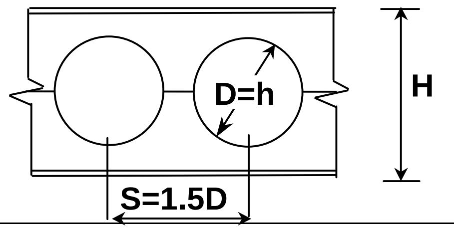
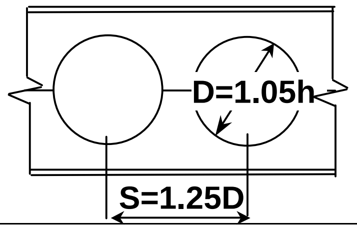
CELLULAR BEAM
SECTION PROPERTIES
I-SECTIONS

OPTIMISATION

The Geometry and properties are **infinitely variable**. The tables which follow only give two examples per section size. For optimization use the CELLBEAM computer program, and/or Macsteel Trading's **free design service.**

STRUCTURAL INTEGRITY

The tables only allow checks for global bending. Lateral torsional buckling and secondary effects must be checked using CELLBEAM, and/or Macsteel Trading's **free design service.**

SECTION	**FLOOR** (Example only)	**ROOF** (Example only)
		

NOT FOR FINAL DESIGN

	H (mm)	D (mm)	S (mm)	I_{xx} 10^6mm^4	Z_{exx} 10^3mm^3	Z_{plxx} 10^3mm^3	A_{net} 10^3mm^2	H (mm)	D (mm	S (mm)	I_{xx} 10^6mm^4	Z_{exx} 10^3mm^3	Z_{plxx} 10^3mm^3	A_{net} 10^3mm^2
203x133x25	289.8	200	300	47.32	326.5	343.1	2.5	309.3	225	300	53.84	348.2	364	2.47
203x133x30	293.4	200	300	58.52	398.9	421	3.05	312.9	225	300	66.56	425.5	446.8	3.01
254x146x31	359.7	250	375	89.71	498.8	523.2	3.07	383.7	275	350	102.62	534.9	559.3	3.06
254x146x37	364.3	250	375	112.54	617.9	650.1	3.77	388.3	275	350	128.59	662.3	694.7	3.77
254x146x43	367.9	250	375	132.75	721.8	763	4.41	391.9	275	350	151.6	773.7	815	4.4
305x102x25	435	300	450	88.16	405.3	430.9	2.12	463.2	325	400	101.24	437.1	463.9	2.14
305x102x29	438.6	300	450	106.57	485.9	515.9	2.52	466.8	325	400	122.14	523.3	554.6	2.54
305x102x33	442.6	300	450	129.32	584.3	621.5	3.01	470.8	325	400	148.01	628.7	667.4	3.03
305x165x40	433.3	300	450	172.37	795.6	832.8	4.04	461.5	325	400	197.18	854.5	893	4.06
305x165x46	436.5	300	450	200.61	919.2	965.2	4.67	464.7	325	400	229.34	987	1034.6	4.69
305x165x54	440.3	300	450	236.7	1075.2	1134.4	54.7	468.5	325	400	270.47	1154.6	1215.6	5.49
356x171x45	503	350	525	242.87	965.8	1013.5	4.25	532.1	375	475	274.36	1031.2	1081	4.28
356x171x51	506.6	350	525	285.01	1125.3	1182.3	4.93	535.7	375	475	321.62	1200.7	1260	4.96
356x171x57	509.6	350	525	323.42	1269.4	1337	5.56	538.7	375	475	364.78	1354.3	1424.4	5.59
356x171x67	515	350	525	392.23	1523.4	1610.9	6.65	554.1	375	475	441.96	1624.5	1715	6.69
406x140x39	571.2	400	600	249.57	873.8	921.2	3.42	604.5	425	525	283.67	938.5	989.7	3.48
406x140x46	576.4	400	600	314.51	1091.3	1149.9	4.23	609.7	425	525	356.62	1169.8	1232.6	4.29

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I-SECTIONS

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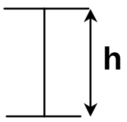	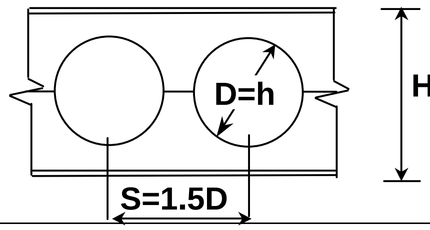	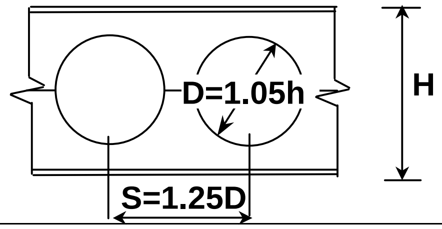

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406x140x39	571.2	400	600	249.57	873.8	921.2	3.42	604.5	425	525	283.67	938.5	989.7	3.48
406x140x46	576.4	400	600	314.51	1091.3	1149.9	4.23	609.7	425	525	356.62	1169.8	1232.6	4.29
406x178x54	575.8	400	600	377.13	1309.9	1377	5.06	609.1	425	525	427.39	1403.3	1475.1	5.12
406x178x60	579.6	400	600	435.65	1503.3	1580.9	5.77	612.9	425	525	492.97	1608.6	1691.1	5.84
406x178x67	582.6	400	600	490.74	1684.6	1776.3	6.47	615.9	425	525	555.11	1802.5	1899.8	6.54
406x178x74	586	400	600	550.63	1879.3	1986	7.21	619.3	425	525	622.47	2010.1	2123.1	7.29
457x191x67	648.3	450	675	593.76	1831.9	1926.9	6.29	682.5	475	600	666.18	1952.1	2053.6	6.37
457x191x74	651.9	450	675	673.73	2067.1	2176.9	7.08	686.1	475	600	755.22	2201.4	2318.2	7.16
457x191x82	654.9	450	675	748.91	2287.3	2414.4	7.83	689.1	475	600	839.24	2435.7	2570.6	7.92
457x191x89	658.3	450	675	828.71	2517.9	2662.5	8.61	692.5	475	600	928.09	2680.3	2833.4	8.71
457x191x98	662.1	450	675	923.09	2788.6	2956.3	9.53	696.3	475	600	1033.29	2967.8	3144.9	9.63
533x210x82	759.1	525	775	965.81	2544.5	2682.9	7.51	796.1	550	675	1076.46	2704.3	2853.7	7.62
533x210x92	763.9	525	775	1123.66	2941.8	3103	8.63	800.9	550	675	1250.7	3123.2	3296.2	8.75
533x210x101	767.5	525	775	1252.04	3262.5	3446.4	9.55	804.5	550	675	1392.74	3462.4	3658.9	9.68
533x210x109	770.3	525	775	1359.78	3530.4	3736	10.34	807.3	550	675	1512.2	3746.3	3965.7	10.47
533x210x122	775.3	525	775	1546.62	3989.3	4232.8	11.67	812.3	550	675	1718.88	4232.1	4490.7	11.82

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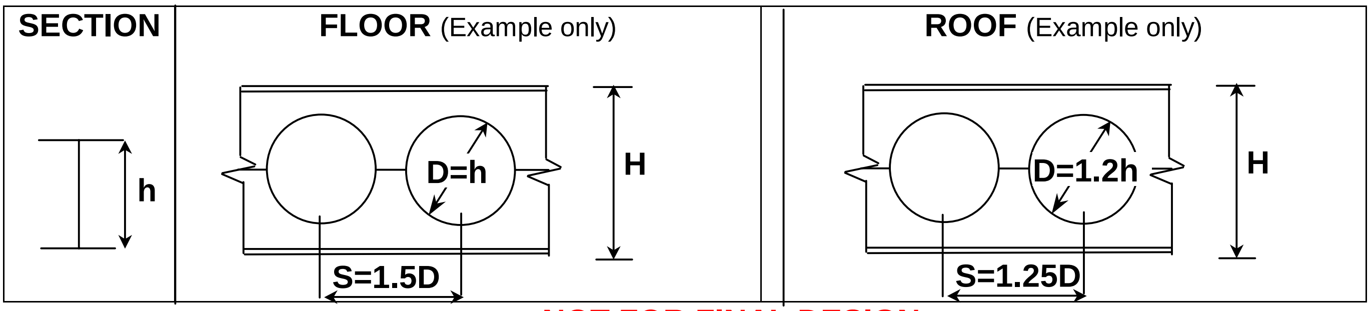

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152x152x23	217.4	150	225	25.41	233.8	245.5	2.38	239.5	180	225	30.8	257.1	267.9	2.34
152x152x30	222.6	150	225	35.43	318.4	337.3	32.2	244.7	180	225	42.91	350.7	368.6	3.17
152x152x37	226.8	150	225	44.56	393.1	420.2	3.98	248.9	180	225	53.89	433	458.9	3.92
203x203x46	269.3	200	350	79.06	587.1	616.7	4.82	322	245	305	115.71	718.7	750.4	4.87
203x203x52	272.3	200	350	90.98	668.1	705.4	5.48	325	245	305	132.83	817.5	857.1	5.54
203x203x60	275.7	200	350	105.64	766.2	814.1	6.29	328.4	245	305	153.94	937.6	988.5	6.36
203x203x71	281.9	200	350	131.16	930.4	997.9	7.61	334.6	245	305	190.13	1136.6	1207.8	7.69
203x203x86	288.3	200	350	161.61	1120.9	1215.4	9.17	341	245	305	233.42	1369.1	1468.8	9.27
254x254x73	362.4	250	375	234.72	1295.5	1364.1	7.95	399.3	300	375	285.48	1429.8	1494.7	7.84
254x254x89	368.6	250	375	292.31	1586.2	1683.7	9.73	405.5	300	375	355.02	1750.9	1844	9.6
254x254x107	375	250	375	356.71	1902.7	2037.4	11.69	411.9	300	375	432.47	2099.7	2229	11.52
254x254x132	384.6	250	375	454.88	2365.8	2562.5	14.51	421.5	300	375	550.32	2611	2801.5	14.31
254x254x167	397.4	250	375	598.01	3009.9	3309.3	18.43	434.3	300	375	721.31	3321.4	3613.4	18.18
305x305x97	437.8	300	450	452.98	2069.3	2173.2	10.46	486	370	470	556.87	2291.6	2386.7	10.25
305x305x118	444.4	300	450	561.63	2527.6	2674.1	12.78	492.6	370	470	689.54	2799.5	2935.2	12.52
305x305x137	450.4	300	450	663.58	2946.6	3137.4	14.9	498.6	370	470	813.8	3264.3	3442.5	14.6
305x305x158	457	300	450	780.01	3413.6	3659.8	17.25	505.2	370	470	955.38	3782.1	4013.8	16.91