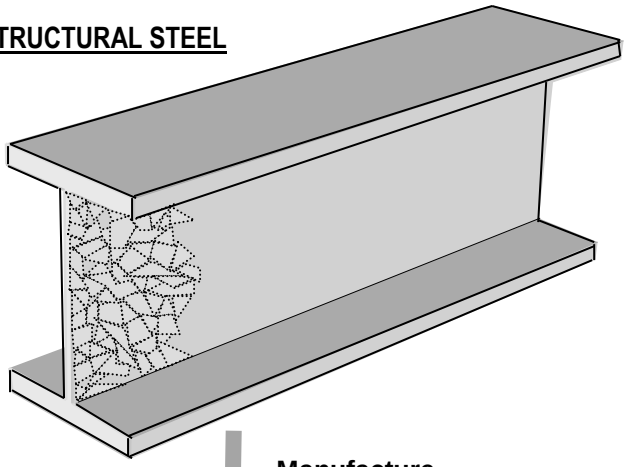
STRUCTURAL STEEL



University of Salford MANCHESTER

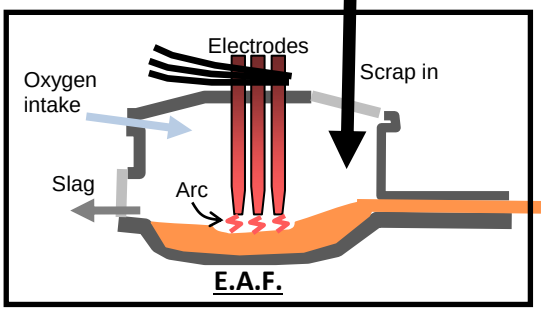
Manufacture.

The manufacture of Structural steel integrates both natural resource and reclaimed/recyclable steel within its processes. The following diagram explains the integrated process.

Scrap

Raw materials

Iron ore Limestone Coke



E.A.F.

Refined molten iron

Waste gases

Hot air

Slag

Blast furnace

Molten iron

Contains; Fe;C;S;P

Oxygen lance Pressurised, pure Oxygen is blown onto molten iron Oxygen lance is used to remove C;S; and P from the molten iron (Oxygen creates oxides with C; S; and P which escape as gases)

Gases escape with unwanted elements (SO_2, CO_2)

B.O.S.

Refined molten iron

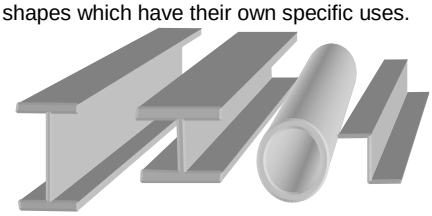
Product is further refined:

Cr and Ni added to create stainless steel
Amount of Carbon is controlled (0.1%-1%)
Phase diagrams used

Secondary steelmaking

Products

Structural steel products are formed into different shapes which have their own specific uses.



UB UC CHS Z purlin

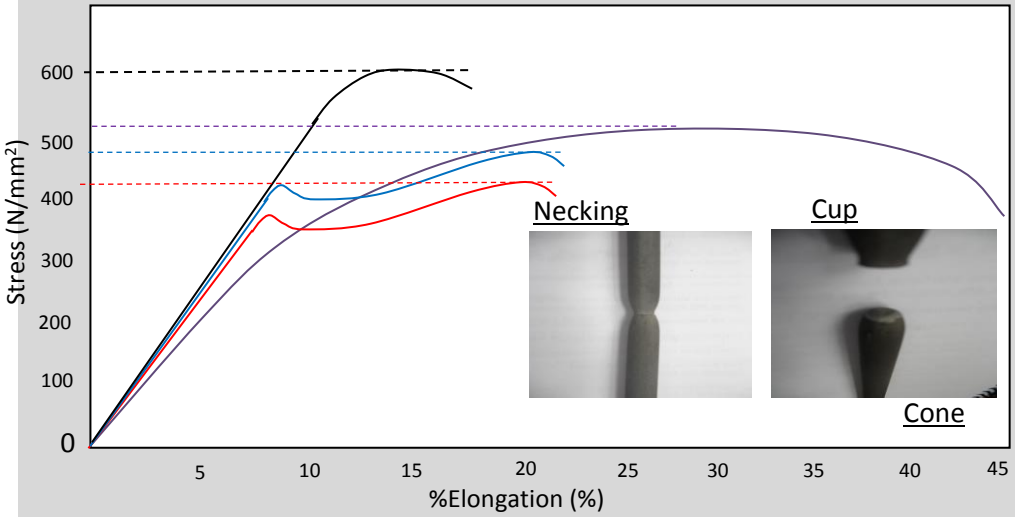
Forming

The steel is cooled into the required shape.

Hot rolled (structural sections)
Cold formed (light gauge)

Properties of construction steels

Steels used in construction can vary in their mechanical properties – depending on the alloying processes they experience (see phase diagram for carbon steel). The chart shows curves for four common grades or types of steel – each showing different stress-strain behaviour. The table gives exact values for important points on each curve (these of course vary between manufacturers)



Grade	U.T.S. (N/mm^2)	Yield strength (N/mm^2)	E (kN/mm^2)	%Elongation	Example of use
S275	410	275	205	22%	Building structures (steel frames)
S355	490	355	205	22%	Building structures (steel frames)
S460 (HTS)	600	460	205	18%	Steel piles / offshore structures
304 (stainless)	520	210	200	45%	Exposed/architectural steelwork

Discussing the features of each plot:

Grade S275 initially shows a high elastic stiffness up until the limit of proportionality. After a slight increase in stress past the limit of proportionality, a point is reached called the yield point. At the yield point the steel elongates for no increase in stress (in fact there is a slight decrease in the stress). Then, the steel material undergoes significant elongation for a slight increase in stress. This is plastic deformation and is unrecoverable. If the stress was to be removed then there would be a residual deformation. During the plastic deformation range dislocations are occurring in the micro structure. Eventually the Ultimate Tensile Stress is reached, followed by 'necking' of the steel material, and failure. This is a 'ductile' steel.

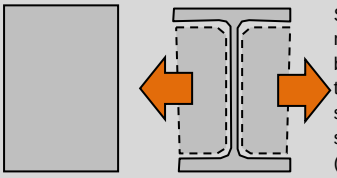
S355 show similar behaviour although S355 has slightly greater strength than S275.

For S460 HTS steel, more carbon is alloyed with the iron - changing the behaviour of the curve. Initially there is a similar and high stiffness, but the limit of proportionality is much higher. The yield point is also higher. However, after the yield point, there is a much reduced ductile zone. This steel is a 'brittle' steel.

304 Ni-Cr stainless steel has a much lower limit of proportionality – the stress strain curve departs from linearity at a much lower stress. However the curve exhibits extremely ductile behaviour, and, although there is a large non-linear portion to the curve, the ultimate tensile stress develops to a comparably high value. After the UTS has been attained there is further ductility to the curve – giving stainless steels a greater capacity for strain hardening.

Hot rolled structural steel sections

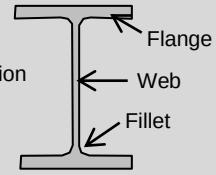
Because steel is expensive, solid square/rectangular members are not used. Instead the steel is shaped into a structurally efficient shape which uses less material. Consequently the steel member is also lighter (as well as cheaper) for just a small reduction in strength.



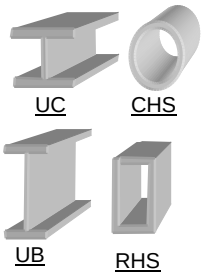
Surplus steel material can be eliminated to create a structural section shape (eg UB)

Standardised tables are published which give the dimensions of available steel sections. An example of such a table is shown here for Universal Beams

For a UB, each part of the section shape is called something…

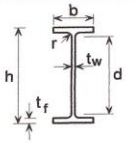


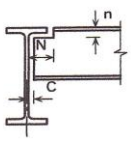
Some shapes of structural steel sections



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

UNIVERSAL BEAMS





Dimensions

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f/t_f	c_w/t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
533x165x85 +	84.8	534.9	166.5	10.3	16.5	12.7	476.5	3.96	46.3	7	90	30	1.69	19.9
533x165x75 +	74.7	529.1	165.9	9.7	13.6	12.7	476.5	4.81	49.1	7	90	28	1.68	22.5
533x165x66 +	65.7	524.7	165.1	8.9	11.4	12.7	476.5	5.74	53.5	6	90	26	1.67	25.4
457x191x161 +	161.4	492.0	199.4	18.0	32.0	10.2	407.6	2.52	22.6	11	102	44	1.73	10.7
457x191x133 +	133.3	480.6	196.7	15.3	26.3	10.2	407.6	3.06	26.6	10	102	38	1.70	12.8
457x191x106 +	105.8	469.2	194.0	12.6	20.6	10.2	407.6	3.91	32.3	8	102	32	1.67	15.8
457x191x98	98.3	467.2	192.8	11.4	19.6	10.2	407.6	4.11	35.8	8	102	30	1.67	17.0
457x191x89	89.3	463.4	191.9	10.5	17.7	10.2	407.6	4.55	38.8	7	102	28	1.66	18.6
457x191x82	82.0	460.0	191.3	9.9	16.0	10.2	407.6	5.03	41.2	7	102	28	1.65	20.1
457x191x74	74.3	457.0	190.4	9.0	14.5	10.2	407.6	5.55	45.3	7	102	26	1.64	22.1
457x191x67	67.1	453.4	189.9	8.5	12.7	10.2	407.6	6.34	48.0	6	102	24	1.63	24.3
457x152x82	82.1	465.8	155.3	10.5	18.9	10.2	407.6	3.29	38.8	7	84	30	1.51	18.4
457x152x74	74.2	462.0	154.4	9.6	17.0	10.2	407.6	3.66	42.5	7	84	28	1.50	20.2
								4.15	45.3	7	84	26	1.50	22.3