

STEEL

Based on carbon content iron is classified as

- a) Wrought iron - carbon content < 0.15%
- b) Steel - carbon content 0.15% to 1.5%
- c) Cast iron - carbon content 1.5% to 4%

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STEEL

- Most popular & effective building material.
- Alloy of iron & carbon.
- Based on the percentage of carbon, steel is classified as follows:

1. Mild carbon steel

-Carbon content is less than 0.25%.

2. Medium carbon steel

-Carbon content varies from 0.25 to 0.6%.

3. High carbon steel or hard steel

-Carbon content varies from 0.6 to 1.5%.

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STEEL – USES

Type of Steel	Uses
Mild steel	Motor body, Sheet metal, plate etc
Medium Carbon steel	Structural steel, rails
High Carbon steel	Miners drills, Stone mason's tools, smith's tools, axes, knives, hammers etc

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Uses of steel in construction industry

- Truss work for roofing
- Grill works for gates, windows etc
- Flooring
- Columns, beams, foundation
- Reinforcement in concrete

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Qualities of Mild steel

- Can be magnetised permanently
- Readily forged and welded
- Malleable and ductile
- Not easily attacked by salt water
- Tougher and elastic
- Specific gravity 7.8
- Compressive strength 80-120 kN/cm²
- Ultimate tensile and shear strength are about 60 to 80 kN/cm²

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Qualities of Hard steel

- Easily hardened and tempered
- Can be magnetised permanently
- Not easily attacked by salt water
- Tougher and more elastic than MS
- Specific gravity 7.9
- Compressive strength 140-200 kN/cm²
- Ultimate tensile is about 80 to 110 kN/cm²
- Ultimate shear strength is about 110 kN/cm²

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MARKET FORMS OF STEEL SECTIONS

Angle sections	Round bars
Channel	Square bars
Corrugated sheets	Flat bars
Expanded metal	Ribbed MS bars
I section	Thermo- mechanically Treated (TMT) bars
T section	Cold Twisted Deformed bars (CTD)
Plate	Welded Wire Fabrics (WWF)
Ribbed (HYSD) bars	

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MARKET FORMS OF STEEL SECTIONS

Angle sections

- Angle sections consist of two legs of equal or unequal sizes.
- ISA (40x40x3)mm means size of two legs is 40mm & thickness 3mm.
- Angle sections are available in (20x20x3)mm to (200x200x25)mm sizes.
- Used in structural steel works like trusses.



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MARKET FORMS OF STEEL SECTIONS

Channel sections

- Consisting of a web and two flange.
- Channel section is designated by height of the web and width of the flange.
- Size of channel section varies from (100x45)mm to (400x100)mm.
- Used for truss work, built-up columns etc.



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MARKET FORMS OF STEEL SECTIONS

I – sections

- Also called rolled steel joists or beams
- Consisting of a web and two flange.
- Designated by overall depth of section, width of flange.
- Available in sizes from (75x50)mm to (600x210)mm.
- Used as beams, lintels, columns, members in roof truss etc.
- Used in grillage foundations, built-up columns etc.
- Very economical in carrying lateral loads.



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MARKET FORMS OF STEEL SECTIONS

T - sections

- Consisting of a flange & web and has the shape of the letter T.
- Designated by overall dimensions and thickness.
- Used for steel roof trusses, built-up sections, fabrication of water tanks etc.
- Available sizes from (20x20x3) mm to (150x150x10)mm



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MARKET FORMS OF STEEL SECTIONS

Flat sections

- They are plate like sections with more length & less width
- Thickness of plate varies from 3 to 40mm
- Width of plate varies from 10 to 400mm
- Used for grillage works, built-up beams & columns, plate girder bridges etc.

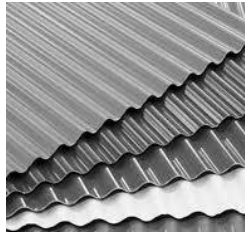


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MARKET FORMS OF STEEL SECTIONS

Corrugated sheets

- Formed by passing steel sheets through grooves
- Grooves bend and press steel sheets as a result corrugation are formed on the sheets
- Corrugated sheets are usually galvanized and are known as galvanized iron sheets or GI sheets
- GI sheets are used for roof covering & cladding



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MARKET FORMS OF STEEL SECTIONS

Round bars

- Available in circular cross sections
- Both solid & hollow sections are available
- Hollow sections are called pipes
- Used as reinforcement in concrete construction, steel grill work, window bars etc
- Size of round bars varies from 5 to 250mm
- ISRO10 = steel round bars of diameter 10mm

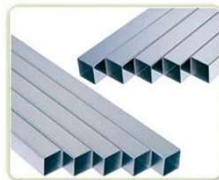


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MARKET FORMS OF STEEL SECTIONS

Square bars

- Available in square cross section
- Both solid & hollow sections are available
- ISSQ 12 means solid square bars of size 12mm
- Used for the construction of steel grills for window & gates



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REINFORCING BARS

Steel bars used in reinforced cement concrete are called reinforcing bars.

Types of reinforcing bars

1. Plain steel bars
2. High Yield Strength Deformed (HYSD) bars
3. Cold Twisted Deformed (CTD) bars / TOR steel bars
4. Thermo Mechanically Treated (TMT) bars

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REINFORCING BARS

1. Plain steel bars

- Round in section
- Made up of mild steel, medium tensile steel or high tensile steel
- Used in reinforced cement concrete
- Available sizes varies from 5mm to 32mm



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REINFORCING BARS

2. High Yield Strength Deformed (HYSD) bars

- They are deformed high strength steel
- These bars have ribs or projections on the surface which increases the bond between the concrete and steel bars.
- HYSD bars are thermo mechanically treated i.e. they are treated at high temperatures and then rolled and twisted for shaping.
- They are produced by either hot working or cold working.
- These bars have more tensile strength than mild steel.
- Two types of HYSD bars are: (i) TOR (ii) TMT

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REINFORCING BARS

2. High Yield Strength Deformed (HYSD) bars



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REINFORCING BARS

Advantages of HYSD

1. These bars have good bonding capacity
2. Used for major reinforcement works
3. Better structural properties
4. Yield strength of these bars is high
5. Substantial saving in reinforcement
6. These bar can be bent to 180 degree without any cracks

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REINFORCING BARS

i. Cold Twisted Deformed (CTD) bars / TOR steel bars

- CTD bars are available in the market in the name of TOR.
- TOR is a brand name which stands for Toristeg Steel Corporation of Luxembourg.
- Round plain steel bars (mild steel) dominated the industry till seventies.
- Thereafter, CTD (TOR) steel dominated the industry till 90s
- Nowadays, TMT or hot treated bars are the most popular due to its advantages over CTD (TOR) such as high strength and corrosion resistance

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REINFORCING BARS

ii. Thermo Mechanically Treated (TMT) bars

- TMT bars are manufactured by quenching (sudden cooling by spraying of water) and tempering process which allows the outer surface to cool much faster than inner core and hence TMT bars have a hard outer surface and softer core.
- TMT bars are also rolled to have ribs to increase the bond strength.

Advantages of TMT

- more ductile, have high yield strength
- possess good bendability, weldability more corrosion resistance, fire resistance

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CONCRETE

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Materials used in Concrete

- Cement
- Aggregates – 1. Fine aggregate or sand (size <4.75mm)
2. Coarse aggregate or broken stone (4.75mm- 75mm)
- Water

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Materials used in Concrete

- Cement
 - Before the introduction of Portland cement, lime was used as the binding material
- Aggregates
 - inert or chemically inactive material which forms volume of cement concrete
 - these are bound together by cement
 - Fine (size less than 4.75mm) and coarse aggregate (4.75mm to 75mm)
 - Should be hard, durable, and clean

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Materials used in Concrete

- Water
 - Most important
 - Should be clean and free from harmful impurities
 - potable water is normally used for construction purpose
- Other than these, some ingredients are added to improve the quality of concrete by changing its properties in fresh and hardened stages. Such ingredients are called **admixtures**
- Addition of **Admixtures** may improve the concrete wrt its strength, hardness, workability, water resisting power, reduce bleeding etc

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Some admixtures

- Alum
- Barium oxide
- Bitumen
- Calcium chloride
- Coal ash
- Volcanic ashes
- Zinc chromate
- Silicate of soda
- potassium chloride
- Mineral oils

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Properties of fresh concrete

- Workability – ease with which concrete may be mixed, handled, transported, placed in position and compacted
- Segregation – Separation of coarser particles from concrete mix
- Bleeding - Separation of water from concrete(water rises to the top surface of freshly laid concrete)
- Laitance – Separation of cement paste from freshly laid concrete and rises to its top surface

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Properties of Hardened concrete

- Compressive strength – depends on grades of concrete, water cement ratio, method of compaction, curing period
- Shrinkage – shrinks with age and depends on water content, environmental conditions, size of the concrete member etc
- Creep – Change in dimension due to loading. Depends on constituent of concrete, size of member, environmental conditions, stress in concrete, age of concrete at loading etc
- Thermal expansion
- Free from corrosion
- Hardens with age
- Economical than steel
- Weak in tension

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Proportioning concrete

- Process of selection of relative proportions of cement, sand, coarse aggregate and water to obtain a concrete of desired quality
- Different mixes available from 1:5:10 to 1:1:2
- 1:5:10 means one portion cement, 5 portion fine aggregate and 10 portion coarse aggregate
- 1:5:10 represents weak mix and 1:1:2 represents very high strength
- Design mixes are also available for obtaining more high strength

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Mix	Proportion of concrete mix (cement: Fine Aggregate:Coarse Aggregate)
M5	1:5:10
M7.5	1:4:8
M10	1:3:6
M15	1:2:4
M20	1:1.5:3
M25	1:1:2

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Tests on fresh concrete – Slump test

- Slump cone with bottom dia 20cm, top dia 10 cm and height 30cm
- Cone is place on the ground and filled with concrete in 4 layers
- Each layer is rammed 20 times with a rod of dia 16mm and length 60cm
- Top concrete surface is struck off so that the cone is completely filled with concrete
- Cone is gradually raised vertically and removed
- Concrete is allowed to subside and height is measured

Slump = height of subsidence



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Test on hardened concrete

- Cube compressive strength test
- IS 516:1959 Methods of tests for strength of concrete
- Test specimen – 3 cubes of size 15cm x 15cm x 15cm
- Placed under water @ 24-30°C until tested
- Testing is usually done at 7 days of curing or 28 days of curing
- Surface water is wiped off and specimen is kept in CTM
- Load is applied gradually until the specimen breaks
- $\text{Compressive Strength} = \text{Breaking Load} / \text{Cross sectional area}$

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Types of concrete

- Plain Cement concrete (PCC)
- Reinforced cement concrete (RCC)

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