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# IES MASTER

## Civil Engineering

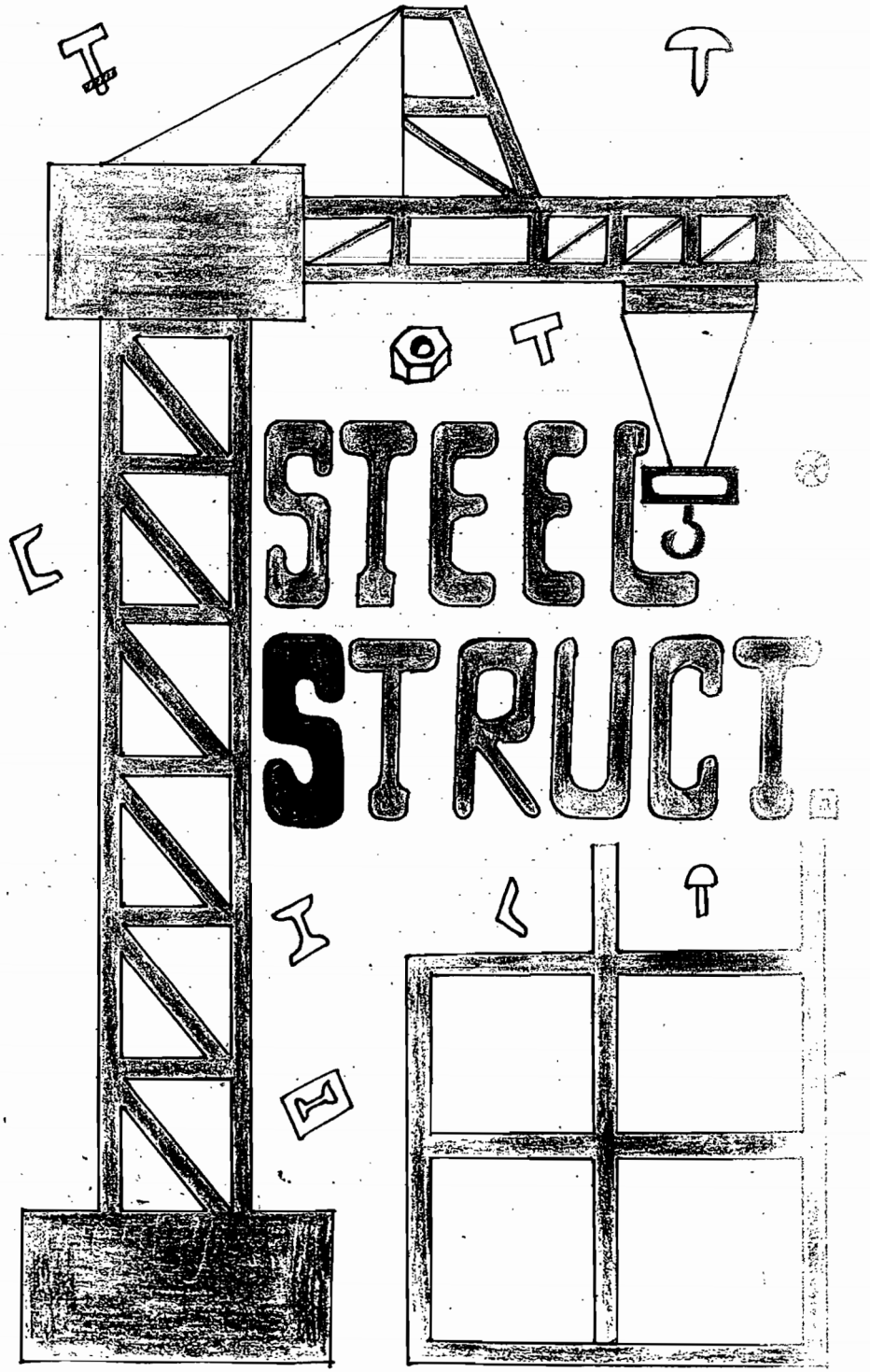
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### DESIGN OF STEEL STRUCTURES

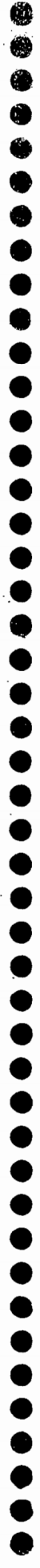
- Theory BY-GHANSHYAM SIR
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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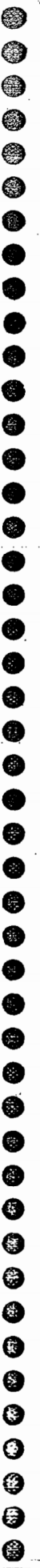
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STEEL  
STRUCT.



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Date  
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# 1. INTRODUCTION

- WSM - Working Stress Method → No Load factor
- LSM - Limit State Method → FOS in mat. strength
- ULM - Ultimate load method.

## \* IMPORTANT IS-CODE:-

1. IS 800:2007 - General Construction in steel (with amendment no.1 generally 2012).
2. IS 808:2021 - Hot rolled steel beam, columns, channel & angle section.

## \* PURPOSE OF IS CODE:-

1. Ensuring adequate structural safety by specifying certain essential min. requirements.
2. Make the task of designer simple by providing tables, charts, etc.
3. Ensure consistency among different designers.
4. May provide some legal validity.

## \* STEEL:- The three different form of iron are:-

1. Wrought Iron :- Carbon approximately 0.2%.
2. Steel :- Carbon approx. 0.1 - 1.1%.
3. Cast iron :- Carbon approx 2.5 - 4.5%.
4. Cast iron is the crude form of iron, wrought iron is the purest form of iron & steel is midway between wrought iron & cast iron.

→ Steel is an alloy of iron & consist of about 98% of iron.

Based on carbon content there are four types of steel:-

1. Low Carbon steel:- Less than ( $< 0.15\%$ )
2. Mild Carbon steel/ Mild steel :- 0.15% to 0.29%.
3. Medium Carbon steel :- 0.30 to 0.59%.
4. High Carbon steel:- 0.60 to 1.7%.

→ De-oxidizer such as silicon and/or aluminium used to control dissolved oxygen during the manufacturing process of steel.

→ Lower % of oxygen content is good for durability of steel. On the basis of oxygen content steel can be classified as:-

1. Yield Steel :- (Oxygen  $< 30$  PPM)
2. Semi-yield steel :- (30 to 150 ppm)
3. Rimmed steel :- ( $> 150$  ppm)

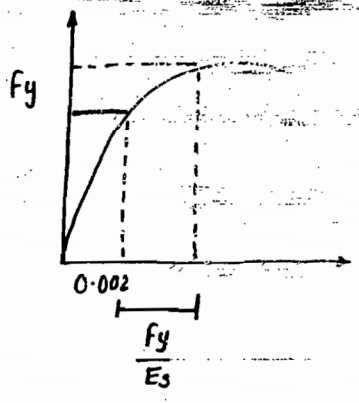
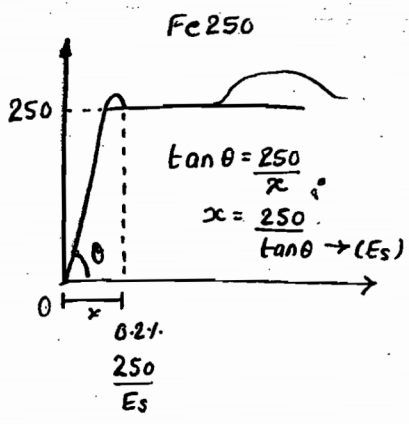
→ Structural steel section are generally produce using either yield or semi-yield steel. Carbon % in structural steel is generally less than ( $< 0.25\%$ ).

\* NOTE:-

1. With increase in carbon content, the tensile strength & hardness of steel increases. However ductility, toughness and weldability decreases.

\* VARIOUS GRADES OF STEEL:-

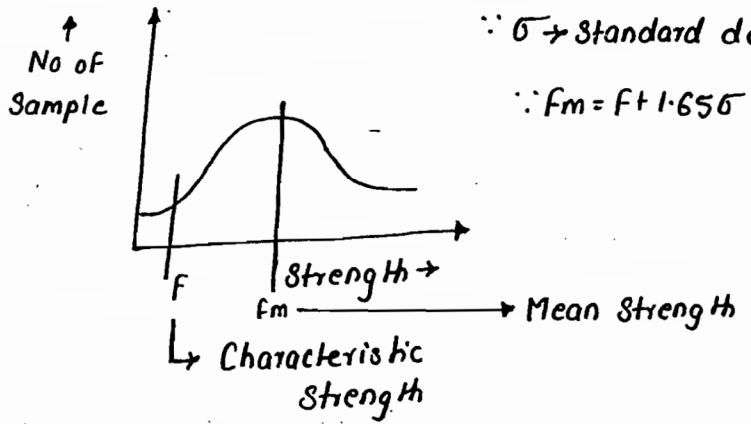
St. No.	Grade	Ultimate tensile strength in MPa ( $f_u$ )	Yield Strength in MPa ( $f_y$ )	Min. (%) elongation
1	E250 (Fe410) A B C	410	250	23%
2	E300 (Fe440)	440	300	22%



\* Note:-

- E 250 (Fe 410) A → Grade of Steel
  - ↓
  - Characteristic yield strength
  - ↘
  - Characteristic ultimate strength
- Fe 410 W
  - ↳ Enhance weldability

- Structural Steel is specified according to characteristic ultimate tensile strength ( $f_u$ ). However reinforcement steel in R-C-C is specified as per yield stress ( $f_y$ ).
- Characteristic ultimate stress is the stress below which not more than 5% of the material expected to fail.



- Thinner the section higher is the strength due to higher amount of rolling, Cold working, uniform rate of cooling.

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	$t < 20\text{mm}$	$20 < t < 40\text{mm}$	$t > 40\text{mm}$
E250 (Fe410)	$F_y = 250$	$F_y = 240\text{MPa}$	$F_y = 230\text{MPa}$

- Brittle fracture occurs due to higher tensile stress, lower temp., thicker material and rapid change of stresses.
- Stain-less steel is low carbon steel with greater than ( $> 10.5\%$ ) of chromium by weight.
- Stain-less steel has better fire-resistance & ductility than mild steel. Grad(A) steel is used for non-critical application i.e when members are not prone to brittle fracture.
- Grade(B) steel is used for critical application when temp. doesn't fall below ( $0^\circ\text{C}$ ) and when parts are prone to brittle fracture or fluctuation of stresses as in the case of bridges.
- Grade(C) steel has granted low temp. performance (upto  $-40^\circ\text{C}$ ) and impact properties and shall be used when chances of brittle fracture is there.

\* PHYSICAL PROPERTIES OF STEEL (Valid for all Grades):-

1. Density of steel =  $7850\text{ kg/m}^3$
2. Modulus of elasticity =  $E = 2 \times 10^5\text{MPa}$
3. Poisson's Ratio ( $\mu$ ) =  $0.3$  (Elastic zone)  
 $0.5$  (Plastic range/zone)
4. Shear modulus/modulus of rigidity ( $G$ ) =  $\frac{E}{2(1+\mu)}$
5. Co-efficient of thermal expansion ( $\alpha$ ) =  $12 \times 10^{-6}/^\circ\text{C}$

## \* ADVANTAGES OF STEEL AS A STRUCTURAL MATERIAL:-

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1. High strength per unit weight
2. High ductility
3. High toughness i.e good for impact loading
4. Uniformity & quality in property.
5. Environmental friendly that is can 100% re-used.
6. Faster construction & easily modification.
7. Long life if properly maintain.

## \* DISADVANTAGE OF STEEL AS A STRUCTURAL MATERIAL:-

1. Low fire-resistance
2. Higher maintenance due to corrosion
3. Prone to buckling due to longer & cylinder member.
4. Chances of fatigue when subjected to large no. of stress reversal.

$$\left\{ P_{cr} = \frac{\pi^2 EI}{l_{eff}^2} \right\}$$

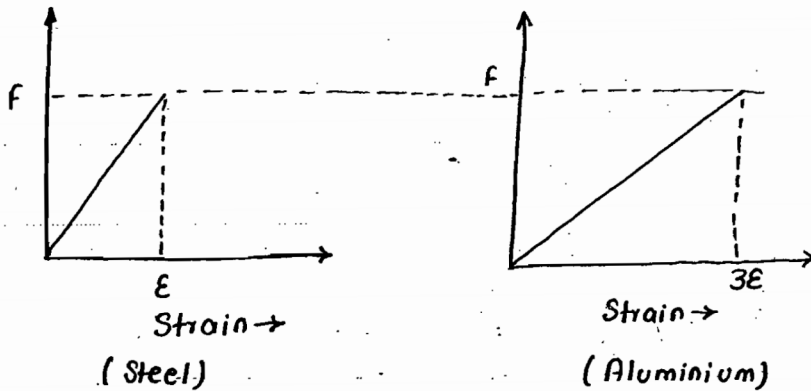
## \* ALUMINIUM :-

1. Greater strength to unit weight ratio compare to steel.
2. However due to lower modulus of elasticity (appr.  $\frac{1}{3}$  of steel) bigger section are required to minimize chances of buckling.
3. Greater resistance against corrosion and hence less maintenance cost.
4. Density is approx.  $\frac{1}{3}$  of the steel.
5. Less ductile than mild steel.
6. Co-efficient of thermal expansion is twice that of steel ( $23 \times 10^{-6} / ^\circ C$ ).

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7. Does not have a well define yield point and hence yield is assume at 0.2% proof stress.

8. As its modulus of elasticity is  $\frac{1}{3}$  of steel, it can absorb 3 time the energy for the same stress provided the stress does not exceed the proportionally limit.



$$E = \frac{F}{\epsilon} \quad \therefore \quad \epsilon = \frac{F}{E/3}$$

9. It is good for impact loading provided higher deflection is permissible

10. Design concept is same as steel structure design.

\* CONVENTION FOR MEMBER AXIS :- { IS 800:2007 }

