

# **PNS SCHOOL OF ENGINEERING & TECHNOLOGY**

**INTERNAL ASSESSMENT EXAMINATION -2022(5<sup>TH</sup> SEMESTER)**

**SUB: TH-2 ( STRUCTURAL DESIGN-2)**

**BRANCH : CIVIL ENGINEERING**

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NO-1 Answer of the following question ? (2\*5)

(a) What are the actions in the limit state method of design ?

Ans - A degree of loading or other actions imposed on a structure can result in a 'limit state', where the structure's condition no longer fulfills its design criteria, such as; fitness for use, structural integrity, durability, and so on.

(b) State any two physical properties of structural steel?

Ans -The physical properties of steel include: high strength, low weight, durability, ductility and corrosive resistance. Steel offers great strength, even though it is light in weight. In fact, the ratio of strength to weight for steel is lower than any other building material.

(c) How are the structural members graded ?

Ans - Structural grading is the process by which timber is sorted into groups - or stress grades - with ideally, similar structural properties in each group. Inevitably there is a very substantial range of properties within a group and significant overlap in properties between the groups.

(d) What is gauge distance?

Ans - A row of rivets parallel to the direction of force is called a gauge line. The normal distance between two adjacent gauge lines is called the gauge distance.

(e) What is gross area ?

Ans - The gross area is the total cross-sectional area of a tensile member taken perpendicular to the load, where no holes are provided.

(F) What is lap joint ?

Ans -A lap joint is the joint between two pieces of metal in which the edges or ends are overlapped and fastened together to produce a continuous or flush surface.

(g) What is butt joint ?

Ans-A butt joint is a technique in which two pieces of material are joined by simply placing their ends together without any special shaping. The name "butt joint" comes from the way the material is joined.

(h) What is tearing failure of plate ?

Ans- If the force is too large that stress in the plate exceeds the allowable tensile stress of plate material, then the plate may fail in tension along the row.

(i) What is shear failure of plate ?

Ans-It is a failure in which a block of a member is torn out as depicted below around the bolt holes in the periphery. When high shear strength bolt and high bearing strength plates are used, length of connection gets reduced leading to block shear failure.

(j) What is bearing failure of plate ?

Ans -Bearing failure modes include corrosion, wear, plastic deformation, fatigue, lubrication failures, electrical damage, fracture, and incorrect design. Out of these, classical localized defects result from fatigue.

NO-2 Answer the following question ( 5\*2)

(a) What are the advantages and disadvantages of steel structure?

Ans-Advantages of Steel Construction

#### 1. Reliability

Steel structures are very reliable. The reasons for this reliability include consistency and uniformity in properties, better quality control because of factory manufacture, large elasticity, and ductility. If different specimens of some type of steel are tested in the laboratory for yield stress, ultimate strengths and elongations, the variation is much lesser than other materials like concrete and wood. Further, because of truly homogeneous and elastic material, steel satisfies most of the assumptions involved in the derivation of the analysis and design formulas and the results obtained are reliable. This may not be the case in concrete structures because of heterogeneous material, cracking and non-linearity of stress-strain relationship.

#### 2. Industrial Behavior

Rolled steel sections are manufactured in factories. Also, the members may be cut and prepared for assembly in factories while only joining of these components is carried out at the site by installing rivets or bolts and by welding different components. Sometimes parts of the structure are also assembled in the factories, that is, there is a great adaptation to prefabrication. Manual errors reduce greatly in such cases, the speed of construction increases and the total cost reduces.

#### 3. Lesser Construction Time / Greater Erection Speed

Because of the industrial nature of steel construction. Progress of the work is fast making the structures economical. The reason is that these structures can be put to use earlier. The reduction

in labor cost and overhead changes and the benefits obtained from the early use of the building contribute to the economy.

#### 4. High Strength And Light Weight Nature

The high strength of steel per unit weight means that the dead loads will be smaller. It is to be noted that dead loads are a bigger part of the total loads on structure. When dead load reduces, the underneath members become still smaller due to less weight acting on them. This fact is of great importance for long-span bridges, tall building, and for structures having poor foundation conditions.

#### 5. Uniformity, Durability And Performance

Steel is a very homogeneous and uniform material. Hence, it satisfies the basic assumptions of most of the analysis and design formulas. If properly maintained by painting, etc. the properties of steel do not change appreciably with time; whereas, the properties of concrete in a reinforced concrete structure are considerably modified with time. Hence, steel structures are more durable.

#### 6. Elasticity

Steel behaves closer to design assumption than most of the other material because it follows Hooke's law up to fairly high stresses. The stress produced remains proportional to the strain applied off the stress-strain diagram remains a straight line. The steel sections do not crack or tear before ultimate load and hence the moments of inertia of a steel structure can be definitely calculated. The moments of inertia obtained for a reinforced concrete structure are rather indefinite.

#### 7. Ductility And Warning Before Failure

The Property of a material by which it can withstand extensive deformation without failure under high tensile stresses is said to be its ductility. Mild steel is a very ductile material. The percentage elongation of a standard tension test specimen after fracture can be as high as 25 to 30%. This gives visible deflections of evidence of impending failure in case of overloads. The extra loads may be removed from the structure to prevent collapse. Even if collapse does occur, time is available for occupants to vacate the building.

In structural members under normal loads, high stress concentrations develop at various points. The ductile nature of the usual structural steel enables them to yield locally at those points, thus redistributing the stresses and preventing premature failures.

#### 8. Additions To Existing Structures

Additions to existing steel structures are very easy to made. Connections between new and existing structures can be employed very effectively. New bays or even entire new wings can added to existing steel frame building, and steel bridges may often be widened.

#### 9. Possible Reuse

Steel sections can be reused after a structure is disassembled.

#### 10. Scrap Value

Steel has a scrap value even though it is not reusable in its existing form.

### 11. Water-Tight And Air-Tight Constructions

Steel structures provide completely impervious construction and structures like reservoirs, oil pipes, gas pipes, etc. are preferably made from structural steel.

### 12. Long Span Construction

High-rise buildings, long span bridges and tall transmission towers are made up of structural steel. Industrial buildings up to a span of 90.m can be designed by plate girders or trusses. Bridge spans up to 260.m are made with plate girders. For through truss bridges, Bridge spans of 300.m have been used.

### 13. Temporary Construction

For temporary structures, steel construction is always preferred. Army constructions during war are mostly made out of structural steel. The structures may be disassembled by opening few bolts, component parts are carried to new places and the structure is easily reassembled.

## Disadvantages of Steel Construction

### 1. High Maintenance Costs And More Corrosion

Most steels are susceptible to corrosion when freely exposed to air and water and must therefore be periodically painted. This requires extra cost and special care. The use of weathering steels, in stable design applications, tends to eliminate this cost. If not properly maintained, steel members can lose 1 to 1.5 mm of their thickness each year. Accordingly such constructions can lose weight up to 35% during their specified life and can fail under the external loads.

### 2. Fireproofing Costs

Although steel members are incombustible, their strength is tremendously reduced at temperatures prevailing in fires. At about 400°C, creep becomes much more pronounced. Creep is defined as plastic deformation under a constant load for a long period of time. This produces excessively large deflections/deformations of main members forcing the other members to higher stresses or even to collapse. Steel is an excellent conductor of heat and may transmit enough heat from a burning compartment of a building to start fire in other parts of the building. Extra cost is required to properly fire proof the building.

### 3. Susceptibility To Buckling

The steel sections usually consist of a combination of thin plates. Further, the overall steel member dimensions are also smaller than reinforced concrete members. If these slender members are subjected to compression, there are greater chances of buckling. Buckling is a type of collapse of the members due to sudden large bending caused by a critical compressive load. Steel when used for columns is sometimes not very economical because considerable material has to be used merely to stiffen the columns against buckling.

### 4. Higher Initial Cost / Less Availability

In few countries, steel is not available in abundance and its initial cost is very high compared with the other structural materials. This is the most significant factor that has resulted in the decline of steel structures in these countries.

### 5. Aesthetics

For certain types of buildings, the steel form is architecturally preferred. However, for majority of residential and office buildings, steel structures without the use of false ceiling and cladding are considered to have poor aesthetic appearance. A considerable cost is to be spent on such structures to improve their appearance. Cladding is a covering of metal, plastic or timber put on the surface of a structural member to completely encase it. The cladding not only protects the member but also improves its appearance.

(c) Write the different types of load acting on a structure?

### **Ans-Different types of loads**

The loads in buildings and structures can be classified as vertical loads, horizontal loads and longitudinal loads. The vertical loads consist of dead load, live load and impact load. The horizontal loads consist of wind load and earthquake load. The longitudinal loads i.e. tractive and braking forces are considered in special cases of design. The estimation of various loads acting is to be calculated precisely. Indian standard code IS: 875-1987 and American Standard Code ASCE 7: Minimum Design Loads for Buildings and Other Structures specifies various design loads for buildings and structures. Each of them is discussed below.

#### **1-Dead load**

Dead loads, also known as permanent or static loads, are those that remain relatively constant over time and comprise, for example, the weight of a building's structural elements, such as beams, walls, roof and structural flooring components. Dead loads may also include permanent non-structural partitions, immovable fixtures and even built-in cupboards. Dead loads comprise the weight of the structure or other fixed elements before any live loads are taken into consideration. Live loads are added to the dead load to give the total loading exerted on the structure. The calculation of dead loads of each structure is calculated by the volume of each section and multiplied by the unit material weight.

#### **2-Live load**

Live load is a civil engineering term that refers to a load that can change over time. The weight of the load is variable or shifts locations, such as when people are walking around in a building. Anything in a building that is not fixed to the structure can result in a live load since it can be moved around. Live loads are factored into the calculation of the gravity load of a structure. They are measured in pounds per square foot. The minimum live-load requirements are based on the expected maximum load. A live load can be expressed either as a uniformly distributed load (UDL) or as one acting on a concentrated area (point load). It may eventually be factored into the calculation of gravity loads.

#### **3-Wind load**

Wind loads can be applied by the movement of air relative to a structure, and analysis draws upon an understanding of meteorology and aerodynamics as well as structures. Wind load may not be a

significant concern for small, massive, low-level buildings, but it gains importance with height, the use of lighter materials and the use of shapes that may affect the flow of air, typically roof forms. Where the dead weight of a structure is insufficient to resist wind loads, additional structure and fixings may be required. Wind load is required to be considered in structural design especially when the height of the building exceeds two times the dimensions transverse to the exposed wind surface.

#### 4-Snow load

This is the load that can be imposed by the accumulation of snow and is more of a concern in geographic regions where snowfalls can be heavy and frequent. Significant quantities of snow can accumulate, adding a sizable load to a structure. The shape of a roof is a particularly important factor in the magnitude of the snow load.

#### 5-Earthquake load

Earthquake load takes place due to the inertia force produced in the building because of seismic excitations. Inertia force varies with the mass. The higher mass of the structure will imply that the earthquake loading will also be high. When the earthquake load exceeds the moment of resistance offered by the element, then the structure will break or damage. The magnitude of earthquake loading depends upon the weight or mass of the building, dynamic properties of the building and difference in stiffness of adjacent floors along with the intensity and duration of the earthquake. Earthquake load acts over the surface of a structure placed on the ground or with an adjacent building. Buildings in areas of seismic activity need to be carefully analysed and designed to ensure they do not fail if an earthquake should occur.

**(d)** Write advantages and disadvantages of Bolted connection?

Ans- Advantages of bolted connection

##### 1. Simple Design

The bolted joint having simple design, which helps to identify the joints are easy than welded joint or riveted joint.

##### 2. Easy Operation

The bolted joint is a simple joint so that the operation of the bolted joint is easy.

Only two parts that is nut and bolt are required for connection of the bolted joint.

### 3. High Strength Joint

The strength of the bolt joint is higher than riveted joint. Bolted joint required less number of bolts for the same strength are getting from riveted joint.

### 4. Low Cost

The cost of bolted joint is less compared to riveted joint and also it required less number of equipment so that, the cost of equipments is decrease.

### 5. Low Noise

The operation of bolted joint is less noisy. At the time of tightening the bolt and nut operation is silent and compared to a riveted joint.

Disadvantages of Bolted connection-

#### 1. Accuracy of Joint

The accuracy of bolted joint is totally depend upon the tightening of the joint.

Also depend on the friction between nut and bolt.

#### 2. Less Axial Tensile Strength

The bolted joint having less axial tensile strength. If the high axial load applied on our place then the chance failure of the bolted joint is more.

#### 3. Effect Of Vibration

The bolted joint having high effect of vibration. Under the vibrational load the strength of the joint is decreases.

#### 4. Unfinished Bolt

If the bolt is unfinished the strength of the bolt is decreases while the use.

#### 5. More Weight

When the two plates joined by the bolted joint having high weight compared to joining riveted joint.

## 6. Proper Lubrication Required

In a bolted joint over a period of time proper lubrication required for smoothening operation.