

Application of the Hanger Reinforcement

Dr. Shrishail Anadinni

Assistant Professor, Department of Civil Engineering, Presidency University, Bangalore, India
Email Id-shrishail@presidencyuniversity.in

ABSTRACT:

A crucial component of structural design is hanger reinforcement, especially in situations where slabs or beams must sustain suspended loads. The main goal of hanger reinforcement is to make sure that vertical loads are transferred from the hanger to the supporting structure safely. An overview of hanger reinforcement, including its importance, design concerns, and typical reinforcement techniques, is given in this abstract. Maintaining the structural integrity and load-carrying capacity of hanging parts depends heavily on hanger reinforcement. As a result of the imposed loads, it aids in preventing excessive deflection, cracking, and hanger failure. Considerations for the design process include the size and kind of loads, the hanger's geometry, and the characteristics of the supporting structure. Determining the necessary tensile strength and assuring compliance with the supporting structure are design factors for hanger reinforcement. Steel bars, wire ropes, or tendons that have been pre-stressed are just a few examples of the different reinforcement methods that can be used. The load requirements, available space, and construction feasibility all play a role in choosing the best reinforcement method. The anchorage length, development length, and transparent cover requirements are among the detailing factors taken into account when designing hanger reinforcement.

KEYWORDS:

Axial, Design, Hanger, Material, Member.

I. INTRODUCTION

An important consideration in structural design and construction is hanger reinforcement, especially in situations where heavy loads must be supported by hung elements or components. Hangers are frequently used to support and stabilize components like beams, joists, trusses, and pipes in a variety of constructions, including bridges, buildings, industrial facilities, and infrastructure projects. The transfer of loads from these suspended items to the supporting structure is made safe and effective by the application of hanger reinforcement. The idea of hanger reinforcement, its significance in structural design, and the major factors involved in its application will all be covered in this article. We will also go over several hanger reinforcement kinds and how they are used [1], [2].

Hanger reinforcement is crucial.

Maintaining the structural integrity and load-carrying capacity of hanging parts depends heavily on hanger reinforcement. The main goal of hanger reinforcement is to withstand forces acting vertically and horizontally on the hanger and ensure that these forces are safely transferred to the supporting structure. Structural engineers can optimize load distribution, reduce the chance of failure, and prevent excessive deflections in the suspended elements by appropriately reinforcing hangers [3], [4].

Key Factors to Consider When Designing Hanger Reinforcement

Calculating the loads that the hanger must support is the first step in the design of hanger reinforcement. This entails taking into account both the live loads (temporary or movable loads) and the dead loads (permanent weights) operating on the hanging piece. Depending on the particular application and the requirements of the design, the loads may change.

Material Selection: It's important to choose the right materials to reinforce hangers. Steel, reinforced concrete, and wood are frequently utilized as hanger-reinforcing materials. The selection of a material is influenced by various elements, including structural requirements, load capacity, durability, and economics [4], [5].

Type and Configuration of the Hanger: The hanger's type and configuration are determined by the particular application and the load specifications. Steel straps, cables, rods, and brackets are typical hanger kinds. Depending on the weight distribution and structural soundness, the design may use a single hanger or numerous hangers.

Connection and Attachment of the Hanger: The hanger must be correctly connected and attached to the supporting structure as well as the suspended piece. To ensure weight transfer and avoid early failure or displacement, the connection details must be properly specified.

Different Hanger Reinforcement Types

Steel Hangers: Because of their high strength and longevity, steel hangers are utilized extensively in a variety of applications. They are frequently used when constructing industrial buildings, bridges, and other structures with heavy loads and lengthy spans. Depending on the exact needs, steel hangers can be made as cables, rods, or brackets [6], [7].

Reinforced concrete hangers are frequently employed in building projects, particularly in frames made of reinforced concrete. Typically, reinforcing bars are included in the concrete members to create these hangers. Hangers made of reinforced concrete offer sturdiness, longevity, and fire resistance [8], [9].

Timber Hangers: When a lightweight, affordable solution is required, timber hangers are used. They frequently support joists and beams while building homes, for example. Usually made of treated wood to increase strength and resistance to decay, timber hangers take the form of brackets or straps [10].

Hanger reinforcement applications include:

Many different structural elements and systems use hanger reinforcement, such as:

Bridge Building: To support suspended parts including girders, cables, and deck segments, hanger reinforcement is frequently employed in bridge building. The loads are distributed from the bridge deck to the bridge piers or towers and are stabilized by the hangers.

Industrial Facilities: To support equipment, pipes, ducts, and other suspended components, hanger reinforcement is used in industrial facilities. It guarantees the effective and safe transfer of loads, avoids extreme deflections, and reduces the chance of structural collapse.

Building Construction: HVAC (Heating, Ventilation, and Air Conditioning) systems, beams, joists, and other structural components are supported in buildings using hanger reinforcement. It aids in load distribution and gives stability to the suspended part. Projects involving infrastructure, such as tunnels, pipelines, and electricity transmission lines, require the reinforcing of hangers. It guarantees the safe installation and maintenance of these essential infrastructure components. To ensure the secure and effective support of suspended elements, hanger reinforcement is a crucial aspect of structural design and construction. It is essential for preserving the stability, load-bearing ability, and structural integrity of structures including bridges, buildings, and industrial facilities. Careful consideration of loads, material selection, hanger type, layout, and connection details is necessary for the proper design and implementation of hanger reinforcement. Engineers can increase the performance, safety, and longevity of suspended elements in a variety of applications by introducing hanger reinforcement into structural designs. In particular, when building bridges and other hanging structures, hanger reinforcement is a crucial component of structural design. Bridge decks and overhead signage can be supported vertically by hangers, which are load-bearing members. These components are subjected to a variety of forces, including dead loads, live loads, and dynamic loads, which can cause the hangers to experience high tensile forces.

By offering sufficient tensile strength and deformation resistance, hanger reinforcement serves to assure the structural integrity and safety of the hung items. This abstract examines hanger reinforcement design concepts, techniques, and materials, using bridge construction as the principal application. To develop hanger reinforcement that meets design requirements, it is necessary to ascertain the necessary tensile strength. The design process must take into account elements including the size and distribution of the loads, the span length, the geometry of the suspended piece, and the surrounding environment. Steel cables, rods, or strands can be utilized as reinforcement for hangers, among other materials. The choice of material is influenced by variables such as the required load, structural limitations, and financial concerns. Steel cables are frequently employed because of their excellent tensile strength, long lifespan, and simplicity of installation.

Choosing an acceptable hanger material and calculating the needed cross-sectional area of the hanger based on the tensile load are common design steps. To ensure adequate weight transmission and efficient reinforcement, the hanger length and anchorage details are also crucial factors to take into account. Determine the forces acting on the hangers and confirm their sufficiency using analytical techniques like static and dynamic analysis. Structural analysis tools and computer-aided design (CAD) software can help with precise calculations and simulations. Construction techniques are extremely important in assuring the efficiency of hanger reinforcement

in addition to design considerations. To achieve the specified load-carrying capacity and reduce the risk of failure, proper installation techniques, including suitable anchorage, alignment, and tensioning, are crucial.

There are various benefits to using hanger reinforcement while building bridges. Longer spans are possible, fewer additional vertical supports are required, and the structure's visual appeal is improved. Additionally, hanger reinforcement offers design flexibility and enables modifications to account for various loads and environmental factors. However, difficulties in hanger reinforcement design could occur because of material corrosion, fatigue from cyclic stress, and upkeep needs. Hanger reinforcement systems must be properly protected against corrosion and subjected to routine inspections and maintenance procedures to guarantee their long-term performance and safety. Hanger reinforcement is a vital feature of structural design in hanging buildings, especially in bridge buildings. To maintain the structural integrity and safety of the suspended elements, careful consideration of loads, geometry, materials, and construction techniques is required during the design phase. Using the right materials, making correct calculations, and using the right installation methods are essential for attaining effective hanger reinforcement. Hanger reinforcement can help build safe, enduring, and visually beautiful structures by adhering to best practices and sound design concepts.

II. DISCUSSION

Design of Hanger Reinforcement in a Beam-Girder Junction

One crucial component of structural engineering is the design of the hanger reinforcement in a junction of beams and girders. The junction is supported and stabilized by the hanger reinforcement, ensuring the secure passage of loads from the beam to the girder. Here are some crucial factors to take into account when designing hanger reinforcement in a junction between beams and girders:

Determine the loads affecting the hanger reinforcement as the initial stage in the design process. To do this, the loads that are transported from the beam to the girder must be examined, taking into account any relevant load combinations as well as dead, live, and dynamic loads. The quantity and nature of the forces that the hanger reinforcement must withstand are determined by the load analysis.

Hanger Configuration: The arrangement of the hanger reinforcement is determined by the particular design specifications and the intersection's geometry. Typically, hangers are created as vertical or oblique pieces that join the beam to the girder. Steel bars, rods, or other suitable materials that can offer the necessary strength and durability could make up the hangers. The stability and load-carrying capability of the beam-girder junction are significantly influenced by the spacing and size of the hangers. Based on the predicted load distribution and the junction's structural study, the hanger spacing should be chosen. The diameter and cross-sectional area of the hangers are chosen based on the required material strength and the anticipated forces.

Hanger Reinforcement Material: The selection of the hanger reinforcement material is influenced by several criteria, such as the structural requirements, the surrounding structural elements, and the environmental conditions. Steel, stainless steel, or other corrosion-resistant materials are frequently utilized as hanger reinforcement. The chosen material should be strong and long-lasting enough to bear the projected loads and guarantee the junction's long-term stability.

Connection Information: The junction's total performance depends on how the hanger reinforcement is connected to the beam and girder. The connection needs to be built with enough rigidity and strength to adequately transfer the stresses. Depending on the design requirements and the particulars of the project, welding, bolting, or other suitable connection methods may be utilized.

Design Codes and Standards: Hanger reinforcement in a beam-girder junction should be designed following the relevant design codes and standards. These codes offer recommendations for load analysis, material attributes, design approaches, and building techniques. The hanger reinforcement is developed safely and achieves the necessary performance criteria thanks to adherence to the appropriate rules and standards.

Structural study and Verification: To confirm the suitability of the hanger reinforcement design, a thorough structural study is required. Static and dynamic loads, stress concentrations, load distribution, and stability are all elements that should be taken into account throughout the analysis. To evaluate the structural behavior and performance of the hanger reinforcement under various loading circumstances, finite element analysis or other suitable analytical techniques may be used.

Construction and Quality Control: To guarantee that the hanger reinforcement is installed correctly and complies with design specifications, adequate installation and quality control methods should be put in place

throughout the construction phase. To confirm the integrity and effectiveness of the hanger reinforcement, inspections, material testing, and quality assurance processes should be carried out.

When constructing hanger reinforcement in a beam-girder junction, it is essential to seek advice from experienced structural engineers and follow local design guidelines and standards. To guarantee the safety and stability of the structure, the design should be based on a full understanding of the structural requirements, load analysis, and proper design approaches.

Shear in axially loaded members

The internal force that applies perpendicular to the member's longitudinal axis is referred to as shear in axially loaded members. It results from the applied loads and travels through the member's cross-section. In structural analysis and design, shear behavior must be understood since it has an impact on the member's ability to absorb loads and maintain structural integrity. The following are some crucial considerations concerning shear in axially loaded members:

Shear Stress: The intensity of the shear force operating on a specific region of the member's cross-section is known as shear stress. By dividing the shear force by the area that it acts on, it is estimated. Shear stress is commonly represented by the symbol τ and is measured in terms of force per unit area, such as psi or Pa (newtons per square meter).

Shear Flow: The distribution of shear stress across the member's cross-section is referred to as shear flow. It is the result of the thickness of the element across which it acts and shear stress. In open sections like I-beams, where shear forces are transferred via the web and flanges, shear flow is very crucial.

Shear Strength: The ability of a part to successfully withstand shear stresses is referred to as shear strength. The safety and structural integrity of the member must be ensured during the design phase. A member's shear strength is influenced by several variables, including the material's characteristics, the cross-sectional form, and the design presumptions.

Shear Diagram: A shear diagram shows the shear force's variation over a member's length graphically. It aids in the visualization of the shear force distribution and the identification of crucial regions where shear forces are greatest or change significantly. When calculating the design specifications for shear reinforcement, such as shear studs or stirrups, shear diagrams are helpful.

Shear Failure Modes: Axially loaded elements may experience shear failure in one of several modes, such as diagonal tension failure, web buckling, or shear buckling. When shear stress exceeds the material's shear capacity, inclined fissures form in the member and cause diagonal tension collapse. When the web elements are unstable, it can lead to localized deformations or failure, which is referred to as web buckling. Shear buckling is characterized by the buckling of the cross-sectional elements and happens in thin members subjected to strong shear stresses.

Shear Reinforcement: Shear reinforcement may be necessary in some circumstances to increase the shear capacity of axially loaded members. Stirrups or shear studs, which serve to distribute and withstand shear stresses, are examples of shear reinforcement. Aspects like the shear force magnitude, member dimensions, material qualities, and design regulations or standards are taken into account while designing shear reinforcement. Design codes and standards for shear-resistant structures give instructions for the study and design of axially loaded members that are subject to shear forces. To guarantee the structural integrity of the members, these rules establish requirements for minimal shear reinforcement, detailed provisions, and safety features. The American Concrete Institute (ACI) code for concrete structures and the American Institute of Steel Construction (AISC) code for steel structures are examples of common design codes for shear.

Designing structural parts safely and effectively requires an understanding of the shear behavior of axially loaded members. Shear forces must be properly analyzed and taken into account during the design process to guarantee that members can successfully withstand shear loads and prevent shear-related failures. To produce solid and trustworthy designs that take into account shear forces in axially loaded components, structural engineers rely on meticulous calculations, shear diagrams, design rules, and appropriate details.

Axial Tension

The term "axial tension" describes the kind of force that lengthens a member along its longitudinal axis. It takes place when a member is pulled apart by an external force or load that is applied in tension. One of the basic forms

of loading that structural elements might encounter is axial tension, which is a crucial factor to take into account when designing and analyzing structures. The following are some essential ideas about axial tension:

Tensile Force: The presence of a tensile force exerted on the member indicates the presence of axial tension. The member experiences axial deformation as a result of this force's tendency to stretch or elongate the member. Usually, the strength of the tensile force is measured in newtons or pounds of force.

Tensile stress and strain are produced within the member as a result of axial tension. Tensile strain is the length change concerning the initial length of the member, while tensile stress is the intensity of the force per unit area. The elastic modulus of the material, which measures the stiffness of the material, connects these elements.

Material Behaviour: A material's mechanical qualities determine how it responds to axial tension. Steel and other ductile materials have a high tensile strength and can elongate significantly before failing. Concrete and cast iron are examples of brittle materials since they have low tensile strength and little ductility. To ensure that constructions can sustain the applied tensile pressures without failing, it is essential to understand the behavior of the materials before designing them.

Failure Modes: There are several ways that axial tension might fail, including necking, rupture, and uniform elongation. The deformation of the member without any localized narrowing is referred to as uniform elongation. When a specific portion of the member experiences severe localized deformation and narrows, a reduction in the cross-sectional area of the member is known as necking. Rupture occurs when the material completely separates, leading to failure.

Design Factors: When designing structural members subject to axial tension, several factors must be taken into account. The applied loads and structural configurations often have an impact on the maximum tensile force that may be applied to the member, which must be determined by engineers. To make sure that the member can withstand the imposed tensile pressures without experiencing excessive deformation or failure, the cross-sectional dimensions and material qualities are also crucial considerations. To increase the tensile capacity and overall structural integrity, proper reinforcing and detailing are used, such as the use of steel bars in reinforced concrete or high-strength bolts in steel constructions.

Safety considerations and codes: Design standards and codes offer direction for the analysis and planning of structural member's subject to axial tension. To make sure that the structure can safely bear the applied tensile forces, these regulations establish safety factors, design processes, and detailed requirements. These codes include the International Building Code (IBC) for general structural design, the American Concrete Institute (ACI) code for concrete structures, and the American Institute of Steel Construction (AISC) code for steel structures. To maintain the safety and functionality of structures, it is essential to comprehend how axial tension behaves. To make sure that the members can withstand the axial tension without failing, structural engineers analyze the applied loads, compute the resulting tensile forces, choose suitable materials, and establish proper cross-sectional dimensions. Engineers can build strong, dependable structures that can safely sustain the applied tensile stresses by taking into account the laws of axial tension and observing design norms and standards.

Axial Compression

The term "axial compression" describes the kind of force that shortens a member along its longitudinal axis. It takes place when a member is compressed by an external force or load that is pushing the member together. One of the basic forms of loading that structural elements might face is axial compression, which is a crucial factor to take into account when designing and analyzing structures. The following are some essential ideas about axial compression:

Compressive Force: The presence of a compressive force exerted on the member is what distinguishes axial compression. The member experiences axial deformation as a result of this force's tendency to shorten or compress the member. The Compressive force is commonly measured in newtons or pounds, which are units of force. Compressive stress and strain inside the member are produced as a result of axial compression. Compressive strain is the length change concerning the initial length of the member, while compressive stress is the magnitude of the force per unit area. The elastic modulus of the material, which measures the stiffness of the material, connects these elements.

Material Behaviour: A material's mechanical qualities determine how it responds to axial compression. Materials having excellent compressive strength and the ability to endure large compressive forces include concrete, masonry, and several metals, notably steel. However, materials like wood and plastic may only have a little amount of weight-carrying capability in compression because of their lower compressive strength. To

ensure that buildings can sustain the applied compressive stresses without failing, it is essential to understand the behavior of the materials before designing them.

Buckling: In constructions subjected to axial compression, buckling is a frequent form of failure. It happens when an unstable, thin part deforms laterally or to the side. The member's ability to carry its load is reduced by buckling, which increases the risk of structural failure. Buckling effects can be reduced through proper design considerations such as choosing the right cross-sectional forms, offering enough bracing, and guaranteeing enough rigidity.

Engineers must take several things into account when designing structural members that are subject to axial compression. The maximum compressive force that can be applied to the member must be determined. This force is often affected by the applied loads and structural configurations. To make sure that the member can withstand the applied compressive stresses without experiencing excessive deformation or failure, it is crucial to take into account the cross-sectional dimensions, material qualities, and slenderness ratio (the ratio of the member's length to its least radius of gyration). To increase the compressive capacity and overall structural integrity, reinforcement and detailing techniques are used, such as the use of steel reinforcement in concrete columns or bracing components in steel structures.

Safety considerations and codes: Design codes and standards offer recommendations for the evaluation and planning of structural members subjected to axial compression. To make sure that the structure can safely sustain the applied compressive forces, these rules establish safety considerations, design approaches, and detailing requirements. These codes include the International Building Code (IBC) for general structural design, the American Concrete Institute (ACI) code for concrete structures, and the American Institute of Steel Construction (AISC) code for steel structures.

It is essential to comprehend how axial compression behaves while designing structures to guarantee their operation and safety. To make sure that the members can withstand the axial compression without failing, structural engineers analyze the applied loads, compute the resulting compressive forces, choose the proper materials, and establish optimal cross-sectional dimensions. Engineers can develop strong, dependable structures that can securely endure the applied compressive stresses by taking into account the principles of axial compression and adhering to design norms and standards.

III. CONCLUSION

An essential component of structural engineering is the design of hanger reinforcement in the junction of beams and girders. The junction is supported and stabilized by hanger reinforcement, ensuring the secure passage of loads from the beam to the girder. The load analysis, hanger configuration, spacing, and size, material choice, connection details, structural analysis, and construction quality control are important factors to take into account while designing hanger reinforcement. A careful examination of the loads transported from the beam to the girder, taking into account aspects like dead loads, live loads, dynamic loads, and load combinations, serves as the first step in the design process. The geometry of the beam-girder connection and the unique design requirements are used to establish the hanger layout. In order to guarantee the junction's stability and load-carrying capacity, hanger spacing and size are essential. The size of the hangers is chosen based on the anticipated forces and material strength requirements, while the spacing is chosen based on the load distribution and structural studies. Considerations including structural requirements, environmental circumstances, and compatibility with adjacent structural parts should all be taken into account when choosing the hanger reinforcement material. Steel, stainless steel, or other corrosion-resistant materials are frequently utilized as hanger reinforcement.

REFERENCES

- [1] H. Zhang, Y. Zhao, and C. Cheng, "Experimental study on dapped ends for precast concrete double tee," *Jianzhu Jiegou Xuebao/Journal Build. Struct.*, 2018, doi: 10.14006/j.jzjgxb.2018.S2.005.
- [2] E. D. S. K. Er. C. Dinesh Kumar and I.P.G., "Flexural Behaviour of Concrete Beam With Glass Fiber Reinforced Polymer Bars," *Int. Res. J. Eng. Technol.*, 2018.
- [3] Q. M. Shakir, B. B. Abd, and A. T. Jasim, "Experimental and Numerical Investigation of Self Compacting Reinforced Concrete Dapped End Beams Strengthened with CFRP Sheets," *J. Univ. Babylon Eng. Sci.*, 2018, doi: 10.29196/jubes.v26i7.1482.
- [4] A. Sharma, R. Eligehausen, J. Asmus, J. Bujnak, and K. Schmid, "Analytical model for anchorages with supplementary reinforcement under tension or shear forces," in *fib Symposium*, 2018. doi: 10.1007/978-3-319-59471-2_113.
- [5] N. A. Hamid, A. Ibrahim, A. Adnan, and M. H. Ismail, "Behaviour of smart reinforced concrete beam with super

- elastic shape memory alloy subjected to monotonic loading,” in AIP Conference Proceedings, 2018. doi: 10.1063/1.5034565.
- [6] B. S. Mohammed, M. Aswin, M. S. Liew, and N. A. W. A. Zawawi, “Structural Performance of RC and R-ECC Dapped-End Beams Based on the Role of Hanger or Diagonal Reinforcements Combined by ECC,” *Int. J. Concr. Struct. Mater.*, 2019, doi: 10.1186/s40069-019-0356-x.
- [7] S. Yuan, W. Chen, F. Yang, T. He, and G. Liu, “Reinforcement Analysis of Rigid Hangers for Existing Old Arch Bridges: A Case Study of Ling Bridge,” *Int. J. Steel Struct.*, 2019, doi: 10.1007/s13296-019-00242-2.
- [8] G. Klein, H. Gleich, R. Leistikow, and G. Lucier, “Hanger Reinforcement For Corbels,” *PCI J.*, 2019, doi: 10.15554/pcij64.6-03.
- [9] Q. M. Shakir and R. Alliwe, “Behavior of Self-Compacting Reinforced Concrete Dapped End Beams,” *Int. J. Appl. Sci.*, 2019, doi: 10.30560/ijas.v2n1p33.
- [10] A. Morales et al., “Optimization of bridges reinforcement by conversion to tied arch using an animal migration algorithm,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2019. doi: 10.1007/978-3-030-22999-3_70.