KALYANI CHARITABLE TRUST'S

LATE G. N. SAPKAL COLLEGE OF ENGINEERING

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Date: 1st November 2023

A

SITE VISIT REPORT

ON

DESIGN OF STEEL STRUCTURES
(TE-Civil)

Department of Civil Engineering

Late G. N. Sapkal College of Engineering, Nashik.

Acknowledgement

On behalf of the third-year civil engineering students of Late G N Sapkal College of Engineering, Nashik, I would like to express our sincere gratitude to the Central Engineering Workshop, Manmad, for arranging a site visit for our class.

We were particularly grateful for the guidance of Mr. Mayank Sinha Sir (Workshop Manager and Deputy Chief Engineer), Mr. Sharma Sir (Senior Section Engineer), and Mr. Jivan Chaudhari Sir (Junior Section Engineer). They were very knowledgeable and helpful, and they took the time to answer all of our questions.

We also appreciated the opportunity to see the workshop in operation and to learn about the different types of work that are done there. We were particularly interested in the manufacturing of steel structures and the repair and maintenance of railway equipment.

We would like to thank Respected Chairman of Sapkal Knowledge Hub Dr. Ravindra Sapkal Sir for giving us opportunity to do learn new things and providing necessary facilities. We are also thankful to Respected Principal of Late G N Sapkal College of Engineering Nashik Prof. Dr. Sahebrao Bagal Sir for giving us permission for the visit.

We would also like to thank Head of the Department of Civil Engineering Prof. Dr. R. T. Pardeshi and Prof. Kiran Deore for coordinating the site visit.

We believe that the site visit was a valuable learning experience for our students. It gave them a chance to see the construction industry in action and to learn about the different types of work that civil engineers do. We are grateful to the Central Engineering Workshop, Manmad, for providing us with this opportunity.

Venue: Central Engineering Workshop, Manmad-423104

Date: 27th October 2023, Friday at 10:45 AM.

Class: TE

Faculty coordinator: Prof. Kiran Deore

Number of Students: 40

No. of Teachers: 02

Mode of Transportation: Bus

Travelling Distance: 80 km (One Side)

Guided by: Mr. Mayank Sinha Sir (Workshop Manager and Deputy Chief Engineer)
Mr. Sharma Sir (Senior Section Engineer)
Mr. Jivan Chaudhari Sir (Junior Section Engineer)

Figure 1: Central Engineering Workshop Model

Introduction

The Department of Civil Engineering of Late G. N. Sapkal College of Engineering, Nashik organized one day visit to Central Engineering Workshop, Manmad on 27th Oct. 2023 for the third year student of Civil Engineering (BE) program.

The visit was organized with the prior permission and guidance of Respected Principal Prof. Dr. S. B. Bagal and HOD of Civil Department Prof. Dr. R. T. Pardeshi. Along with the staff member Prof. Kiran Deore have taken hard efforts and initiative for the visit.

Objectives of the Steel Industrial Site Visit

1. This course is designed to provide understanding of IS code provisions, fundamentals of structural steel design and its applications for design of various components.
2. Students should be able to understand components of steel structures and its arrangements
3. Student should be able to design beams, columns, column footings, roof trusses, gantry girder and plate girders

Steel structures

Steel structure is a metal structure which is made of structural steel components connect with each other to carry loads and provide full rigidity. Because of the high strength grade of steel, this structure is reliable and requires fewer raw materials than other types of structure like concrete structure and timber structure.

In modern construction, steel structures are used for almost every type of structure including heavy industrial building, high-rise building, equipment support system, infrastructure, bridge, tower, airport terminal, heavy industrial plant, pipe rack, etc.

It is steel construction material which fabricated with a specific shape and chemical composition to suit a project’s applicable specifications.

Depending on each project’s applicable specifications, the steel sections might have various shapes, sizes and gauges made by hot or cold rolling, others are made by welding together flat or bent plates. Common shapes include the I- beam, HSS, Channels, Angles and Plate.

Permission for the Visit

The college wrote a permission letter to The Chief Workshop Manager, Chief Workshop Manager's Office, Central Engineering Workshop to obtained permission.

Kalyani Charitable Trust's

LATE G. N. SAPKAL COLLEGE OF ENGINEERING

(Accredited with Grade 'B' by NAAC)

Affiliated to > Savitribai Phule Pune University (ID. No.PU/NA/Engg./152/2009 Ref No. CA/6501 Dated: 18/11/2009)
Approved by > A.I.C.T.E., New Delhi (F.N. 06/07/MS-Engg/2008/O-17, Dated : 11th June 2009)
> Govt. of Maharashtra (No. GEC-2009/67/09/VT.E. / 4, Dated : 15th June 2009)
> D.T.E., M.S., Mumbai (No.2/NGC/Engg./Approval/2009/535, Dated - 23rd July 2009)
> AISHE CODE : C-42196

Dr. Sahebrao B. Bagal

SAPKAL KNOWLEDGE HUB

Dr. Ravindra G. Sapkal
Chairman & Managing Director
Kalyani Charitable Trust

Ref: KCT's/LGNSCOE/Civil/Visit/2023-24/

Date: Oct. 17, 2023

To,
The Chief Workshop Manager,
Chief Workshop Manager's Office,
Central Engineering Workshop,
Manmad-423104

Subject: Help for academic site visit.

Respected Sir,

We would like to introduce ourselves as an emerging organization in Nashik district. We are affiliated to Savitribai Phule Pune University and we offer five engineering courses viz. Bachelors in Civil Engineering, Computer Engineering, Electronics and Telecommunication, Mechanical Engineering and Electrical Engineering.

Indian Railways has a great contribution to the society. We are grateful that Manmad Railway Junction is always helping our students to arrange visit for them to the workshop. I will be very happy to engage with you to develop academic-department interactions.

As part of this interaction, may I request your permission for a visit?

In the third year of Civil Engineering of Savitribai Phule Pune University, there is a subject Design of Steel Structures. This is a very important subject in Civil Engineering. As per the syllabus of SPPU, industrial site visit is mandatory in the course of this subject. Different steel structures are studied in this subject like welded connection, bolted connection, beam design, column design, base plate design, roof truss design, gantry girder, plate girder etc. For that, your Railway Workshop is the best place to learn everything.

Therefore, we are requesting you to allow us on one of the ***25th, 26th and 27th of October 2023*** for the visit. A total of ***60 students*** will come for the visit and ***3 professors*** will accompany the students to maintain discipline and safety.

We hope that you will give us full cooperation and guide the aspiring and ambitious civil engineering students.

Details of Visit Coordinator:
Prof. K. M. Deore, 7249739924

Thanking You.
Yours Sincerely,

Prof. Dr. R. T. Pardeshi
HoD, Department of Civil Engineering

Prof. Dr. S. B. Bagal
Principal, LGNSCOE, Nashik

Prof.(Dr.) Sahebrao B. Bagal
Principal

Sapkal College of Engineering, Anjaneri, Nashik 422 212

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- **MUMBAI OFFICE** : Sapkal Knowledge Hub, Unit No. 22, 1st Floor, Shubhada Tower Shopping Centre, Sir Pochkhanwala Road, Near R.T.O. Office, Worli, Mumbai - 400 030. Tel.: + 91 - 22 - 24938914 / 15 | **E-mail** : cmd@sapkalknowledgehub.org, ravi.sapkal@gmail.com

Figure 2: Site visit permission letter

Central Engineering Workshop

On 02/11/2023, a batch of third year civil engineering students from Late G. N. Sapkal College of Engineering, Nashik visited the Central Engineering Workshop in Manmad, Maharashtra. The purpose of the visit was to learn about the design and construction of steel structures.

Figure 3: Central Engineering Workshop

Brief history of workshop

Central Engineering Workshop, Central Railway, Manmad is a premier fabrication workshop of Indian Railways. Welded Girders of 12.2m, 18.3m, 24.4m, 30.5m, 45.7m, 61.0m, 76.2m span and many other non-standard steel girders for rail and road bridges are being fabricated by the workshop. Manmad workshop has a programmed capacity of 5000 MT for fabrication of Bridge Girders and history of delivering the girders within desired schedule.

The Workshop is headed by Chief Workshop Manager and is assisted by Assistant Workshop Manager, Assistant Personnel Officer, Workshop Assistant Accounts Officer (in-charge of the Associate Finance Office) and Senior Materials Manager (in-charge of the Stores Depot attached to the workshop).

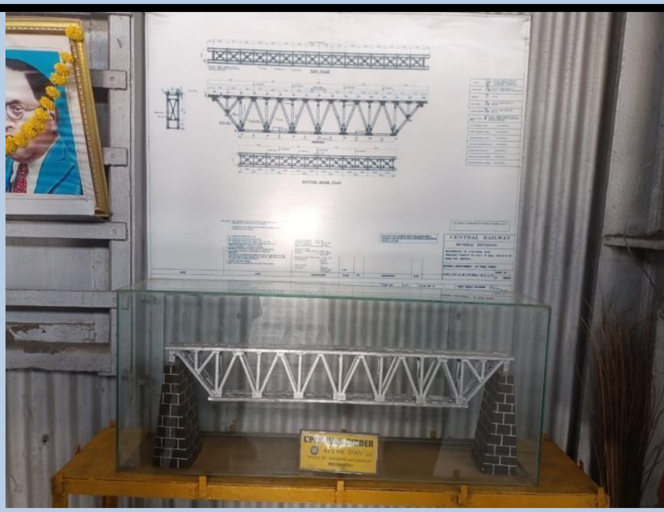
- 1906: Engineering Workshop, Manmad was established in the year 1906 as a small unit for assembly of imported bridge components for the then GIPR and was initially known as Girder Shop.
- 1929: The Workshop started modification and reconditioning of released girders for major bridges. Subsequently, Smithy, Carpentry, Mechanical, Foundry and Bolts-Nuts-Rivets shops were also added to Girder Shop.

- 1939: During Second World War, the Workshop was engaged in production of war materials. After the war, normal activities were resumed in the Workshop.
- 1958: Due to massive re-girdering Programme on Central Railway, a major re-modelling of the Workshop was undertaken. A new Template Shop for fabrication of 76.2 m span Open Web Girders and a Points & Crossing Shop was added.
- 1979 to 1994: The Workshop was functioning in a small shed till 1979. The new covered accommodation was provided during the year 1979 to 1994. The total covered area of the Workshop is now about 21,000 Sq. M.
- 1981-82: the fabrication of welded plate girders of 12.2 m span was started. The Workshop is now engaged in the regular production of welded girders up to 30.5m spans.
- 1989-1994: Modernization of Central Engineering Workshop, Manmad was started in 1989 and completed in 1994 during which the entire handling system of Workshop has been switched over from ordinary rail mounted cranes to electric overhead cranes. Due to modernization, it was possible to manufacture 3/122m through spans (Welded type) for K.R.C.L.
- 2009-10: 12.2 m & 18.3 m 25 T. loading standard and 18.3 m DFC loading standard welded girder fabrication started. Similarly, fabrication of 45.7 m Open web Girder for 25T loading started in 2009-10.

The functions of workshop are divided in two wings:

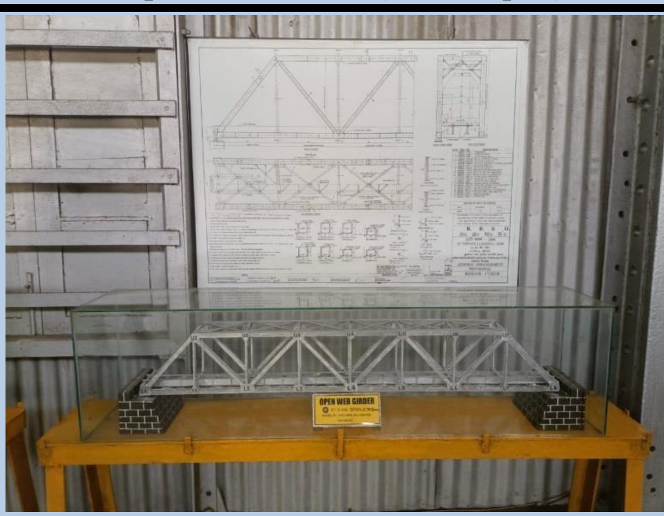
Sr. No.	Section	Description of Works
1	**Structural Yard**	Core activity of fabrication of Girder bridges is carried out. Capacity of girder manufacturing is 395 MTs/month which includes 160 MTs/month of plate girders & remaining OWG(R)/ (W). 1. Open Web Girders 25 T Axle Load (Welded) up to 122.32m spans. 2. Welded Plate Girders 25 T Axle Load up to 30.5 m spans 3. Composite Welded Plate Girder 25 T Axle Load up to 30.5 M Spans 4. Welded Plate Girders 25 T. Axle/ DFC Loading
2	**General Yard**	Supplementary works for self-reliance in Track items, Bridge bearings, EUR etc. are carried out 1. Points & Crossing Shop – SEJs, Built up Crossings, check rails etc. 2. Bolts, Nuts, Rivet Shop (B.N.R.) 3. Blacksmith Shop – Fish Plates, Clamps, brackets, etc. 4. Machine Shop – Bridge Bearings, EUR, etc.

Girder Models

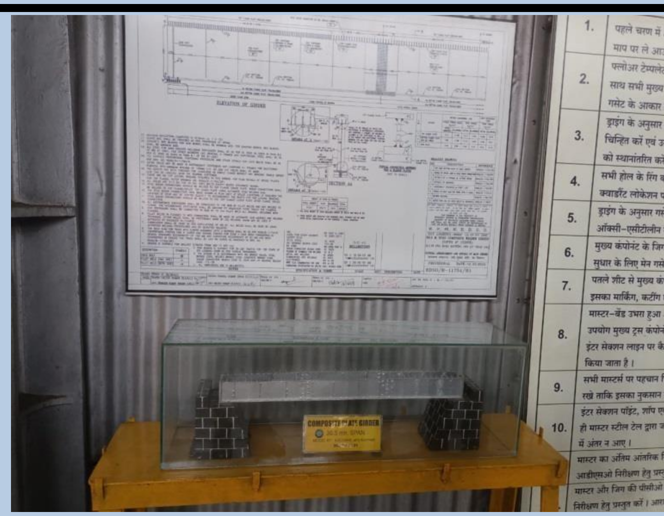


Open Web Girder (43.5 m Span)

Kokan Railway Open Web Girder (122.32 m Span)



Open Web Girder (61 m Span)



Composite Plate Girder (30.5 m Span)

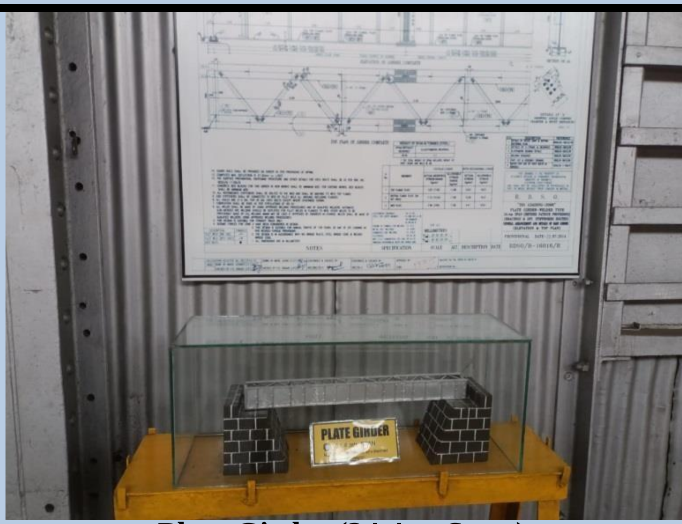
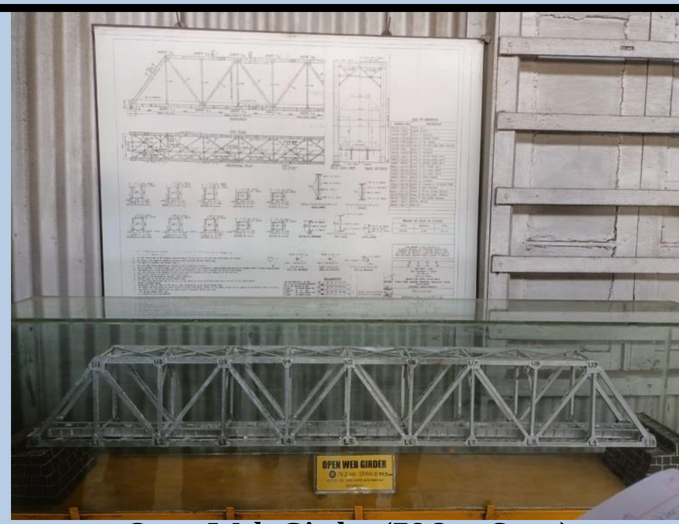


Plate Girder (24.4 m Span)



Open Web Girder (76.2 m Span)

The students were accompanied by their faculty members, Mr. Kiran Deore and Mr. Abhishek Shimpi. Upon arrival at the workshop, the students were welcomed by the workshop manager, who gave them a brief overview of the workshop and its operations.

Figure 4: Workshop engineer gave a brief overview of the workshop and its operations to the students

The students were then taken on a tour of the workshop, where they saw various types of steel structures being fabricated. The students learned about the different types of steel sections used in the fabrication of steel structures, as well as the different types of welding and bolting joints used to connect the steel sections together.

Figure 5: Students saw various types of steel structures being fabricated

The students also learned about the different design considerations that need to be taken into account when designing steel structures. These design considerations include the type of load that the structure will be subjected to, the strength of the steel material, and the stability of the structure.

Specific Steel Structures

The students saw and learned about the following specific steel structures during their visit:

1. **Welded connections:** The students saw how welded connections are made between different steel sections. They also learned about the different types of welding joints used in steel structures, such as butt welds, fillet welds, and lap welds.

   Welded connections are made by melting the edges of two or more steel sections together and allowing them to solidify. This creates a strong and permanent bond between the steel sections.

   There are many different types of welded joints, but the most common types used in steel structures are:

   a) ***Butt welds:*** Butt welds are used to join two pieces of steel that are end-to-end. The edges of the steel are prepared by beveling them at a 45-degree angle. The beveled edges are then melted together and allowed to solidify.

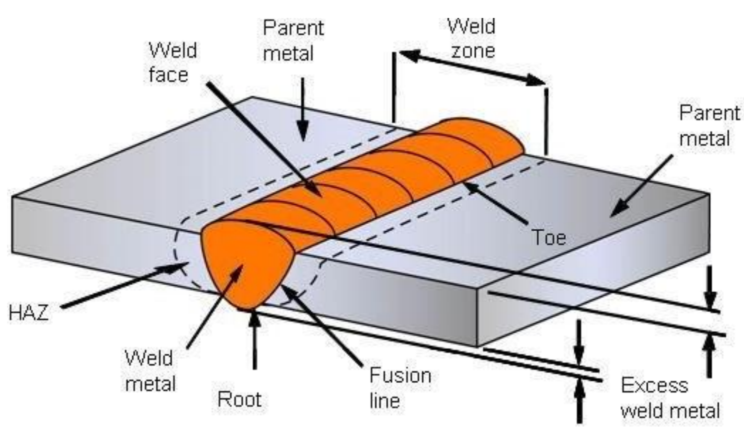


Figure 6: Butt weld

   b) ***Fillet welds:*** Fillet welds are used to join two pieces of steel that are perpendicular to each other. The weld is made in the corner where the two pieces of steel meet.

   The type of welded joint that is used depends on the specific application. For example, butt welds are stronger than fillet welds, so they are often used in applications where high strength is required.

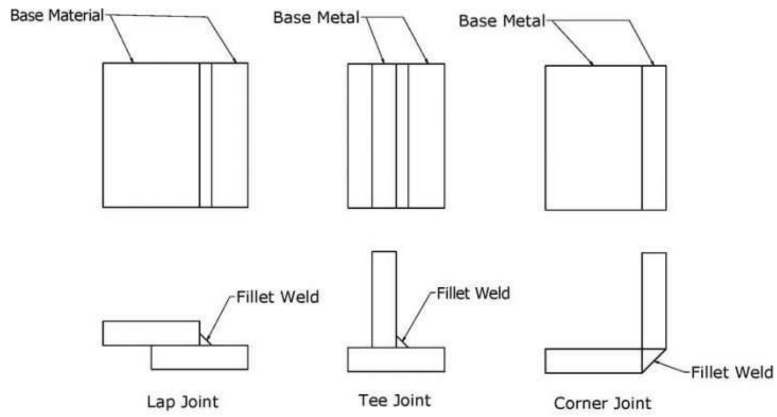


Figure 7: Types of Fillet welds

2. **Bolted connections**: The students saw how bolted connections are made between different steel sections. They also learned about the different types of bolts used in steel structures, such as high-strength bolts and friction grip bolts.

Figure 8: Bolted connections

Bolted connections are a common type of connection used in steel structures. They are made up of two or more steel sections that are connected together using bolts. High-strength bolts and friction grip bolts are two of the most common types of bolts used in steel structures.

High-strength bolts are made from a high-strength material and are heat treated to give them even greater strength. They are used in applications where a high degree of clamping force is required, such as in the connections of steel columns and beams.

Friction grip bolts are designed to create a high clamping force between the steel sections being connected. This is done by using a special type of washer that is placed under the bolt head. When the bolt is tightened, the washer creates friction between the bolt head and the steel section, which clamps the two sections together. Friction grip bolts are often used in applications where the steel sections are subject to vibration or fatigue, such as in bridges and other structures that are subjected to heavy traffic.

Here is a summary of the benefits of using high-strength bolts and friction grip bolts in steel structures:

a) High-strength bolts:

i. High clamping force
ii. High strength
iii. Durable
iv. Easy to install and inspect

b) Friction grip bolts:

i. High clamping force
ii. Low installation torque
iii. Resistant to vibration and fatigue
iv. Easy to inspect

Overall, bolted connections are a versatile and reliable way to connect steel sections together. High-strength bolts and friction grip bolts are two of the most common types of bolts used in steel structures, and they offer a number of benefits, including high clamping force, durability, and ease of installation and inspection.

Figure 9: Students were learnt welded and bolted connections

3. **Beam design:** The students learned about the different types of beams used in steel structures, such as I-beams, H-beams, and channel beams. They also learned about the design considerations for steel beams, such as the type of load, the span of the beam, and the deflection of the beam.

Types of beams used in steel structures

The most common types of beams used in steel structures are:

a) ***I-beams:*** I-beams have a cross-section that resembles the letter "I". They are the most common type of beam used in steel structures because they are very efficient at resisting bending moments.

Figure 10: Rolled-I beam sections

b) ***H-beams:*** H-beams have a cross-section that resembles the letter "H". They are similar to I-beams, but they have a wider flange, which gives them additional strength.

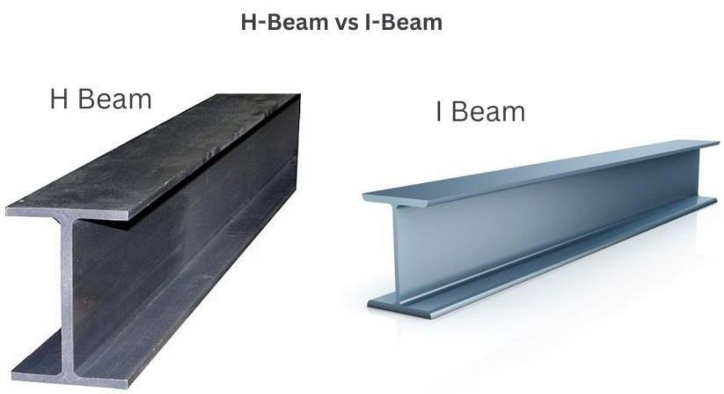


Figure 11: Difference between I and H section

c) ***Channel beams:*** Channel beams have a C-shaped cross-section. They are not as strong as I-beams or H-beams, but they are often used in applications where space is limited.

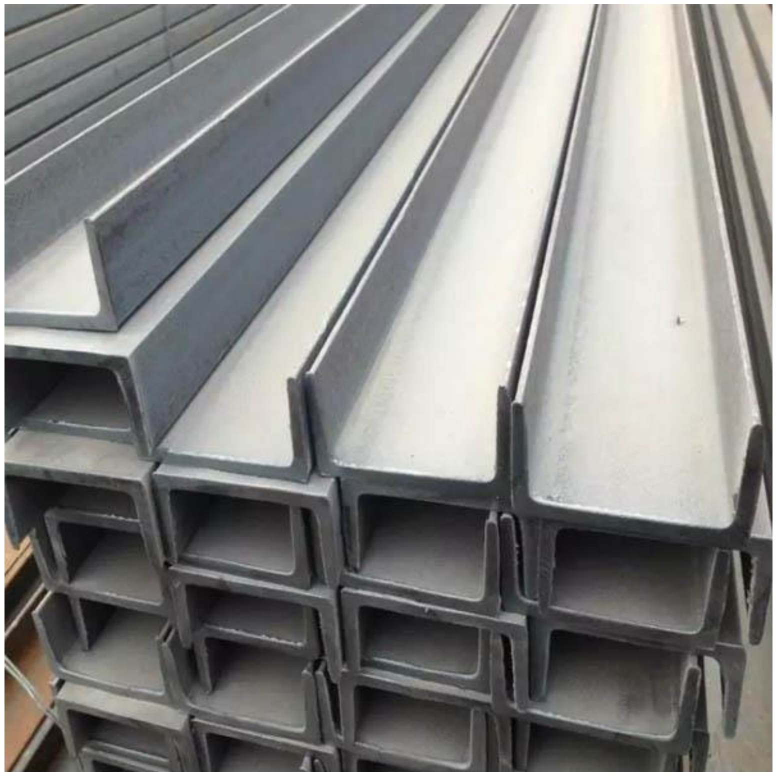


Figure 12: Rolled-C beam sections

Design considerations for steel beams

When designing a steel beam, the following factors must be considered:

i. ***Type of load:*** The type of load that the beam will be carrying will determine the required strength of the beam. Common types of loads include dead loads (the weight of the beam and the other structural elements it supports), live loads (the weight of people, furniture, and other objects placed on the beam), and snow loads.
ii. ***Span of the beam:*** The span of the beam is the distance between the two supports. The longer the span, the stronger the beam must be.
iii. ***Deflection of the beam:*** Deflection is the amount that the beam will bend under load. The deflection of the beam must be limited to prevent damage to the beam and the other structural elements it supports.

In addition to the above factors, the following design considerations must also be taken into account:

i. ***Material properties:*** The type of steel used in the beam will affect its strength, ductility, and resistance to corrosion and fire.
ii. ***Fabrication methods:*** The methods used to fabricate the beam, such as welding and cutting, can affect its strength and fatigue resistance.

iii. ***Connection details:*** The way in which the beam is connected to other structural elements can also affect its strength and performance.

Figure 13: Students were learnt the beam design

4. **Column design:** The students learned about the different types of columns used in steel structures, such as wide flange columns, tubular columns, and built-up columns. They also learned about the design considerations for steel columns, such as the type of load, the height of the column, and the buckling of the column.

Figure 14: Built-up columns

Types of columns used in steel structures

The most common types of columns used in steel structures are:

a) ***Wide flange columns:*** Wide flange columns are made from a single piece of rolled steel. They are the most common type of column used in steel structures because they are very efficient at resisting axial loads.
b) ***Tubular columns:*** Tubular columns are made from a hollow steel tube. They are stronger than wide flange columns of the same cross-sectional area, but they are also more expensive.
c) ***Built-up columns:*** Built-up columns are made from two or more steel sections that are welded together. They are often used in applications where a very strong column is required, such as in high-rise buildings.

Design considerations for steel columns

When designing a steel column, the following factors must be considered:

i. ***Type of load:*** The type of load that the column will be carrying will determine the required strength of the column. Common types of loads include axial loads (the weight of the column and the other structural elements it supports), bending moments, and shear forces.
ii. ***Height of the column:*** The height of the column is a critical factor in its design. As the height of the column increases, its tendency to buckle increases. Therefore, taller columns must be stronger than shorter columns.
iii. ***Buckling of the column:*** Buckling is the failure of a column due to lateral instability. Buckling can be caused by axial loads, bending moments, or shear forces. To prevent buckling, the column must be designed to have a sufficient slenderness ratio. The slenderness ratio is a measure of the column's flexibility.

In addition to the above factors, the following design considerations must also be taken into account:

i. ***Material properties:*** The type of steel used in the column will affect its strength, ductility, and resistance to corrosion and fire.
ii. ***Fabrication methods:*** The methods used to fabricate the column, such as welding and cutting, can affect its strength and fatigue resistance.
iii. ***Connection details:*** The way in which the column is connected to other structural elements can also affect its strength and performance.

5. **Base plate design:** The students learned about the different types of base plates used in steel structures. They also learned about the design considerations for steel base plates, such as the type of load, the strength of the concrete foundation, and the anchorage of the base plate to the concrete foundation.

Figure 15: Base Plate

Types of base plates used in steel structures

The most common type of base plate used in steel structures is a rectangular plate. However, triangular and circular base plates are also used in some applications. The type of base plate used will depend on the configuration of the column and the loads that the base plate must support.

Design considerations for steel base plates

When designing a steel base plate, the following factors must be considered:

i. ***Type of load:*** The type of load that the base plate will be carrying will determine the required strength of the base plate and the type of anchorage that is required. Common types of loads include axial loads, bending moments, and shear forces.
ii. ***Strength of the concrete foundation:*** The base plate must be designed so that the bearing pressure on the concrete foundation does not exceed the allowable bearing pressure of the concrete.
iii. ***Anchorage of the base plate to the concrete foundation***: The base plate must be anchored to the concrete foundation using anchor bolts or other types of anchorage. The anchorage system must be designed to resist the uplift and shear forces that the base plate will be subjected to.

In addition to the above factors, the following design considerations must also be taken into account:

i. ***Material properties:*** The type of steel used in the base plate will affect its strength, ductility, and resistance to corrosion and fire.
ii. ***Fabrication methods:*** The methods used to fabricate the base plate, such as welding and cutting, can affect its strength and fatigue resistance.
iii. ***Connection details:*** The way in which the base plate is connected to the column and the concrete foundation can also affect its strength and performance.

Here are some additional design considerations for steel base plates:

i. ***Thickness of the base plate:*** The thickness of the base plate must be sufficient to resist the bearing pressure on the concrete foundation and the bending moments and shear forces that the base plate will be subjected to.
ii. ***Size of the base plate:*** The size of the base plate must be sufficient to distribute the load from the column to the concrete foundation over a large enough area to prevent the bearing pressure from exceeding the allowable bearing pressure of the concrete.
iii. ***Location of the anchor bolts:*** The anchor bolts must be located so that they provide adequate resistance to the uplift and shear forces that the base plate will be subjected to.
iv. ***Welding of the base plate:*** The base plate must be welded to the column in a way that ensures a strong and durable connection.

6. **Roof truss design:** The students learned about the different types of roof trusses used in steel structures. They also learned about the design considerations for steel roof trusses, such as the type of load, the span of the truss, and the deflection of the truss.

Types of roof trusses used in steel structures

The most common types of roof trusses used in steel structures are:

a) ***Truss with parallel chords:*** This is the simplest type of truss, with two parallel chords (top and bottom) and a series of diagonal members connecting the two chords.
b) ***Truss with inclined chords:*** This type of truss has inclined top and bottom chords, which gives it greater strength and stiffness.
c) ***Truss with multiple chords:*** This type of truss has more than two chords, which makes it stronger and stiffer than trusses with two chords

The type of roof truss used will depend on the span of the truss, the loads that it must support, and the desired aesthetic appearance.

Figure 16: The students learned about the different types of roof trusses, different components and its design.

Design considerations for steel roof trusses

When designing a steel roof truss, the following factors must be considered:

i. ***Type of load:*** The type of load that the truss will be carrying will determine the required strength of the truss. Common types of loads include dead loads (the weight of the truss and the other structural elements it supports), live loads (the weight of people, furniture, and other objects placed on the truss), and snow loads.
ii. ***Span of the truss:*** The span of the truss is the distance between the two supports. The longer the span, the stronger the truss must be.
iii. ***Deflection of the truss:*** Deflection is the amount that the truss will bend under load. The deflection of the truss must be limited to prevent damage to the truss and the other structural elements it supports.

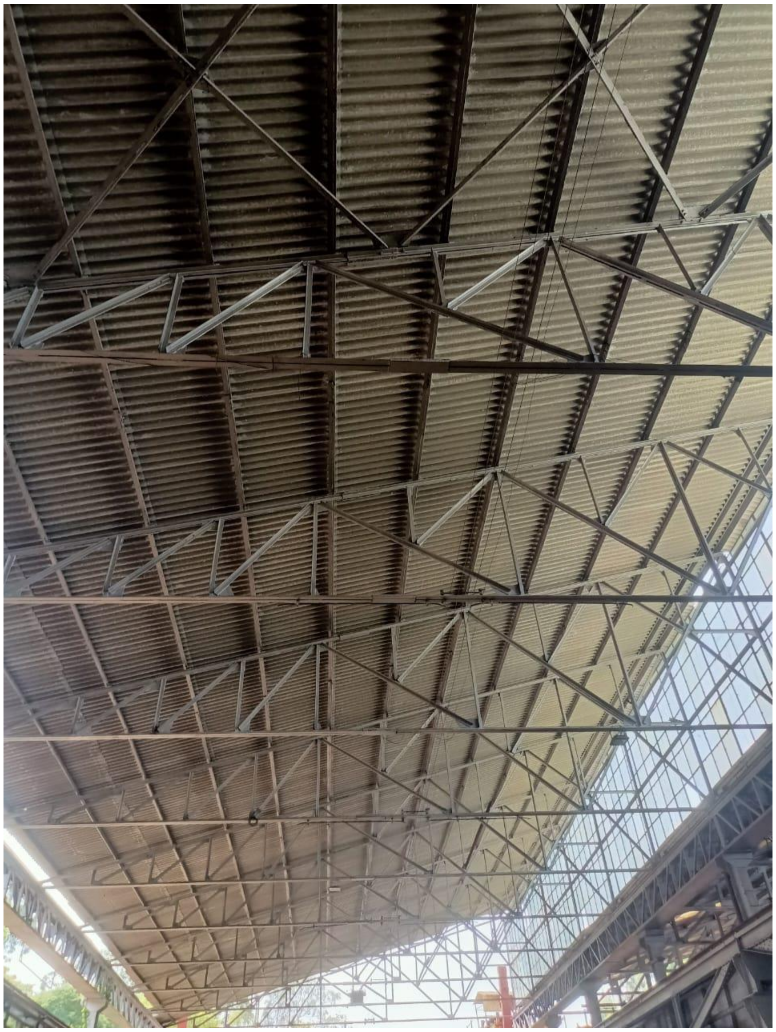


Figure 17: Components of roof truss

In addition to the above factors, the following design considerations must also be taken into account:

i. ***Material properties:*** The type of steel used in the truss will affect its strength, ductility, and resistance to corrosion and fire.
ii. ***Fabrication methods:*** The methods used to fabricate the truss, such as welding and cutting, can affect its strength and fatigue resistance.
iii. ***Connection details:*** The way in which the truss members are connected together can also affect its strength and performance.

Here are some additional design considerations for steel roof trusses:

i. ***Wind loads:*** Roof trusses must be designed to resist wind loads. The engineer must calculate the wind loads that the truss will be subjected to and design the truss to have sufficient strength and stiffness to resist these loads.

ii. ***Snow loads:*** Roof trusses must also be designed to resist snow loads. The snow loads that the truss will be subjected to will depend on the geographic location of the structure. The engineer must use a snow load map to determine the snow load that the truss must be designed to resist.

iii. ***Camber:*** Roof trusses are often designed with a slight camber, which is an upward curvature of the top chord. This camber helps to offset the deflection of the truss under load.

7. **Gantry girder:** The students saw and learned about gantry girders, which are used to support cranes and other lifting equipment. They learned about the different types of gantry girders, as well as the design considerations for gantry girders, such as the type of load, the span of the girder, and the deflection of the girder.

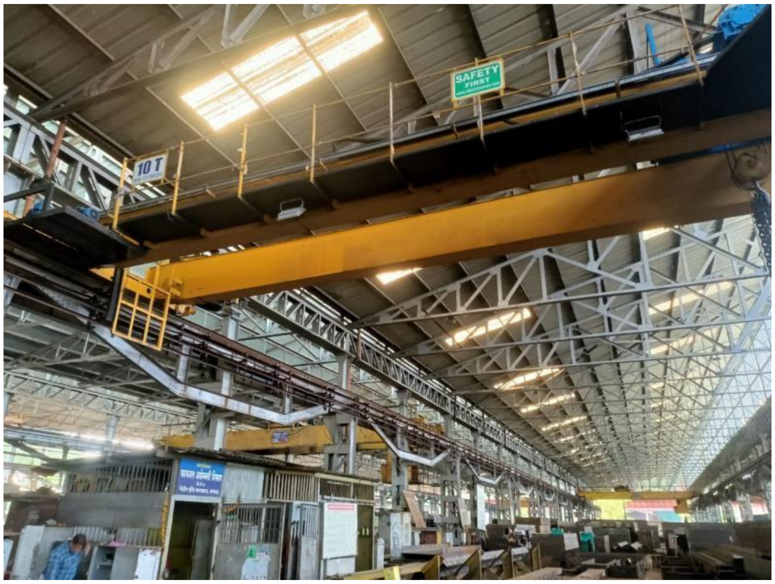


Figure 18: Gantry Girder

Gantry girders are a type of steel beam that is used to support cranes and other lifting equipment. They are typically made from a wide-flange steel section, and they can be either single-span or multi-span. Gantry girders are typically supported by two or more legs, which are also made from steel.

Types of gantry girders

There are two main types of gantry girders:

a) ***Single-span gantry girders:*** Single-span gantry girders are supported by two legs at each end. They are the most common type of gantry girder, and they are typically used for smaller cranes and lifting equipment.

b) ***Multi-span gantry girders:*** Multi-span gantry girders are supported by three or more legs. They are typically used for larger cranes and lifting equipment, and they can also be used to support bridges and other structures.

Design considerations for gantry girders

When designing a gantry girder, the following factors must be considered:

i. ***Type of load:*** The type of load that the girder will be carrying will determine the required strength of the girder. Common types of loads include dead loads (the weight of the girder and the other structural elements it supports), live loads (the weight of the crane and the lifting equipment), and dynamic loads (the forces generated by the crane's movements).
ii. ***Span of the girder:*** The span of the girder is the distance between the two supports. The longer the span, the stronger the girder must be.
iii. ***Deflection of the girder:*** Deflection is the amount that the girder will bend under load. The deflection of the girder must be limited to prevent damage to the girder and the other structural elements it supports.

In addition to the above factors, the following design considerations must also be taken into account:

i. ***Material properties:*** The type of steel used in the girder will affect its strength, ductility, and resistance to corrosion and fire.
ii. ***Fabrication methods:*** The methods used to fabricate the girder, such as welding and cutting, can affect its strength and fatigue resistance.
iii. ***Connection details:*** The way in which the girder is connected to the legs and other structural elements can also affect its strength and performance.

Here are some additional design considerations for gantry girders:

i. ***Fatigue resistance:*** Gantry girders are often subjected to cyclic loading from the crane's movements. Therefore, they must be designed to have sufficient fatigue resistance.
ii. ***Corrosion resistance:*** Gantry girders are often exposed to the elements, so they must be designed to have sufficient corrosion resistance.
iii. ***Fire resistance:*** Gantry girders may be exposed to fire in some applications, so they may need to be designed to have sufficient fire resistance.

8. **Plate girder:** The students saw and learned about plate girders, which are used to support heavy loads over long spans. They learned about the different types of plate girders, as well as the design considerations for plate girders, such as the type of load, the span of the girder, and the deflection of the girder.

Plate girders are a type of steel beam that is used to support heavy loads over long spans. They are typically made from a web plate and two flange plates, which are welded together to form a box-shaped cross-section. Plate girders can be either simple-span or continuous-span, and they can be supported by two or more supports.

Figure 19: Plate Girder

Types of plate girders

There are two main types of plate girders:

a) ***Web-stiffened girders:*** Web-stiffened girders have stiffeners welded to the web plate to increase its stability. Stiffeners are typically used in girders with deep webs.
b) ***Corrugated web girders:*** Corrugated web girders have a corrugated web plate, which increases its stiffness without the need for stiffeners. Corrugated web girders are typically used in girders with shallow webs.

Design considerations for plate girders

When designing a plate girder, the following factors must be considered:

i. ***Type of load:*** The type of load that the girder will be carrying will determine the required strength of the girder. Common types of loads include dead loads (the weight of the girder and the other structural elements it supports), live loads (the weight of people, furniture, and other objects placed on the girder), and dynamic loads (the forces generated by moving vehicles or equipment).
ii. ***Span of the girder:*** The span of the girder is the distance between the two supports. The longer the span, the stronger the girder must be.
iii. ***Deflection of the girder:*** Deflection is the amount that the girder will bend under load. The deflection of the girder must be limited to prevent damage to the girder and the other structural elements it supports.

In addition to the above factors, the following design considerations must also be taken into account:

i. ***Material properties:*** The type of steel used in the girder will affect its strength, ductility, and resistance to corrosion and fire.

ii. ***Fabrication methods:*** The methods used to fabricate the girder, such as welding and cutting, can affect its strength and fatigue resistance.
iii. ***Connection details:*** The way in which the girder is connected to the supports and other structural elements can also affect its strength and performance.

Additional design considerations for plate girders

i. ***Fatigue resistance:*** Plate girders are often subjected to cyclic loading from moving vehicles or equipment. Therefore, they must be designed to have sufficient fatigue resistance.
ii. ***Corrosion resistance:*** Plate girders may be exposed to the elements, so they must be designed to have sufficient corrosion resistance.
iii. ***Fire resistance:*** Plate girders may be exposed to fire in some applications, so they may need to be designed to have sufficient fire resistance.

9. Stud Shear Connector

Stud shear connectors are the most common type of shear connector used in steel composite construction. They are typically made from a steel stud that is welded to the top flange of a steel beam. A concrete slab is then poured over the steel beam, and the stud shear connectors embed themselves in the concrete.

Figure 20: Stud shear connectors

Stud shear connectors transfer shear forces between the steel beam and the concrete slab. This allows the steel beam and the concrete slab to act together as a composite beam, which has a greater stiffness and strength than either the steel beam or the concrete slab alone.

Stud shear connectors are typically used in bridges, buildings, and other structures where high shear forces are expected. They are also used in retrofit projects to strengthen existing steel structures.

Here are some of the advantages of using stud shear connectors:

i. They are easy to install.

ii. They are relatively inexpensive.
iii. They provide a strong and reliable connection between the steel beam and the concrete slab.
iv. They are durable and resistant to corrosion and fire.
v. Shear connector design

The design of shear connectors is a complex process that must be carried out by a qualified engineer. The engineer must consider the following factors when designing shear connectors:

i. The type of load that the shear connectors will be carrying.
ii. The strength of the steel beam and the concrete slab.
iii. The spacing of the shear connectors.
iv. The edge distance of the shear connectors.
v. The welding requirements for the shear connectors.

Conclusion

The industrial site visit to the Central Engineering Workshop in Manmad was a valuable experience for the students. They learned about the design and construction of various types of steel structures, as well as the different types of welding and bolting joints used to connect the steel sections together.

The students also learned about the different design considerations that need to be taken into account when designing steel structures. These design considerations include the type of load that the structure will be subjected to, the strength of the steel material, and the stability of the structure.

The students are grateful to the workshop manager and his staff for their hospitality and for sharing their knowledge with them. The students are also grateful to their faculty members, Mr. Kiran Deore and Mr. Abhishek Shimpi, for organizing the visit.

What students learnt?

On successful completion of the visit, the students will be able to:

1. Demonstrate knowledge about the types of steel structures, steel code provisions and design of the adequate steel section subjected to tensile force.
2. Determine the adequate steel section subjected to compression load and design of built up columns along with lacing and battening.
3. Design eccentrically loaded column for section strength and column bases for axial load and uniaxial bending.
4. Design of laterally restrained and unrestrained beam with and without flange plate using rolled steel section.
5. Analyze the industrial truss for dead, live and wind load and design of gantry girder for moving load.
6. Understand the role of components of welded plate girder and design cross section for welded plate girder including stiffeners and its connections.

Figure 21: Group photo of students with workshop engineer