FOSSEE Summer Internship Report

On

Osdag Module Development

Submitted by

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Chapter 1

Introduction

1.1 National Mission in Education through ICT

The National Mission on Education through ICT (NMEICT) is a scheme under the Department of Higher Education, Ministry of Education, Government of India. It aims to leverage the potential of ICT to enhance teaching and learning in Higher Education Institutions in an anytime-anywhere mode.

The mission aligns with the three cardinal principles of the Education Policy—**access, equity, and quality**—by:

- Providing connectivity and affordable access devices for learners and institutions.
- Generating high-quality e-content free of cost.

NMEICT seeks to bridge the digital divide by empowering learners and teachers in urban and rural areas, fostering inclusivity in the knowledge economy. Key focus areas include:

- Development of e-learning pedagogies and virtual laboratories.
- Online testing, certification, and mentorship through accessible platforms like EduSAT and DTH.
- Training and empowering teachers to adopt ICT-based teaching methods.

For further details, visit the official website: www.nmeict.ac.in.

1.1.1 ICT Initiatives of MoE

The Ministry of Education (MoE) has launched several ICT initiatives aimed at students, researchers, and institutions. The table below summarizes the key details:

No.	Resource	For Students/Researchers	For Institutions
		Audio-Video e-content	
1	SWAYAM	Earn credit via online courses	Develop and host courses; accept credits
2	SWAYAMPRABHA	Access 24x7 TV programs	Enable SWAYAMPRABHA viewing facilities
		Digital Content Access	
3	National Digital Library	Access e-content in multiple disciplines	List e-content; form NDL Clubs
4	e-PG Pathshala	Access free books and e-content	Host e-books
5	Shodhganga	Access Indian research theses	List institutional theses
6	e-ShodhSindhu	Access full-text e-resources	Access e-resources for institutions
		Hands-on Learning	
7	e-Yantra	Hands-on embedded systems training	Create e-Yantra labs with IIT Bombay
8	FOSSEE	Volunteer for open-source software	Run labs with open-source software
9	Spoken Tutorial	Learn IT skills via tutorials	Provide self-learning IT content
10	Virtual Labs	Perform online experiments	Develop curriculum-based experiments
		E-Governance	
11	SAMARTH ERP	Manage student lifecycle digitally	Enable institutional e-governance
		Tracking and Research Tools	
12	VIDWAN	Register and access experts	Monitor faculty research outcomes
13	Shodh Shuddhi	Ensure plagiarism-free work	Improve research quality and reputation
14	Academic Bank of Credits	Store and transfer credits	Facilitate credit redemption

Table 1.1: Summary of ICT Initiatives by the Ministry of Education

1.2 FOSSEE Project

The FOSSEE (Free/Libre and Open Source Software for Education) project promotes the use of FLOSS tools in academia and research. It is part of the National Mission on Education through Information and Communication Technology (NMEICT), Ministry of Education (MoE), Government of India.

1.2.1 Projects and Activities

The FOSSEE Project supports the use of various FLOSS tools to enhance education and research. Key activities include:

- **Textbook Companion**: Porting solved examples from textbooks using FLOSS.
- **Lab Migration**: Facilitating the migration of proprietary labs to FLOSS alternatives.
- **Niche Software Activities**: Specialized activities to promote niche software tools.
- **Forums**: Providing a collaborative space for users.
- **Workshops and Conferences**: Organizing events to train and inform users.

1.2.2 Fellowships

FOSSEE offers various internship and fellowship opportunities for students:

- Winter Internship
- Summer Fellowship
- Semester-Long Internship

Students from any degree and academic stage can apply for these internships. Selection is based on the completion of screening tasks involving programming, scientific computing, or data collection that benefit the FLOSS community. These tasks are designed to be completed within a week.

For more details, visit the official FOSSEE website.

Figure 1.1: FOSSEE Projects and Activities

1.3 Osdag Software

Osdag (Open steel design and graphics) is a cross-platform, free/libre and open-source software designed for the detailing and design of steel structures based on the Indian Standard IS 800:2007. It allows users to design steel connections, members, and systems through an interactive graphical user interface (GUI) and provides 3D visualizations of designed components. The software enables easy export of CAD models to drafting tools for construction/fabrication drawings, with optimized designs following industry best practices [?, ?, ?]. Built on Python and several Python-based FLOSS tools (e.g., PyQt and PythonOCC), Osdag is licensed under the GNU Lesser General Public License (LGPL) Version 3.

1.3.1 Osdag GUI

The Osdag GUI is designed to be user-friendly and interactive. It consists of

- **Input Dock**: Collects and validates user inputs.
- **Output Dock**: Displays design results after validation.
- **CAD Window**: Displays the 3D CAD model, where users can pan, zoom, and rotate the design.
- **Message Log**: Shows errors, warnings, and suggestions based on design checks.

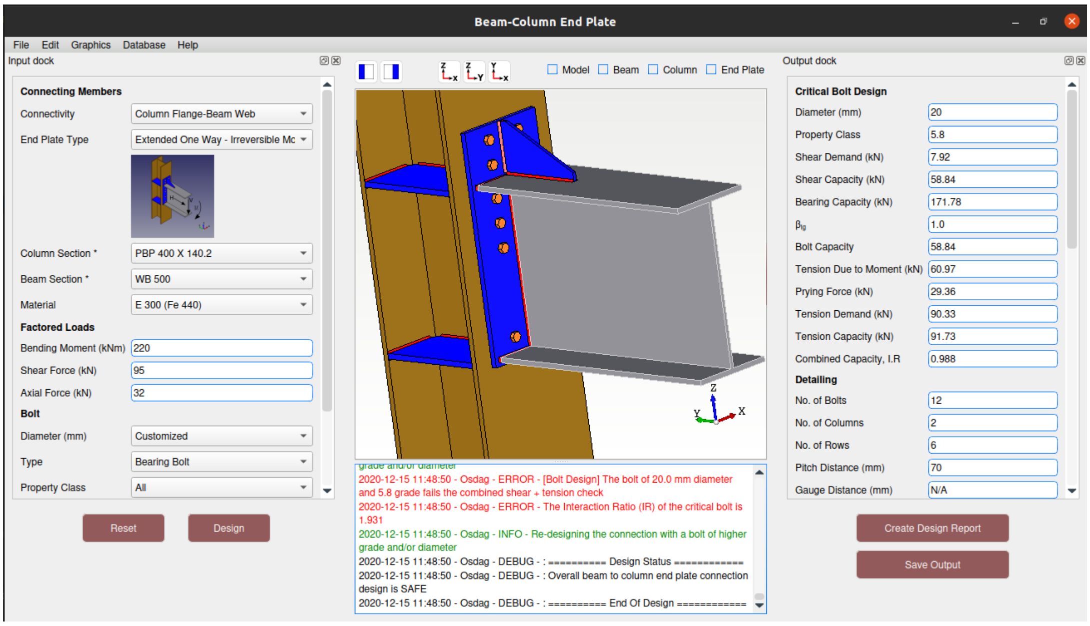


Figure 1.2: Osdag GUI

1.3.2 Features

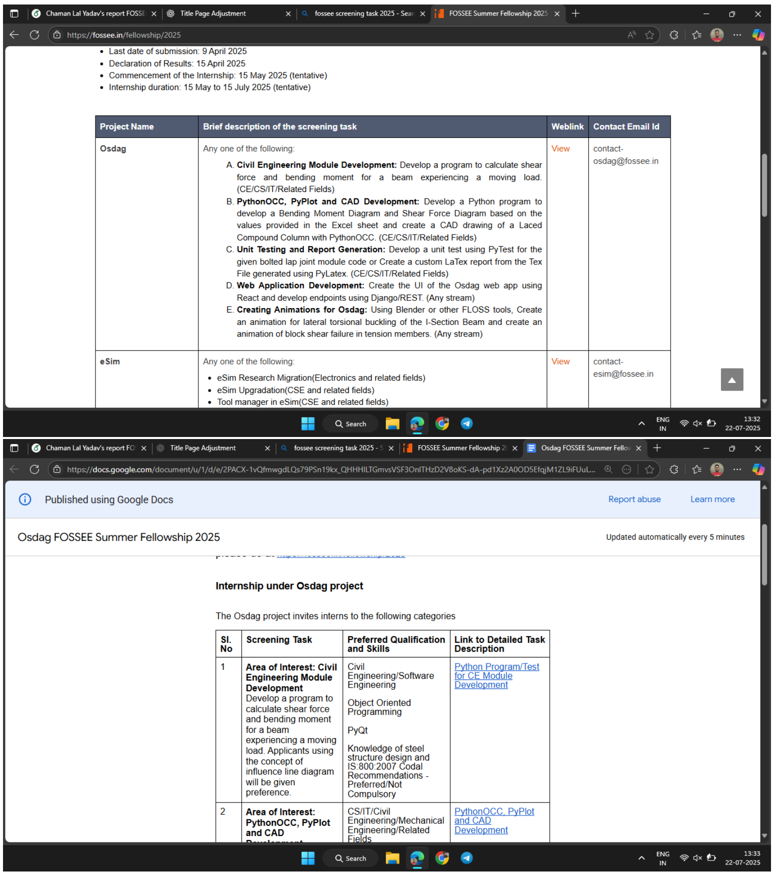
- **CAD Model**: The 3D CAD model is color-coded and can be saved in multiple formats such as IGS, STL, and STEP.
- **Design Preferences**: Customizes the design process, with advanced users able to set preferences for bolts, welds, and detailing.
- **Design Report**: Creates a detailed report in PDF format, summarizing all checks, calculations, and design details, including any discrepancies.

For more details, visit the official Osdag website.

Chapter 2

Screening Task

2.1 Problem Statement



2.2 Tasks Done

Chapter 3

Internship Task 2- Bridge Analysis

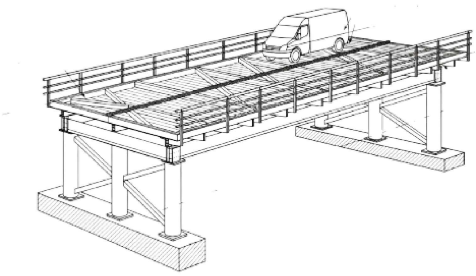
3.1 Task 2: Bridge Analysis DDCL

Create a fresh DDCL for Bridge Analysis module from scratch taking reference from Indian Standards, and mention all necessary parameters.

3.2 Task 2: Tasks Done

Design and detailing checklist (DDCL)

Bridge Analysis



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August 7, 2025

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1. Parameters of Bridge Modelling

1.1 Features of the Module

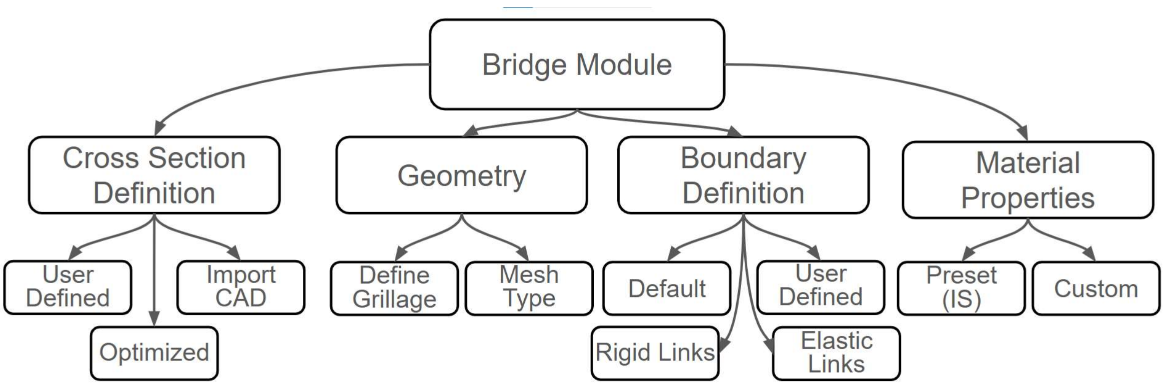

Figure 1.1: Features of the Module

The above chart shows the overview of tasks to be carried out by the module. Every step is addressed in detain in the following sub-sections

1.1.1 Cross Section Definition

1.1.1.1 User Defined

The user can provide properties of cross section for every member by providing the following inputs:

Table 1.1: Section Properties Description

Symbol	Value Type	Description
A	float	Cross sectional area
Iz	float	Moment of inertia about local z axis
Iy	float	Moment of inertia about local y axis
J	float	Torsional inertia – about local x axis
Az	float	Cross sectional area in the local z direction
Ay	float	Cross sectional area in the local y direction

1.1.1.2 Import CAD

The user is allowed to import CAD files of Cross section of various members from well established commercial CAD softwares

1.1.1.3 Optimized

The output of the Particle Swarm Optimisation module will be taken as input for cross section parameters for analysis of an optimum section.

1.1.2 Material Properties

1.1.2.1 Preset (IS)

Select among provided steel grades from IS 2062 *(Material Standard)*.

1.1.2.2 Custom

The user may define the following properties to model the grillage with other materials.

Table 1.2: Inputs for Defining Custom Material Properties

Property	**Value Type**	**Description**
Young's Modulus (E)	float (MPa)	Modulus of elasticity; measures stiffness of material
Shear Modulus (G)	float (MPa)	Modulus of rigidity; relates shear stress and strain (Optional)
Poisson's Ratio (μ)	float (unitless)	Ratio of transverse strain to axial strain
Density (ρ)	float (kg/m^3)	Mass per unit volume of the material (Optional)

1.1.3 Geometry

1.1.3.1 Define Grillage

ext_to_int_dist:

Table 1.3: Inputs for Defining Grillage

Symbol	Value Type	Description
L	float (m)	Length of bridge
w	float (m)	Width of bridge
n_L	int	Number of longitudinal members
n_T	int	Number of transverse members
ext_to_int_dist	float (m)	Distance from exterior to interior longitudinal member
OR	—	—
beam_z_spacing	float (m)	Spacing of members in global Z direction
beam_x_spacing	float (m)	Spacing of members in global X direction
OR	—	—
Multi_span_dist_list	list of float (m)	List specifying lengths of different meshing zones (for multi-span bridges)

Parameter	Type	Description
`ext_to_int_dist`	int, float, or list of int/float	Distance between internal beams and exterior main beams. If a list is provided (usually of size 2), the values are applied to the left and right sides respectively.

Table 1.4: Beam spacing and edge distance parameter

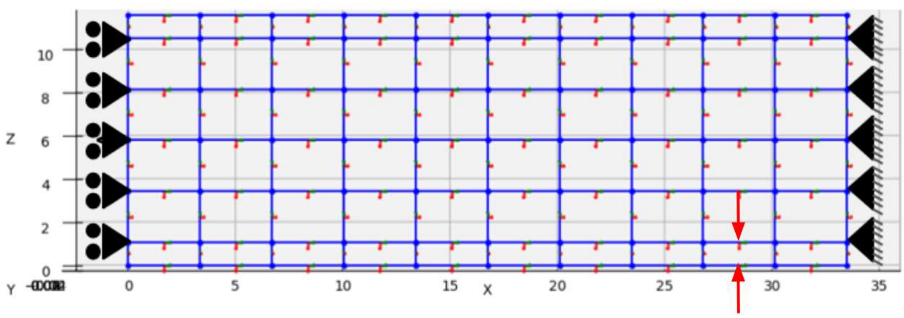

Figure 1.2: Exterior member to interior member distance

beam_z_spacing, beam_x_spacing:

Parameter	Type	Description
beam_z_spacing	list of int or float	Custom distances of longitudinal members (global z-direction). This parameter supersedes num_long_grid.
beam_x_spacing	list of int or float	Custom distances of transverse members (global x-direction). This parameter supersedes num_trans_grid.

Table 1.5: Custom beam spacing parameters

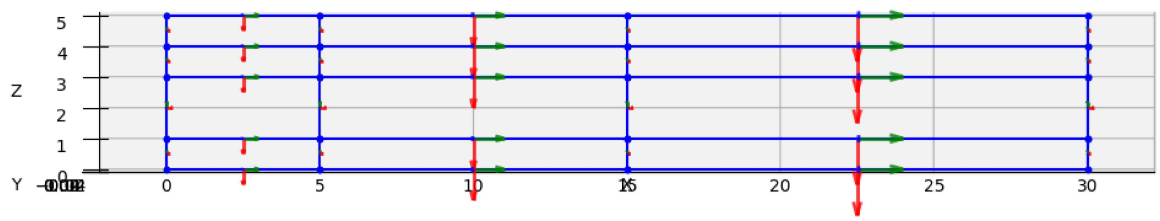

Figure 1.3: Custom beam spacing in both x and z directions

Code example to use the same:

```
# Create grillage model
model = og.create_grillage(
bridge_name = "My_Bridge",
long_dim = 30.0 * m,
width = 10.0 * m,
skew = [0.0,0.0],
num_long_grid = 5, # Number of grid lines
num_trans_grid = 10,
ext_to_int_dist = 2.5 * m,
edge_beam_dist = 0.5 * m,
mesh_type = "Oblique", # ('Ortho' or 'Oblique')
# Use "Oblique" if both x and z custom spacings need to be used.
For only z customization, "Ortho" can be used.
beam_z_spacing = [1,2,1,1],
beam_x_spacing = [5,10,15]
)
```

Multi_span_dist_list

Parameter	Type	Description
multi_span_dist_list	list of int or float	List of distances in the global x-direction corresponding to the span lengths of each multi-span segment.

Table 1.6: Multi-span distance configuration

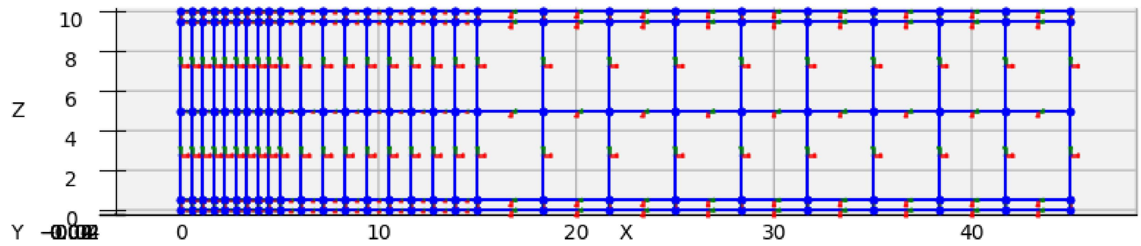

Figure 1.4: Using Multi Span Distance List Function

Code example to use the same:

```
# Create grillage model
model = og.create_grillage(
bridge_name = "My_Bridge",
long_dim = 30.0 * m,
width = 10.0 * m,
skew = [0.0,0.0],
num_long_grid = 5, # Number of grid lines
num_trans_grid = 10,
ext_to_int_dist = 2.5 * m,
edge_beam_dist = 0.5 * m,
mesh_type = "Oblique", # ('Ortho' or 'Oblique')
multi_span_dist_list = [5,10,30]
)
```

1.1.3.2 Mesh Type

The user may define a grillage model with or without a full/partial skew angle and has the following options to define the model:

1. **Ortho**:
   The User can model an orthogonal mesh

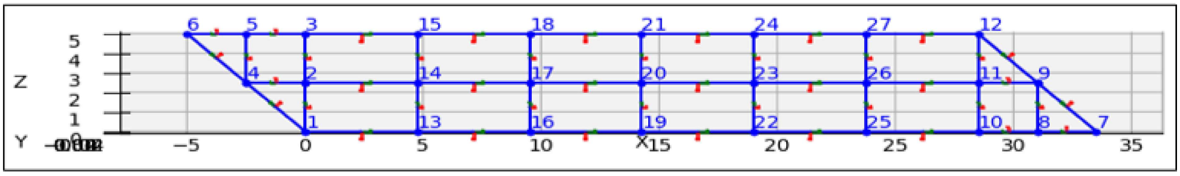

Figure 1.5: Orthogonal Mesh

2. **Oblique**:
   The User can model an oblique mesh

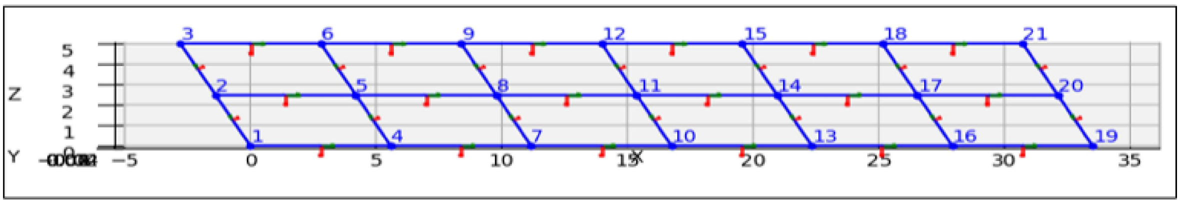

Figure 1.6: Oblique Mesh

1.1.3.3 Rigid Links

As a "multiple point constraint command" (mp constraint commands) in OpenSeesPy, the structural role of rigidLink is to force two or more nodes to act as a single rigid body, meaning they maintain their relative positions and orientations during deformation. This is crucial for modeling stiff connections or diaphragms within a structure that are assumed not to deform internally.

1.1.3.4 Elastic Links

Elastic links in bridges are used to model connections with specific stiffness properties, allowing for a more accurate representation of real-world behavior compared to rigid or fixed connections. They are particularly useful for simulating elements like elastomeric bearings, soil-structure interfaces, and other scenarios where stiffness in certain directions is crucial.

1.1.4 Boundary Definition

1.1.4.1 Default

To provide ease of use, one end hinged and other roller for ends of interior longitudinal members are set unless the user specifies otherwise.

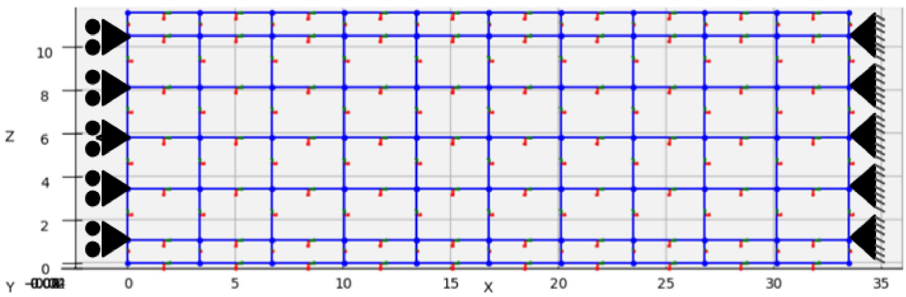

Figure 1.7: Default Supports

1.1.4.2 User Defined

The user can apply restraint against any degree of freedom (DOF) on any chosen node on the model.

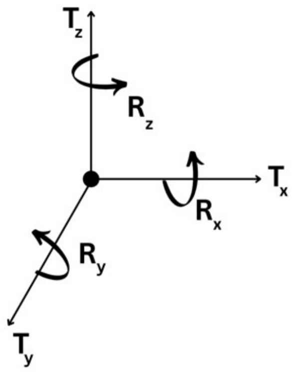

Figure 1.8: Degrees of Freedom per Node

2. Loads on Composite I-Girder Bridges & Required Inputs

2.1 Introduction

- Composite I-Girder Bridges combine steel girders (I-shaped beams) and a concrete deck connected by shear studs. This design leverages steel's tensile strength and concrete's compressive strength.
- **Key Goal:** Calculate all loads to ensure the bridge is safe (won't collapse) and functional (won't crack/excessively bend).

2.2 Types of Loads & Their Effects

Loads are categorized into three types:

Permanent (Dead Loads - DL)

- **Self-weight:** Steel girders (Cl. 203.2)
- Causes constant bending and compression
- **Superimposed DL:** Concrete deck, asphalt, barriers (Cl. 203.2)

Live Loads (LL)

- Traffic (Class 70R/A vehicles), pedestrians (Cl. 205.2)
- Causes dynamic bending, shear, vibration

Environmental Loads

- Wind, temperature changes, earthquakes (Cl. 212, 218, 219)
- Causes lateral force, expansion/contraction, or seismic shaking

2.3 Detailed Breakdown of Loads & Required Inputs

2.3.1 Permanent Loads (DL)

2.3.1.1 Description

- **Stage 1**: Weight during construction (steel girders + wet concrete) (Cl. 203.2)
- **Stage 2**: Added after construction (asphalt, barriers, utilities) (Cl. 203.2)

2.3.1.2 Critical Inputs Needed

Geometry:

- Cross-section dimensions (girder height, flange width, deck thickness)
- **Span Length (L):** Distance between supports [m]
- **Bridge Width:** Total width including shoulders [m]
- **Number of Girders:** Quantity of steel I-girders
- **Girder Spacing:** Center-to-center distance between girders [m]

Steel I-Girder Cross-Section:

- **Overall Depth:** Total height of I-girder [mm]
- **Top Flange Width:** Width of compression flange [mm]
- **Top Flange Thickness:** Thickness of compression flange [mm]
- **Bottom Flange Width:** Width of tension flange [mm]
- **Bottom Flange Thickness:** Thickness of tension flange [mm]
- **Web Thickness:** Thickness of vertical web [mm]
- **Web Height:** Clear height between flanges [mm]

Concrete Deck:

- **Deck Thickness:** Overall slab thickness [mm]
- **Deck Overhang:** Cantilever length beyond exterior girders [mm]
- **Haunch Thickness:** Additional concrete above top flange [mm]

2.3.2 Material Properties

2.3.2.1 Steel Properties

- **Density of Steel:** $78.5\,\mathrm{kN\,m^{-3}}$ (standard)
- **Elastic Modulus (E_s):** $2 \times 10^5\ \mathrm{N\,mm^{-2}}$
- **Coefficient of Thermal Expansion (α_s):** $12 \times 10^{-6}\ /°\mathrm{C}$
- **Yield Strength:** $[\mathrm{N/mm^2}]$ - depends on steel grade

2.3.2.2 Concrete Properties

- **Density of Concrete:** $25\,\mathrm{kN\,m^{-3}}$ (standard)
- **Elastic Modulus (E_c):** $3 \times 10^4\ \mathrm{N\,mm^{-2}}$ (typical)
- **Coefficient of Thermal Expansion (α_c):** $10 \times 10^{-6}\ /{}^\circ\mathrm{C}$
- **Compressive Strength (f_{ck}):** $[\mathrm{N/mm^2}]$ - design grade

2.3.2.3 Other Materials

- **Asphalt Density:** $\sim 23\,\mathrm{kN\,m^{-3}}$
- **Asphalt Layer Thickness:** [mm]
- **Non-Structural Elements:**
  - Weight of barriers per meter (e.g., 5 kN/m)
  - Utilities (pipes, cables) weight

2.3.3 Live Loads (LL)

2.3.3.1 Complete IRC:6-2017 Live Loads and Load Combinations for Composite I-Girder Bridges

PART A: LIVE LOAD CLASSES (IRC:6-2017)

1. **IRC CLASS AA LOADING (Section 207.1)**

   - **Code Reference:** IRC:6-2017, Clause 207.1
   - **Application:** Special loading for important bridges, highways with very heavy traffic
   - **Minimum Carriageway Width:** Not specified (used for special cases)

   Tracked Vehicle Option (Clause 207.1.1):

   - **Total Load:** 700 kN
   - **Track Configuration:**
     - Track Contact Area: 3.6 m × 0.84 m per track
     - Track Spacing: 1.8 m (center to center)
     - Load per Track: 350 kN each
     - Contact Pressure: 275 $\mathrm{kN/m^2}$

   Wheeled Vehicle Option (Clause 207.1.2):

   - **Total Load:** 1000 kN
   - **Axle Configuration:**
     - Front Axle: 200 kN (2 wheels × 100 kN each)
     - Rear Axle: 800 kN (8 wheels × 100 kN each)

- Wheelbase: 6.1 m
- Rear Axle Spacing: 1.2 m between twin axles

- **Wheel Contact:** 500 mm × 250 mm per wheel
- **Contact Pressure:** 800 kN/m² per wheel

2. **IRC CLASS 70R LOADING (Section 207.2)**

- **Code Reference:** IRC:6-2017, Clause 207.2
- **Application:** Standard loading for all permanent bridges and culverts
- **Minimum Carriageway Width:** 7.5 m (1.2 m + 2 × 3.05 m + 1.2 m per IRC:6-2017, Clause 205.3)

Tracked Vehicle Option (Clause 207.2.1):

- **Total Load:** 700 kN
- **Track Configuration:**
  - Track Contact Area: 4.87 m × 0.84 m per track
  - Track Spacing: 1.8 m (center to center)
  - Load per Track: 350 kN each
  - Vehicle Length: 7.92 m (nose to tail)
  - Contact Pressure: 171 kN/m²

Wheeled Vehicle Option (Clause 207.2.2):

- **Total Load:** 700 kN
- **Axle Configuration:**
  - Front Axle: 80 kN (2 wheels × 40 kN each)
  - Intermediate Axle: 150 kN (4 wheels × 37.5 kN each)
  - Rear Axle: 170 kN (4 wheels × 42.5 kN each)
  - Total Wheelbase: 6.1 m
  - Axle Spacing: 1.2 m between intermediate and rear axles
- **Wheel Contact:** 500 mm × 250 mm per wheel
- **Minimum Spacing:** 30 m between successive vehicles

3. **IRC CLASS A LOADING (Section 207.3)**

- **Code Reference:** IRC:6-2017, Clause 207.3
- **Application:** General highway bridges, all bridges must be checked for this loading
- **Note:** Even bridges designed for 70R loading must be verified for Class A loading

Single Vehicle Configuration:

- **Total Load:** 554 kN
- **Axle Configuration:**

  - Front Axle: 68 kN (twin wheels)
  - Rear Axle: 114 kN (twin wheels)
  - Wheelbase: 3.05 m
- **Wheel Contact:** 380 mm × 250 mm per wheel

Train of Vehicles:

- Leading Vehicle: 554 kN (as specified above)
- Following Vehicles: 400 kN each
- Vehicle Spacing: 1.2 m clear between vehicles
- Maximum Number: 3 vehicles in train

4. **IRC CLASS B LOADING (Section 207.4)**

- **Code Reference:** IRC:6-2017, Clause 207.4
- **Application:** Temporary bridges, light traffic areas, timber bridges

Single Vehicle Configuration:

- **Total Load:** 400 kN
- **Axle Configuration:**
  - Front Axle: 68 kN (twin wheels)
  - Rear Axle: 114 kN (twin wheels)
  - Wheelbase: 3.05 m
- **Wheel Contact:** 380 mm × 250 mm per wheel

Train of Vehicles:

- Leading Vehicle: 400 kN
- Following Vehicle: 300 kN
- Vehicle Spacing: 1.2 m clear between vehicles
- Maximum Number: 2 vehicles in train

5. **SPECIAL VEHICLE LOADING (Section 207.5)**

- **Code Reference:** IRC:6-2017, Clause 207.5
- **Application:** Site-specific heavy vehicles requiring special permits
- **Requirements:** Analysis based on actual vehicle specifications provided by permit authority

6. **PEDESTRIAN LOADING (Section 208)**

- **Code Reference:** IRC:6-2017, Clause 208.1
- **Loading Specifications:**
  - Footpath Loading: 4.0 kN/m^2 (Clause 208.1.1)
  - Cycle Track Loading: 2.5 kN/m^2 (Clause 208.1.2)

- Combined Loading: 5.0 kN/m^2 (Clause 208.1.3)

PART B: IMPACT FACTORS (Section 211) Impact Factor Formula (Clause 211.1):

- **Code Reference:** IRC:6-2017, Clause 211.1
- **Formula:** $I = \frac{4.5}{L+6}$ where L = effective span in meters

Application Rules (Clause 211.2):

1. Applied ONLY to wheeled vehicles - NOT to tracked vehicles
2. Height Limitation: Applied only up to 1.2 m above roadway level
3. Minimum Value: 0.10 (10%)
4. Maximum Value: No upper limit specified (governed by span length)

2.3.3.2 Ultimate Limit State (ULS) - Safety Check

- **Load Combination:** $1.5 \times DL + 2.2 \times LL +$ Environmental loads
- **Impact Factor Application:** YES, Applied - The impact factor IS applied to wheeled live loads in ULS
- **Reasoning:** ULS checks for structural collapse/failure. Dynamic effects from moving vehicles create additional stresses that could lead to failure
- **Calculation:** $LL_{(with\ impact)} = LL \times (1 + Impact\ Factor) = LL \times \left(1 + \frac{4.5}{L+6}\right)$
- **Total ULS Load:** $1.5 \times DL + 2.2 \times [LL \times (1 + Impact\ Factor)] +$ Environmental

Why Applied in ULS:

- Prevents catastrophic failure due to dynamic amplification
- Accounts for vehicle bouncing, road irregularities, bridge vibration
- Impact factor should be applied 1.2 m above the roadway

2.3.3.3 Serviceability Limit State (SLS) - Functionality Check

- **Load Combination:** $1.0 \times DL + 1.0 \times LL +$ Environmental loads
- **Impact Factor Application:** Depends on SLS Check Type

PART D: LOAD COMBINATIONS (Section 305)
D.1 ULTIMATE LIMIT STATE (ULS) COMBINATIONS Code Reference: IRC:6-2017, Section 305.2
Fundamental Combinations (Clause 305.2.1):

- **ULS-1: Basic Combination**
  - **Formula:** $1.5 \times DL + 2.2 \times LL$
  - **Code Reference:** IRC:6-2017, Table 305.1

  - **Impact Factor:** Applied to wheeled live loads
  - **Calculation:** $1.5 \times DL + 2.2 \times [LL \times (1 + I)]$

- **ULS-2: Dead + Live + Wind**
  - **Formula:** $1.25 \times DL + 1.5 \times LL + 1.5 \times WL$
  - **Code Reference:** IRC:6-2017, Table 305.1
  - **Condition:** Wind as leading variable action

- **ULS-3: Dead + Live + Temperature**
  - **Formula:** $1.25 \times DL + 1.5 \times LL + 1.5 \times T$
  - **Code Reference:** IRC:6-2017, Table 305.1
  - **Condition:** Temperature as leading variable action

- **ULS-4: Dead + Live + Braking**
  - **Formula:** $1.5 \times DL + 2.2 \times LL + 1.5 \times BF$
  - **Code Reference:** IRC:6-2017, Table 305.1
  - **Braking Force:** As per Clause 214.2 (20% of LL)

- **ULS-5: Dead + Live + Centrifugal (Curved Bridges)**
  - **Formula:** $1.5 \times DL + 2.2 \times LL + 1.5 \times CF$
  - **Code Reference:** IRC:6-2017, Clause 215 & Table 305.1
  - **Application:** Only for curved bridges

Accidental Combinations (Clause 305.2.2):

- **ULS-6: Seismic Combination**
  - **Formula:** $1.0 \times DL + 0.5 \times LL + 1.0 \times EQ$
  - **Code Reference:** IRC:6-2017, Table 305.2 & Clause 219
  - **Note:** Impact factor NOT applied in seismic combinations
  - **Live Load:** 50% of live load considered for seismic mass calculation

- **ULS-7: Vehicle Collision**
  - **Formula:** $1.0 \times DL + 0.5 \times LL + 1.0 \times CV$
  - **Code Reference:** IRC:6-2017, Table 305.2
  - **Application:** When collision forces are applicable

Serviceability Limit State (SLS) Combinations
Code Reference: IRC:6-2017, Section 305.3
Characteristic Combinations (Clause 305.3.1):

- **SLS-1: Basic Serviceability**
  - **Formula:** $1.0 \times DL + 1.0 \times LL$

  - **Code Reference:** IRC:6-2017, Table 305.3
  - **Impact Factor:** Applied for deflection and stress checks
  - **Usage:** Deflection limits, stress verification

- **SLS-2: Dead + Live + Wind**
  - **Formula:** $1.0 \times DL + 1.0 \times LL + 1.0 \times WL$
  - **Code Reference:** IRC:6-2017, Table 305.3

- **SLS-3: Dead + Live + Temperature**
  - **Formula:** $1.0 \times DL + 1.0 \times LL + 1.0 \times T$
  - **Code Reference:** IRC:6-2017, Table 305.3

Frequent Combinations (Clause 305.3.2):

- **SLS-4: Frequent Loading**
  - **Formula:** $1.0 \times DL + 0.75 \times LL + 0.5 \times (WL\ or\ T)$
  - **Code Reference:** IRC:6-2017, Table 305.4
  - **Usage:** Vibration checks, crack width calculations

Quasi-Permanent Combinations (Clause 305.3.3):

- **SLS-5: Long-term Effects**
  - **Formula:** $1.0 \times DL + 0.3 \times LL$
  - **Code Reference:** IRC:6-2017, Table 305.5
  - **Usage:** Long-term deflection, creep effects, prestress losses

Pedestrian Loads (if applicable)

- **Pedestrian Load:** Per unit area [kN/m^2]
- **Footpath Width:** [m]

2.3.4 Environmental Loads (IRC:6-2017)

2.3.4.1 Description

Environmental loads are site-specific forces requiring precise geographic/climatic data:

- **Wind:** Lateral pressure on girders/deck
- **Temperature:** Expansion/contraction of materials
- **Seismic:** Ground shaking during earthquakes

2.3.4.2 Critical Inputs Needed

Wind Loads: (IRC:6-2017, Cl. 212 + IS: 875-2015)

- **Basis:** Lateral pressure on exposed surfaces (girders/deck/cantilevers)
- Bridge exposure category (urban/rural/coastal)

Wind Load Parameters:

- **Site Location:** Urban/Rural/Coastal classification
- **Basic Wind Speed (V_b):** From IS:875-2015 wind map [m/s]
- **Terrain Category:** Based on ground roughness
- **Topography Factor:** Hills, valleys, escarpments
- **Bridge Height:** Above ground level [m]
- **Exposed Area:** Solid projected area of girders and deck [m^2]
- **Shape Factor (C_f):** From IRC:6-2017 Table 11

Design Wind Pressure (P_z):

$$P_z = 0.6 \cdot V_z^2 \text{ (Pa)}$$

Where V_z = Site-specific design wind speed (m/s), adjusted for:

- Terrain category (Urban/Rural/Coastal) (IS:875-2015, Cl. 6.3)
- Topography (e.g., hills/valleys) (IS:875-2015, Cl. 6.4)

Force Calculation: Lateral force: $F_{wind} = P_z \cdot A \cdot C_f$ Where:

- A = Solid projected area (m^2) (Cl. 212.4)
- C_f = Force coefficient (shape factor; Table 11, Cl. 212.4)

Temperature Loads:

- **Basis:** Thermal expansion/contraction due to seasonal/daily ΔT
- **Effective Temperature Range:** $\Delta T = T_{max} - T_{min}$ (e.g., 45°C summer to 0°C winter, Cl. 218.2)
- **Differential Effects in Composite Sections:** Steel ($\alpha_s = 12 \times 10^{-6}$/°C) expanding faster than concrete ($\alpha_c = 10 \times 10^{-6}$/°C), inducing stress (Cl. 218.2)

Stress Calculation: $\sigma = E \cdot \alpha \cdot \Delta T$ (N/mm^2) Where E = Elastic modulus (steel: 2×10^5 N/mm^2, concrete: 3×10^4 N/mm^2)
Critical Inputs:

- Shade air temperature extremes (site weather data, Cl. 218.2)
- Restraint conditions (e.g., fixed/sliding bearings, Cl. 218.4)

Seismic Loads: (IRC:6-2017, Cl. 219 + IS: 1893-2016)

- **Basis:** Ground acceleration during earthquakes (zone/soil-dependent)

Design Horizontal Seismic Coefficient (A_h):

$$A_h = \frac{Z \cdot I \cdot S_a}{2R}$$

Where:

- $Z =$ Zone factor (0.36 for Zone V, IS: 1893-2016, T-2)
- $I =$ Importance factor (1.5 for bridges, Cl 219.4.1)
- $R =$ Response reduction factor (3.0 for bridges, Cl 219.4.2)
- $S_a/g =$ Spectral acceleration (Soil-specific, IS: 1893-2016, Fig.11)

Force Application: Lateral force at deck level: $F_{Seismic} = A_h \cdot W$ Where $W =$ Seismic Weight (DL + 50% LL, Cl. 219.4.3)
Critical Inputs:

- Soil type (I: Rock $\rightarrow$ IV: Soft clay, IS: 1893-2016, Cl. 6.4.2)
- Bridge fundamental period (T) for S_a/g calculation (Cl. 219.5)
- Zone Factor (Z): 0.10 (Zone II) to 0.36 (Zone V)

Soil Type Classification:

- Type I: Rock
- Type II: Dense/Medium sand and gravel
- Type III: Soft soil
- Type IV: Very soft clay

SITE-SPECIFIC INPUTS:

- **Latitude and Longitude:** For climate data
- **Elevation:** Above sea level [m]
- **Local Weather Station Data:** Historical temperature and wind records
- **Geotechnical Information:**
  - Soil Investigation Report: SPT values, soil layers
  - Bearing Capacity: Of foundation soil
  - Groundwater Level: Depth from surface
  - Soil Shear Wave Velocity: For seismic analysis

2.4 Design Standards and Codes

2.4.1 Applicable Codes

- **Primary Code:** IRC:6-2017 (Loads and Stresses)
- **Wind Load Code:** IS:875 (Part 3)-2015
- **Seismic Code:** IS:1893-2016
- **Material Standards:** IS:2062 (Steel), IS:456 (Concrete)

2.5 Key Formulas & Safety Factors

2.5.1 Bending Moment (BM) from Dead Loads

$$BM_{(DL)} = \frac{wL^2}{8}$$

Where: - w = Weight per meter (kN/m) - L = Span length (m)

2.5.2 Total Load for Safety Checks

2.5.2.1 Ultimate Limit State

$$TL = 1.5 \times DL + 2.2 \times LL + \text{Environmental Loads}$$

2.5.2.2 Serviceability Limit State

$$TL = 1.0 \times DL + 1.0 \times LL + \text{Environmental loads}$$

2.6 Summary: Essential Inputs for Analysis

Table 2.1: Essential Inputs for Analysis

Load Type	**Must-Have Inputs**
Permanent (DL)	Girder dimensions, concrete thickness, asphalt/barrier weights
Live (LL)	Design vehicle type (e.g., Class 70R), axle loads, axle spacing, span length (L), impact factor

Environmental	Wind speed, temperature range, seismic zone, soil type, thermal

2.7 Key Takeaways

- Permanent loads are the bridge's "own weight" – need exact dimensions and material data.
- Live loads depend on traffic – use standards (IRC 6) and worst-case vehicle positions.
- Environmental loads are location-specific – consult climate/geological data.
- Always combine loads with safety factors (1.5DL + 2.2LL) for real-world safety.
- Use software (like MIDAS or STAAD) to automate calculations after inputting these parameters.

Chapter 4

Conclusions

4.1 Tasks Accomplished

- Developed Bridge Analysis module (from scratch)
- Verified all designs with IS codes
- Prepared DDCLs for the modules

4.2 Skills Developed

- **Design Verification:** IS code-based calculation checks
- **Documentation:** DDCL writing and formatting
- **Programming:** Python backend module development
- **Structural Concepts:** Steel connections and girder behavior
- **Teamwork:** Collaboration and code debugging

Chapter A

Appendix

Internship Work Report			
Name:		Mohd Faraz Khan	
Project:		Osdag Module Development	
Internship:		FOSSEE Summer Fellowship 2025	
DATE	**DAY**	**TASK**	**Hours Worked**
31-May-2025	Saturday	Tried Installing Osdag on my Laptop (Windows 11) using miniconda 3, got some installation error, forked Osdag-admin/osdag and created conda editable environment.	5
1-Jun-2025	Sunday		
2-Jun-2025	Monday	Assigned a Task_1 to create the report on the Basics of Composite I girder Bridge	8
3-Jun-2025	Tuesday	Meeting to Clarify the various doubts reagrding the Bridge Concepts	8.5
4-Jun-2025	Wednesday	Worked on various parameters of bridge modelling	8
5-Jun-2025	Thursday	Worked on material properties used	7.5
6-Jun-2025	Friday	Worked to various types of loads included	6.5
7-Jun-2025	Saturday	Worked to the effects of the loads	8
8-Jun-2025	Sunday		
9-Jun-2025	Monday	Started working on breaking the loads in detailed manner	8
10-Jun-2025	Tuesday	Working on Required inputs	7.5
11-Jun-2025	Wednesday	Permanent Loading	7.5
12-Jun-2025	Thursday	Material Properties included	8
13-Jun-2025	Friday	Live Loading.	6.5
14-Jun-2025	Saturday	Environmental Loading	8.5
15-Jun-2025	Sunday		
16-Jun-2025	Monday	Detailing of Environmental Loading	8.5
17-Jun-2025	Tuesday	Design Standards and codes	7
18-Jun-2025	Wednesday	Makes Changes in the created DDCL	8
19-Jun-2025	Thursday	Prathamesh make changes in the mesh tyoe	8
20-Jun-2025	Friday	More Detailing of Environmental loads	6.5
21-Jun-2025	Saturday	IRC Class AA loading included with 70R loading	7
22-Jun-2025	Sunday		
23-Jun-2025	Monday	Finalised the report upto loading	7
24-Jun-2025	Tuesday	Working on Osdag Bridge Figma.	7
25-Jun-2025	Wednesday	Load Combinations introduced	7.5
26-Jun-2025	Thursday	More Load Combinations included curved bridges.	7
27-Jun-2025	Friday	Seismic Combinations	7
28-Jun-2025	Saturday	Vehicle Collision	6
29-Jun-2025	Sunday		
30-Jun-2025	Monday	Quasi Permanent Loading	6.5
1-Jul-2025	Tuesday		
2-Jul-2025	Wednesday		
3-Jul-2025	Thursday	Pedastrian Loading	6
4-Jul-2025	Friday	Inclusion of IS 875 for Wind Data	7
5-Jul-2025	Saturday	Temperature loading	6
6-Jul-2025	Sunday		
7-Jul-2025	Monday	Seismic Loading - IRC 6	6
8-Jul-2025	Tuesday	Load Application : zone factor	6.5
9-Jul-2025	Wednesday	Soil Type Classification	6
10-Jul-2025	Thursday	Site Specific Inputs	6.5
11-Jul-2025	Friday	Geotechnical Information	6
12-Jul-2025	Saturday	Safety Factor	5.5
13-Jul-2025	Sunday		
14-Jul-2025	Monday	Summary Initiate	6
15-Jul-2025	Tuesday	Put Inputs in the summary for Analysis	5
16-Jul-2025	Wednesday	Key Takeaways	6
17-Jul-2025			
18-Jul-2025			
19-Jul-2025			
20-Jul-2025			
21-Jul-2025			
22-Jul-2025			

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