FOSSEE Summer Internship Report

On

Development and error checking of modules for Osdag

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 [1, 2, 3]. 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.

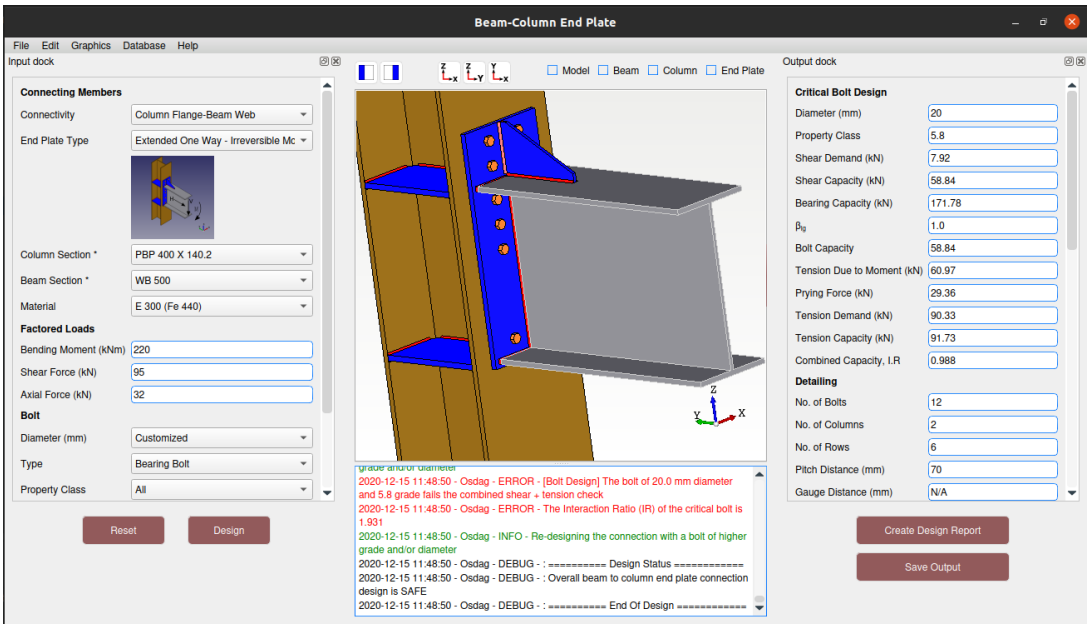


Figure 1.2: Osdag GUI

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.

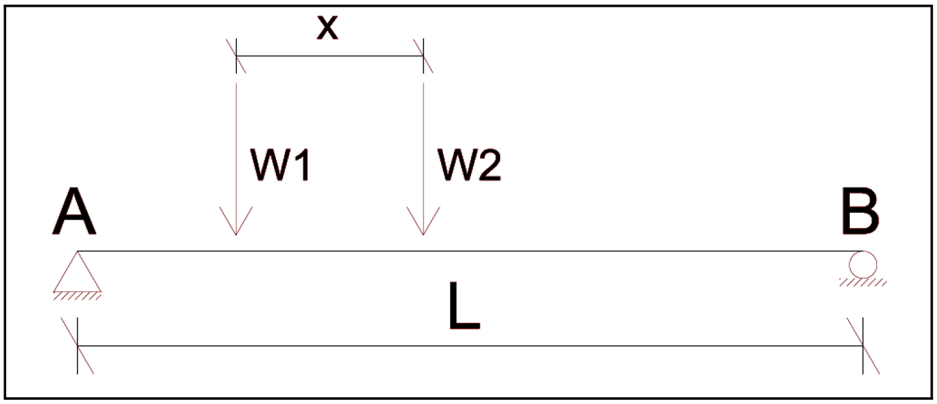
Chapter 2

Screening Task

2.1 Problem Statement

Objective:

Develop an algorithm to calculate the shear force and bending moment values of a simply supported beam subjected to a moving load. The use of Influence Line Diagram is recommended but not compulsory.



Input Parameters:

- Length of beam L (in metres)
- Moving load values W_1 and W_2 (in kN)
- Distance x between W_1 and W_2 (in metres)

Requirements:

- Accept user-defined input values: L, W_1, W_2, and x
- Calculate the maximum reactions at supports A and B
- Calculate bending moment BM_{01} at $W_1 = 0\,\text{m}$
- Calculate shear force SF_{01} at the midpoint $x = 0.5L$
- Determine the maximum shear force SF_{max} and its location $y\,\text{m}$ from Support A
- Determine the maximum bending moment BM_{max} and its location $z\,\text{m}$ from Support A

Design Function:

- Complete the function:

```
analyze_beam(L, W1, W2, x)
```

- Ensure all the required computations are implemented within the function
- Add appropriate comments in the code to aid understanding

Expected Output:

- Maximum Reaction at A
- Maximum Reaction at B
- Bending Moment BM_{01}
- Shear Force SF_{01}
- Maximum Shear Force SF_{max}
- Maximum Bending Moment BM_{max}

2.2 Tasks Done

- **Mathematical Calculations and Logic Development:** Derived precise equations for the required influence lines at designated points, aligning them with the structural analysis objectives of the project.
- **Logic Implementation:** Translated the formulated equations into efficient and modular code, ensuring alignment with the Problem Statement and fulfilling all functional requirements.
- **Demonstration Video Creation:** Produced a silent demo video with clear, concise subtitles that walk through the workflow and functionality of the code, enhancing accessibility and comprehension.
- **Comprehensive Documentation by LaTeX-generated file:** Compiled a professional PDF using LaTeX, documenting the entire process—from interpreting the Problem Statement to detailed calculations, code explanations, and output interpretation.
- **Feature Enhancements:** Post initial submission, introduced additional capabilities, including automatic generation of Influence Line Diagrams and an interactive test function to assess code performance with various user inputs.
- **Final Submission:** Consolidated all improvements and created a comprehensive final demo video and LaTeX-generated PDF file, showcasing the full functionality of the code under varied input scenarios, and completed a successful submission of all deliverables.
- **Link :** Task Folder

Chapter 3

Module Development - Compression Members (Laced Columns)

3.1 Problem Statement

The objective is to develop a **design automation code** for the structural design of **laced compound columns** as per IS:800-2007 guidelines, using the methodology outlined in the OSDAG Design and Detailing Checklist (DDCL). The code must perform comprehensive calculations to determine the appropriate member sections, design forces, lacing arrangements, and connection details for a compression member subjected to axial load.

3.1.1 Inputs

The following design parameters are to be provided by the user:

- **Section Profile**: (e.g., 2-channels back-to-back or toe-to-toe)
- **Section Size**: User-defined or software-optimized
- **Material Grade**: (e.g., E250, E350)
- **Axial Load (AF)**: Factored axial load in kN
- **Unsupported Lengths (in mm)**:
  - Along y–y axis

  - Along z–z axis

- **Boundary Conditions** (at both ends for both axes)
- **Lacing Details**:
  - Lacing Pattern (single, double, with/without tie)
  - Lacing Profile (angle, channel, flat)
- **Type of Connection**: Bolted or Welded
- **Design Preferences** (optional):
  - Effective Area Parameter (0.1 to 1.0)
  - Allowable Utilization Ratio
  - Bolt Diameter
  - Weld Size

3.1.2 Outputs

The expected outputs from the program are:

- Selected compound column section and classification
- Effective slenderness ratio and effective length
- Design compressive stress (f_{cd}) and strength (P_d)
- Spacing between component members of compound column
- Tie plate design: depth, length, and thickness
- Lacing design:
  - Number of lacings and their spacing
  - Angle of lacing (θ)
  - Lacing bar section and size
  - Check for compressive and tensile strength

- Connection design:
  - Bolted connection: shear and bearing strength
  - Welded connection: weld size and strength

3.1.3 Calculation Procedure Overview

The code must execute the following stages, aligned with IS:800-2007 and DDCL guidelines:

1. **Initial Section Selection**: Based on factored axial load and required effective area.
2. **Section Classification**: As per IS:800-2007 Table 2.
3. **Buckling Class Identification and Imperfection Factor**: From IS:800-2007 Table 7 and 10.
4. **Slenderness Ratio Calculation**: Using effective length factors from boundary conditions.
5. **Stress and Strength Calculation**:
   - Compute λ_e, λ, ϕ, χ, f_{cd}, and P_d
6. **Geometric Design**: Determine spacing S and tie plate dimensions.
7. **Lacing Design**:
   - Calculate L_0, N_L, angle θ, and compressive force P_{cal}
   - Check slenderness and strength in both compression and tension
8. **Connection Design**:
   - For bolts: evaluate V_{dsb}, V_{dpb} and determine number of bolts
   - For welds: determine strength and required weld length

The final code should modularly implement all the above steps and validate each design parameter against the limits prescribed by IS:800-2007.

3.2 Tasks Done

After a detailed study of the Design and Detailing Checklist (DDCL) to check for errors and understand the algorithm and the functional flow of the original design methodology, I translated each task into discrete Python functions to ensure modularity and clarity while preserving all structural design requirements. I developed a parallel computational flow tailored specifically for Python implementation maintaining the functionality of the original algorithm.

3.2.1 Python Code

This section presents the Python script developed for the design of laced compound columns as per IS:800-2007, integrated within the Osdag framework. The script handles design inputs, performs calculations, and displays output results through the GUI. It includes provisions for design preferences, validation, and report generation.

Description of the Script

The script is implemented as a class `LacedColumn`, which inherits from the base `Member` class in Osdag. It facilitates the GUI-based input of design parameters such as section properties, axial load, boundary conditions, material grade, and lacing configuration.

Key features of the script:

- **Input Parameters:** User-defined section profile, axial load, unsupported lengths, end conditions, lacing type, connection type, material grade, and design preferences (e.g., bolt diameter, weld size).
- **Design Calculations:** Computation of effective lengths, slenderness ratios, imperfection factors, buckling curves, design compressive stress and strength, and lacing force checks as per IS:800-2007 and DDCL methodology.
- **Output:** Outputs include utilization ratio, section classification, stress values, and verification results, all shown in the GUI and included in the PDF report.

Python Code

Listing 3.2: Laced Column Design in Osdag

```
class LacedColumn(Member):
    def __init__(self):
        super().__init__()
        self.design_status = False
        self.result = {}
        self.utilization_ratio = 0
        self.section_designation = None
        self.material_combo = QComboBox()
        self.axial_load_lineedit = QLineEdit()
        self.unsupported_length_yy_lineedit = QLineEdit()
        self.unsupported_length_zz_lineedit = QLineEdit()
        self.lacing_pattern_combo = QComboBox()
        self.connection_combo = QComboBox()
        ...

    def input_values(self, *args, **kwargs):
        options_list = []
        options_list.append((KEY_SEC_PROFILE, "Section Profile",
           TYPE_COMBOBOX, ["Back-to-Back", "Toe-to-Toe"], True, '
           No Validator'))
        options_list.append((KEY_AXIAL, "Axial Load (kN)",
           TYPE_TEXTBOX, None, True, 'Float Validator'))
        ...
        return options_list

    def output_values(self, flag):
        out_list = []
        out_list.append((KEY_EFF_LEN_YY, "Effective Length (YY)",
            TYPE_TEXTBOX, self.effective_length_yy, True))
        out_list.append((KEY_SLENDER_YY, "Slenderness Ratio (YY)"
           , TYPE_TEXTBOX, self.effective_sr_yy, True))
        out_list.append((KEY_FCD, "Design Compressive Stress",
           TYPE_TEXTBOX, self.result_fcd, True))
        ...
```

```
        return out_list
```

Explanation of the Code

- **Lines 1–13:** Defines the `LacedColumn` class and initializes GUI elements and internal variables.
- **Lines 15–22:** The `input_values` method specifies the GUI form layout for input parameters such as section profile and axial load.
- **Lines 24–30:** The `output_values` method formats the final design results to be displayed in the output dock of the Osdag GUI.

3.2.2 Python Code

The Python script is shown below. Each section is commented for clarity.

Listing 3.1: Laced Column Design in Osdag

```
1
2  import os
3  import sys
4  import math
5  from osdag.design_shear import ShearConnection
6  from osdag.connection_geometry import ConnectionGeometry
7
8  # Input parameters
9  beam_section = "ISMB 300"  # Beam section
10 column_section = "ISWB 500"  # Column section
11 load = 250  # Shear load in kN
12 bolt_diameter = 16  # Diameter of bolts in mm
13 bolt_grade = 8.8  # Grade of bolts
14
15 # Connection design
16 connection = ShearConnection(
17     beam_section, column_section, load, bolt_diameter, bolt_grade
18 )
19 connection.calculate_bolt_group()
20 connection.verify_end_plate()
```

```
21 connection.verify_bolt_strength()
22
23 # Output results
24 print("Number of bolts required:", connection.number_of_bolts)
25 print("Bolt arrangement (rows x columns):", connection.bolt_arrangement
   )
26 print("End plate adequacy:", connection.end_plate_adequacy)
27 print("Bolt group adequacy:", connection.bolt_group_adequacy)
```

3.2.3 Explanation of the Code

- **Line 1-5**: Imports necessary libraries and Osdag modules for design calculations.
- **Line 7-11**: Defines the input parameters, including the beam and column sections, applied load, and bolt properties.
- **Line 13-18**: Creates a `ShearConnection` object and performs design calculations for the bolt group, end plate, and bolt strength.
- **Line 20-23**: Prints the results, including the number of bolts, bolt arrangement, and adequacy checks for the connection components.

3.2.4 Full code

```
"""
Main module: Design of Compression Member
Sub-module:  Design of column (loaded axially)

@author:Sanket Gaikwad

Reference:
            1) IS 800: 2007 General construction in steel - Code
               of practice (Third revision)

"""
```

```
import logging
import math
import numpy as np
from PyQt5.QtWidgets import QTextEdit, QMessageBox, QLineEdit,
   QComboBox, QDialog, QVBoxLayout, QListWidget, QDialogButtonBox
   , QLabel
from PyQt5.QtCore import QObject, pyqtSignal
from ...Common import *
from ..connection.moment_connection import MomentConnection
from ...utils.common.material import *
from ...utils.common.load import Load
from ...utils.common.component import ISection, Material
from ...utils.common.component import *
from ..member import Member
from ...Report_functions import *
from ...utils.common.common_calculation import *
from ...utils.common import is800_2007
from ...design_report.reportGenerator_latex import CreateLatex
from ...Common import TYPE_TAB_4, TYPE_TAB_5
from PyQt5.QtWidgets import QLineEdit, QMainWindow, QMessageBox
from PyQt5.QtCore import Qt
from PyQt5.QtGui import QValidator, QDoubleValidator
from PyQt5.QtWidgets import QComboBox
from PyQt5.QtWidgets import QDialog, QVBoxLayout, QLabel,
   QPushButton, QFormLayout, QTableWidget, QTableWidgetItem,
   QListWidget, QHBoxLayout
from PyQt5.QtWidgets import QDialogButtonBox
import os
import traceback
from ...utils.common.material import Material
from ...Common import KEY_LACING_SECTION_DIM


class LacedColumn(Member):
    def reset_output_state(self):
```

```
        self.effective_length_yy = None
        self.effective_length_zz = None
        self.effective_sr_yy = None
        self.effective_sr_zz = None
        self.result_fcd = None
        self.result_capacity = None
        self.result_UR = None
        self.result_section_class = None
        self.result_effective_area = None
        self.result_bc_yy = None
        self.result_bc_zz = None
        self.result_IF_yy = None
        self.result_IF_zz = None
        self.result_ebs_yy = None
        self.result_ebs_zz = None
        self.result_nd_esr_yy = None
        self.result_nd_esr_zz = None
        self.result_phi_yy = None
        self.result_phi_zz = None
        self.result_srf_yy = None
        self.result_srf_zz = None
        self.result_fcd_1_yy = None
        self.result_fcd_1_zz = None
        self.result_fcd_2 = None
        self.result_cost = None
        self.result = {}
        self.optimum_section_ur_results = {}
        # Any other custom/calculated fields should be reset here
            as well
    def __init__(self):
        super().__init__()
        self.material_property = None  # Defensive: always
           initialize
        self.design_status = False
```

```
        self.failed_reason = None  # Track why design failed
        self.result = {}
        self.utilization_ratio = 0
        self.area = 0
        self.epsilon = 1.0
        self.fy = 0
        self.section = None
        self.material = {}
        self.weld_size = ''
        self.weld_type = ''
        self.weld_strength = 0
        self.lacing_incl_angle = 0
        self.lacing_section = ''
        self.lacing_type = ''
        self.allowed_utilization = ''
        self.module = KEY_DISP_COMPRESSION_LacedColumn
        self.mainmodule = 'Member'
        self.section_designation = None
        self.dialogs = []  # Track all dialogs/windows opened by
            this module
        self.design_pref_dialog = None
        self.output_title_fields = {}
        self.design_pref_dictionary = {
            KEY_DISP_LACEDCOL_WELD_SIZE: "5mm",
            KEY_DISP_LACEDCOL_BOLT_DIAMETER: "16mm",
            KEY_DISP_LACEDCOL_EFFECTIVE_AREA: "1.0",
            KEY_DISP_LACEDCOL_ALLOWABLE_UR: "1.0"
        }
        self.design_pref = {}  # Ensure design_pref is always
            defined
        # Define input line edits for unsupported lengths and
            axial load
        self.unsupported_length_yy_lineedit = QLineEdit()
        self.unsupported_length_zz_lineedit = QLineEdit()
```

```
        self.axial_load_lineedit = QLineEdit()
        # Define combo boxes for dropdowns
        self.material_combo = QComboBox()
        self.connection_combo = QComboBox()
        self.lacing_pattern_combo = QComboBox()
        self.section_profile_combo = QComboBox()
        self.section_designation_combo = QComboBox()
        self.flange_class = None
        self.web_class = None
        self.gamma_m0 = 1.1  # As per IS 800:2007, Table 5 for
            yield stress
        self.optimum_section_cost_results = {}  # Initialize to
            avoid AttributeError
        self.optimum_section_cost = []  # For cost-based
            optimization, as in other modules

##################################################
# Design Preference Functions Start
##################################################
    def tab_list(self):
        """
        Returns list of tabs for design preferences, matching
            flexure.py exactly.
        """
        tabs = []
        # Column Section tab (use tab_section for flexure-like
            behavior)
        t1 = (KEY_DISP_COLSEC, TYPE_TAB_1, self.tab_section)
        tabs.append(t1)
        # Weld Preferences tab (keep as is)
        t2 = ("Weld Preferences", TYPE_TAB_4, self.
            all_weld_design_values)
        tabs.append(t2)
        return tabs
```

```
    def all_weld_design_values(self, *args):
        return [
            (KEY_DISP_LACEDCOL_LACING_PROFILE_TYPE, "Lacing
               Profile Type", TYPE_COMBOBOX, ["Angle", "Channel",
                "Flat"], True, 'No Validator'),
            (KEY_DISP_LACEDCOL_LACING_PROFILE, "Lacing Profile
               Section", TYPE_COMBOBOX_CUSTOMIZED, self.
               get_lacing_profiles, True, 'No Validator'),
            (KEY_DISP_LACEDCOL_EFFECTIVE_AREA, "Effective Area
               Parameter", TYPE_COMBOBOX, ["1.0", "0.9", "0.8", "
               0.7", "0.6", "0.5", "0.4", "0.3", "0.2", "0.1"],
               True, 'No Validator'),
            (KEY_DISP_LACEDCOL_ALLOWABLE_UR, "Allowable
               Utilization Ratio", TYPE_COMBOBOX, ["1.0", "0.95",
                "0.9", "0.85"], True, 'No Validator'),
            (KEY_DISP_LACEDCOL_BOLT_DIAMETER, "Bolt Diameter",
               TYPE_COMBOBOX, ["16mm", "20mm", "24mm", "27mm"],
               True, 'No Validator'),
            (KEY_DISP_LACEDCOL_WELD_SIZE, "Weld Size",
               TYPE_COMBOBOX, ["4mm", "5mm", "6mm", "8mm"], True,
                'No Validator')
        ]

    def tab_value_changed(self):
        """
        Returns list of tuples for tab value changes, matching
           flexure.py exactly.
        """
        change_tab = []
        # Section material changes (auto-populate fu, fy)
        t1 = (KEY_DISP_COLSEC, [KEY_SEC_MATERIAL], [KEY_SEC_FU,
           KEY_SEC_FY], TYPE_TEXTBOX, self.get_fu_fy_I_section)
        change_tab.append(t1)
```

```
        # Section properties update (I-section properties)
        t2 = (KEY_DISP_COLSEC, ['Label_1', 'Label_2', 'Label_3',
           'Label_4', 'Label_5'],
              ['Label_11', 'Label_12', 'Label_13', 'Label_14', '
                 Label_15', 'Label_16', 'Label_17', 'Label_18',
               'Label_19', 'Label_20', 'Label_21', 'Label_22',
                  KEY_IMAGE], TYPE_TEXTBOX, self.
                  get_I_sec_properties)
        change_tab.append(t2)
        # SHS/RHS properties update
        t3 = (KEY_DISP_COLSEC, ['Label_HS_1', 'Label_HS_2', '
           Label_HS_3'],
              ['Label_HS_11', 'Label_HS_12', 'Label_HS_13', '
                 Label_HS_14', 'Label_HS_15', 'Label_HS_16', '
                 Label_HS_17', 'Label_HS_18',
               'Label_HS_19', 'Label_HS_20', 'Label_HS_21', '
                  Label_HS_22', KEY_IMAGE], TYPE_TEXTBOX, self.
                  get_SHS_RHS_properties)
        change_tab.append(t3)
        # CHS properties update
        t4 = (KEY_DISP_COLSEC, ['Label_CHS_1', 'Label_CHS_2', '
           Label_CHS_3'],
              ['Label_CHS_11', 'Label_CHS_12', 'Label_CHS_13', '
                 Label_HS_14', 'Label_HS_15', 'Label_HS_16', '
                 Label_21', 'Label_22',
                KEY_IMAGE], TYPE_TEXTBOX, self.get_CHS_properties)
        change_tab.append(t4)
        # Section source update (when section designation changes
           )
        t5 = (KEY_DISP_COLSEC, [KEY_SECSIZE], [KEY_SOURCE],
           TYPE_TEXTBOX, self.change_source)
        change_tab.append(t5)
        return change_tab
```

```
    def input_dictionary_design_pref(self):
        """
        Returns list of tuples for design preferences, matching
            flexure.py exactly.
        """
        design_input = []
        # Section material (combobox)
        t1 = (KEY_DISP_COLSEC, TYPE_COMBOBOX, [KEY_SEC_MATERIAL])
        design_input.append(t1)
        # Section properties (fu, fy)
        t2 = (KEY_DISP_COLSEC, TYPE_TEXTBOX, [KEY_SEC_FU,
            KEY_SEC_FY])
        design_input.append(t2)
        return design_input

    def input_dictionary_without_design_pref(self, *args, **
        kwargs):
        """
        Returns list of tuples for input dictionary without
            design preferences, matching flexure.py pattern.
        """
        design_input = []

        # Material input with safe defaults
        t1 = (KEY_MATERIAL, [KEY_SEC_MATERIAL], 'Input Dock')
        design_input.append(t1)

        # Weld preferences with safe defaults
        t2 = (None, [
                KEY_DISP_LACEDCOL_LACING_PROFILE_TYPE,
                KEY_DISP_LACEDCOL_LACING_PROFILE,
                KEY_DISP_LACEDCOL_EFFECTIVE_AREA,
                KEY_DISP_LACEDCOL_ALLOWABLE_UR,
                KEY_DISP_LACEDCOL_BOLT_DIAMETER,
```

```
                KEY_DISP_LACEDCOL_WELD_SIZE
            ], '')
        design_input.append(t2)

        return design_input

    def refresh_input_dock(self):
        """
        Returns list of tuples for refreshing input dock,
           matching flexure.py exactly.
        """
        add_buttons = []
        # Add section designation combobox for column section tab
        t1 = (KEY_DISP_COLSEC, KEY_SECSIZE, TYPE_COMBOBOX,
           KEY_SECSIZE, None, None, "Columns")
        add_buttons.append(t1)
        return add_buttons

    def get_values_for_design_pref(self, key, design_dictionary):
        """
        Returns default values for design preferences, matching
           flexure.py pattern.
        """
        if not design_dictionary or design_dictionary.get(
           KEY_MATERIAL, 'Select Material') == 'Select Material':
            fu = ''
            fy = ''
        else:
            material = Material(design_dictionary[KEY_MATERIAL],
               41)
            fu = material.fu
            fy = material.fy

        val = {
```

```
            KEY_SECSIZE: 'Select Section',
            KEY_DISP_LACEDCOL_LACING_PROFILE_TYPE: "Angle",
            KEY_DISP_LACEDCOL_LACING_PROFILE: "ISA 40x40x5",
            KEY_DISP_LACEDCOL_EFFECTIVE_AREA: "1.0",
            KEY_DISP_LACEDCOL_ALLOWABLE_UR: "1.0",
            KEY_DISP_LACEDCOL_BOLT_DIAMETER: "16mm",
            KEY_DISP_LACEDCOL_WELD_SIZE: "5mm",
            KEY_SEC_FU: fu,
            KEY_SEC_FY: fy,
            KEY_SEC_MATERIAL: design_dictionary.get(KEY_MATERIAL,
                'Select Material')
        }.get(key, '')

        return val

    def get_lacing_profiles(self, *args):
        """
        Returns lacing profile options based on selected lacing
           pattern.
        """
        if not args or not args[0]:
            return connectdb('Angles', call_type="popup")

        pattern = args[0]
        if pattern == "Angle":
            return connectdb('Angles', call_type="popup")
        elif pattern == "Channel":
            return connectdb('Channels', call_type="popup")
        elif pattern == "Flat":
            return connectdb('Channels', call_type="popup")
        else:
            return []

    ####################################
```

```
    # Design Preference Functions End
    ###################################
    def module_name(self):
        return KEY_DISP_COMPRESSION_COLUMN

    def set_osdaglogger(self, widget_or_key=None):
        import logging
        self.logger = logging.getLogger('Osdag')
        self.logger.setLevel(logging.DEBUG)
        handler = logging.StreamHandler()
        formatter = logging.Formatter(fmt='%(asctime)s - %(name)s
            - %(levelname)s - %(message)s', datefmt='%Y-%m-%d %H
           :%M:%S')
        handler.setFormatter(formatter)
        self.logger.addHandler(handler)
        handler = logging.FileHandler('logging_text.log')
        handler.setFormatter(formatter)
        self.logger.addHandler(handler)
        # Always use OurLog for colored log messages in the log
           window
        if widget_or_key is not None:
            from ...Common import OurLog
            handler = OurLog(widget_or_key)
            handler.setFormatter(formatter)
            self.logger.addHandler(handler)

    def customized_input(self, *args, **kwargs):
        c_lst = []
        # Section Designation ComboBox with All/Customized
        t1 = (KEY_SECSIZE, self.fn_section_designation)
        c_lst.append(t1)
        return c_lst

    def fn_section_designation(self, *args):
```

```
        # This function is called when the Section Size ComboBox
            (All/Customized) changes
        # args[0] is the selected profile, args[1] is 'All' or '
            Customized'
        if len(args) == 1 and isinstance(args[0], list):
            args = args[0]
        profile = args[0] if len(args) > 0 else None
        mode = args[1] if len(args) > 1 else 'All'

        if mode == 'All':
            # Return all designations from DB for the selected
                profile
            result = self.fn_profile_section(profile)
            if not isinstance(result, list):
                result = [result] if result else []
            # self.logger.info(f"Section designation (All) for
                profile '{profile}': {result}")
            return result
        elif mode == 'Customized':
            # Open popup dialog for user to select
            # Fetch all designations for the selected profile
                from the database
            section_list = self.fn_profile_section(profile)
            if not section_list:
                return []

            if dialog.exec_() == QDialog.Accepted:
                selected = dialog.get_selected()
                if not isinstance(selected, list):
                    selected = [selected] if selected else []
                # self.logger.info(f"Section designation (
                    Customized) selected: {selected}")
                return selected
            else:
```

```
                # self.logger.info("Section designation dialog
                    cancelled; returning previous selection or
                    empty list.")
                return current_selected if current_selected else
                    []
        else:
            return []

    def open_section_designation_dialog(self, selected_profile,
        current_selected=None, disabled_values=None):
        if disabled_values is None:
            disabled_values = []
        section_list = connectdb(selected_profile, call_type="
            popup")
        # Prevent multiple dialogs
        if hasattr(self, 'section_designation_dialog') and self.
            section_designation_dialog is not None:
            if self.section_designation_dialog.isVisible():
                self.section_designation_dialog.raise_()
                self.section_designation_dialog.activateWindow()
                return None
        self.section_designation_dialog =
            SectionDesignationDialog(section_list)
        self.dialogs.append(self.section_designation_dialog)
        if current_selected:
            self.section_designation_dialog.list_widget.
                clearSelection()
            for i in range(self.section_designation_dialog.
                list_widget.count()):
                if self.section_designation_dialog.list_widget.
                    item(i).text() in current_selected:
                    self.section_designation_dialog.list_widget.
                        item(i).setSelected(True)
        result = None
```

```
        if self.section_designation_dialog.exec_() == QDialog.
            Accepted:
                selected = self.section_designation_dialog.
                    get_selected()
                self.sec_list = selected
                result = selected
        # Remove from dialog tracking
        if self.section_designation_dialog in self.dialogs:
            self.dialogs.remove(self.section_designation_dialog)
        self.section_designation_dialog = None
        return result

    def input_values(self, *args, **kwargs):
        """
        Function declared in ui_template.py line 566
        Function to return a list of tuples to be displayed as
            the UI (Input Dock)
        """
        self.module = KEY_DISP_LACEDCOL
        options_list = []

        # Module title and name
        options_list.append((KEY_DISP_LACEDCOL, "Laced Column",
            TYPE_MODULE, [], True, 'No Validator'))

        # Section
        options_list.append(("title_Section ", "Section Details",
            TYPE_TITLE, None, True, 'No Validator'))
        # Add section profile selection like in flexure.py
        options_list.append((KEY_SEC_PROFILE,
            KEY_DISP_SEC_PROFILE, TYPE_COMBOBOX,
            KEY_LACEDCOL_SEC_PROFILE_OPTIONS, True, 'No Validator'
            ))
        # Section Designation ComboBox with All/Customized
```

```
        options_list.append((KEY_SECSIZE, KEY_DISP_SECSIZE,
           TYPE_COMBOBOX_CUSTOMIZED, ['All','Customized'], True,
           'No Validator'))

        # Material
        options_list.append(("title_Material", "Material
           Properties", TYPE_TITLE, None, True, 'No Validator'))
        options_list.append((KEY_MATERIAL, KEY_DISP_MATERIAL,
           TYPE_COMBOBOX, VALUES_MATERIAL, True, 'No Validator'))

        # Geometry
        options_list.append(("title_Geometry", "Geometry",
           TYPE_TITLE, None, True, 'No Validator'))
        options_list.append((KEY_UNSUPPORTED_LEN_YY,
           KEY_DISP_UNSUPPORTED_LEN_YY, TYPE_TEXTBOX, None, True,
            'Float Validator'))
        options_list.append((KEY_UNSUPPORTED_LEN_ZZ,
           KEY_DISP_UNSUPPORTED_LEN_ZZ, TYPE_TEXTBOX, None, True,
            'Float Validator'))
        options_list.append((KEY_END1, KEY_DISP_END1,
           TYPE_COMBOBOX_CUSTOMIZED, VALUES_END1, True, 'No
           Validator'))
        options_list.append((KEY_END2,KEY_DISP_END2,
           TYPE_COMBOBOX_CUSTOMIZED, VALUES_END2, True, 'No
           Validator'))
        # Lacing
        options_list.append((KEY_LACING_PATTERN, "Lacing Pattern"
           , TYPE_COMBOBOX, VALUES_LACING_PATTERN, True, 'No
           Validator'))
        # Connection
        options_list.append((KEY_CONN_TYPE, "Type of Connection",
            TYPE_COMBOBOX, VALUES_CONNECTION_TYPE, True, 'No
           Validator'))
        # Load
```

```
        options_list.append(("title_Load", "Load Details",
            TYPE_TITLE, None, True, 'No Validator'))
        options_list.append((KEY_AXIAL, "Axial Load (kN)",
            TYPE_TEXTBOX, None, True, 'Float Validator'))
        return options_list

    def fn_profile_section(self, *args):
        # Accepts either a list or *args
        if len(args) == 1 and isinstance(args[0], list):
            args = args[0]
        profile = args[0] if args else None

        # Handle laced column specific profiles
        if profile == '2-channels Back-to-Back':
            return connectdb("Channels", call_type="popup")
        elif profile == '2-channels Toe-to-Toe':
            return connectdb("Channels", call_type="popup")
        elif profile == '2-Girders':
            # For girders, we can use either Beams or Columns
                depending on the application
            res1 = connectdb("Beams", call_type="popup")
            res2 = connectdb("Columns", call_type="popup")
            return list(set(res1 + res2))
        # Handle standard profiles for backward compatibility
        elif profile == 'Beams':
            return connectdb("Beams", call_type="popup")
        elif profile == 'Columns':
            return connectdb("Columns", call_type="popup")
        elif profile == 'Beams and Columns':
            res1 = connectdb("Beams", call_type="popup")
            res2 = connectdb("Columns", call_type="popup")
            return list(set(res1 + res2))
        elif profile == 'RHS and SHS':
            res1 = connectdb("RHS", call_type="popup")
```

```
            res2 = connectdb("SHS", call_type="popup")
            return list(set(res1 + res2))
        elif profile == 'CHS':
            return connectdb("CHS", call_type="popup")
        elif profile in ['Angles', 'Back to Back Angles', 'Star
           Angles']:
            return connectdb('Angles', call_type="popup")
        elif profile in ['Channels', 'Back to Back Channels']:
            return connectdb("Channels", call_type="popup")
        else:
            # Default fallback - return empty list
            return []

    def fn_end1_end2(self, *args):
        if len(args) == 1 and isinstance(args[0], list):
            args = args[0]
        end1 = args[0] if args else None

        if end1 == 'Fixed':
            return VALUES_END2
        elif end1 == 'Free':
            return ['Fixed']
        elif end1 == 'Hinged':
            return ['Fixed', 'Hinged', 'Roller']
        elif end1 == 'Roller':
            return ['Fixed', 'Hinged']

    def fn_end1_image(self, *args):
        if len(args) == 1 and isinstance(args[0], list):
            args = args[0]
        val = args[0] if args else None
        if val == 'Fixed':
            return str(files("osdag.data.ResourceFiles.images").
               joinpath("6.RRRR.PNG"))
```

```
        elif val == 'Free':
            return str(files("osdag.data.ResourceFiles.images").
                joinpath("1.RRFF.PNG"))
        elif val == 'Hinged':
            return str(files("osdag.data.ResourceFiles.images").
                joinpath("5.RRRF.PNG"))
        elif val == 'Roller':
            return str(files("osdag.data.ResourceFiles.images").
                joinpath("4.RRFR.PNG"))


    def fn_end2_image(self, *args):
        if len(args) == 1 and isinstance(args[0], list):
            args = args[0]
        end1 = args[0] if args else None
        end2 = args[1] if len(args) > 1 else None
        print("end 1 and end 2 are {}".format((end1, end2)))
        if end1 == 'Fixed':
            if end2 == 'Fixed':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("6.RRRR.PNG"))
            elif end2 == 'Free':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("1.RRFF_rotated.PNG"))
            elif end2 == 'Hinged':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("5.RRRF_rotated.PNG"))
            elif end2 == 'Roller':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("4.RRFR_rotated.PNG"))
        elif end1 == 'Free':
            return str(files("osdag.data.ResourceFiles.images").
                joinpath("1.RRFF.PNG"))
        elif end1 == 'Hinged':
```

```
            if end2 == 'Fixed':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("5.RRRF.PNG"))
            elif end2 == 'Hinged':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("3.RFRF.PNG"))
            elif end2 == 'Roller':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("2.FRFR_rotated.PNG"))
        elif end1 == 'Roller':
            if end2 == 'Fixed':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("4.RRFR.PNG"))
            elif end2 == 'Hinged':
                return str(files("osdag.data.ResourceFiles.images
                    ").joinpath("2.FRFR.PNG"))

    def input_value_changed(self, *args, **kwargs):
        lst = []
        # Section profile changes should update section
            designation (like in flexure.py)
        t1 = ([KEY_SEC_PROFILE], KEY_SECSIZE,
            TYPE_COMBOBOX_CUSTOMIZED, self.fn_section_designation)
        lst.append(t1)
        t2 = ([KEY_LYY], KEY_END_COND_YY,
            TYPE_COMBOBOX_CUSTOMIZED, self.get_end_conditions)
        lst.append(t2)
        t3 = ([KEY_LZZ], KEY_END_COND_ZZ,
            TYPE_COMBOBOX_CUSTOMIZED, self.get_end_conditions)
        lst.append(t3)
        t4 = ([KEY_MATERIAL], KEY_MATERIAL, TYPE_CUSTOM_MATERIAL,
            self.new_material)
        lst.append(t4)
```

```
        t5 = ([KEY_END1, KEY_END2], KEY_IMAGE, TYPE_IMAGE, self.
           fn_end2_image)
        lst.append(t5)
        t6 = ([KEY_END1_Y], KEY_END2_Y, TYPE_COMBOBOX, self.
           fn_end1_end2)
        lst.append(t6)
        t7 = ([KEY_END1_Y, KEY_END2_Y], KEY_IMAGE_Y, TYPE_IMAGE,
           self.fn_end2_image)
        lst.append(t7)
        # t8 = (KEY_END2, KEY_IMAGE, TYPE_IMAGE, self.
           fn_end2_image)
        # lst.append(t8)
        return lst

    def output_values(self, flag):
        # --- DEBUG: Print effective_length_yy and key results at
            the start of output_values ---
        print("[DEBUG][output_values] self.effective_length_yy:",
            getattr(self, 'effective_length_yy', None))
        print("[DEBUG][output_values] self.result_IF_yy:",
           getattr(self, 'result_IF_yy', None))
        print("[DEBUG][output_values] self.result_ebs_yy:",
           getattr(self, 'result_ebs_yy', None))
        if not hasattr(self, 'effective_length_yy') or self.
           effective_length_yy is None:
            print("[WARNING][output_values] self.
               effective_length_yy is missing or None at output
               dock refresh!")
        def get_numeric(val):
            try:
                if val is None or val == '' or val in ['a', 'A']:
                    return None
                return float(val)
            except Exception:
```

```
            return None
        """
        Output the actual calculated values for effective length
           (YY) and slenderness ratio (YY), not classification
           text.
        """
        out_list = []
        def safe_display(val):
            try:
                if val is None:
                    return ''
                if isinstance(val, float):
                    return f"{val:.2f}"
                return str(val)
            except Exception:
                return str(val)

        # --- Always show Effective Lengths (YY/ZZ) at the top of
            output dock ---
        eff_len_yy = ''
        eff_len_zz = ''
        out_list.append((None, "Effective Length", TYPE_TITLE,
           None, True))
        # Forcefully show debug/calculation info for
           effective_length_yy, even if not used in output
        debug_yy_val = None
        if hasattr(self, 'effective_length_yy'):
            try:
                debug_yy_val = float(self.effective_length_yy)
            except (TypeError, ValueError):
                debug_yy_val = None
        if debug_yy_val is not None:
            debug_yy = f"[DEBUG] Calculated effective_length_yy:
               {debug_yy_val}"
```

```
            out_list.append((None, debug_yy, TYPE_TITLE, None,
                True))
        if hasattr(self, 'effective_length_zz') and self.
            effective_length_zz is not None:
            try:
                vnum = float(self.effective_length_zz)
                debug_zz = f"[DEBUG] Calculated
                    effective_length_zz: {vnum}"
                out_list.append((None, debug_zz, TYPE_TITLE, None
                    , True))
            except (TypeError, ValueError):
                pass
        if hasattr(self, 'result') and isinstance(self.result,
            dict):
            # Only use numeric values for effective length, skip
                any string like 'mpc400', 'mpc', etc.
            for k in ['effective_length_yy', 'Effective_length_yy
                ', 'Effective Length YY']:
                v = self.result.get(k, None)
                try:
                    vnum = float(v)
                    eff_len_yy = safe_display(vnum)
                    break
                except (TypeError, ValueError):
                    continue
            for k in ['effective_length_zz', 'Effective_length_zz
                ', 'Effective Length ZZ']:
                v = self.result.get(k, None)
                try:
                    vnum = float(v)
                    eff_len_zz = safe_display(vnum)
                    break
                except (TypeError, ValueError):
                    continue
```

```
        # Fallback to attribute if not found in result, only if
            numeric
        if not eff_len_yy and hasattr(self, 'effective_length_yy'
            ):
            try:
                vnum = float(self.effective_length_yy)
                eff_len_yy = safe_display(vnum)
            except (TypeError, ValueError):
                pass
        if not eff_len_zz and hasattr(self, 'effective_length_zz'
            ):
            try:
                vnum = float(self.effective_length_zz)
                eff_len_zz = safe_display(vnum)
            except (TypeError, ValueError):
                pass
        # Fallback to optimum_section_ur_results if still not
            found, only if numeric
        if (not eff_len_yy or not eff_len_zz) and hasattr(self, '
            optimum_section_ur_results') and self.
            optimum_section_ur_results:
            best_ur = min(self.optimum_section_ur_results.keys())
            best_result = self.optimum_section_ur_results[best_ur
                ]
            if not eff_len_yy:
                for k in ['Effective_length_yy', 'Effective
                    Length YY', 'effective_length_yy']:
                    v = best_result.get(k, None)
                    try:
                        vnum = float(v)
                        eff_len_yy = safe_display(vnum)
                        break
                    except (TypeError, ValueError):
                        continue
```

```
            if not eff_len_zz:
                for k in ['Effective_length_zz', 'Effective
                    Length ZZ', 'effective_length_zz']:
                    v = best_result.get(k, None)
                    try:
                        vnum = float(v)
                        eff_len_zz = safe_display(vnum)
                        break
                    except (TypeError, ValueError):
                        continue
        # --- Final fallback: if eff_len_yy is still blank, but
            self.effective_length_yy is set and numeric, use it
            ---
        if (not eff_len_yy or eff_len_yy == '') and hasattr(self,
            'effective_length_yy'):
            try:
                vnum = float(self.effective_length_yy)
                eff_len_yy = safe_display(vnum)
            except (TypeError, ValueError):
                pass
        if (not eff_len_zz or eff_len_zz == '') and hasattr(self,
            'effective_length_zz'):
            try:
                vnum = float(self.effective_length_zz)
                eff_len_zz = safe_display(vnum)
            except (TypeError, ValueError):
                pass
        # --- FORCE: Always show self.effective_length_yy as
            string in output dock for testing ---
        eff_len_yy_forced = ''
        if hasattr(self, 'effective_length_yy') and self.
            effective_length_yy is not None:
            try:
```

```
                eff_len_yy_forced = str(float(self.
                    effective_length_yy))
            except Exception:
                eff_len_yy_forced = str(self.effective_length_yy)
        out_list.append((KEY_EFF_LEN_YY, "Effective Length (YY)",
            TYPE_TEXTBOX, eff_len_yy_forced, True))
        out_list.append((KEY_EFF_LEN_ZZ, "Effective Length (ZZ)",
            TYPE_TEXTBOX, eff_len_zz, True))

        # Slenderness Ratios
        out_list.append((None, "Slenderness Ratios", TYPE_TITLE,
            None, True))
        slender_yy = ''
        slender_zz = ''
        if flag:
            slender_yy_val = None
            slender_zz_val = None
            # 1. Try optimum_section_ur_results best result FIRST
                (most reliable)
            if hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys())
                best_result = self.optimum_section_ur_results[
                    best_ur]
                for k in ['Effective_sr_yy', 'Slenderness YY', '
                    effective_sr_yy', 'Slenderness_yy']:
                    if k in best_result:
                        try:
                            v = get_numeric(best_result[k])
                        except Exception:
                            v = None
                        if v is not None:
                            slender_yy_val = v
```

```
                        break
            for k in ['Effective_sr_zz', 'Slenderness ZZ', '
                effective_sr_zz', 'Slenderness_zz']:
                if k in best_result:
                    try:
                        v = get_numeric(best_result[k])
                    except Exception:
                        v = None
                    if v is not None:
                        slender_zz_val = v
                        break
        # 2. Fallback to direct attribute if not found above,
            with robust error handling
        if slender_yy_val is None and hasattr(self, '
            effective_sr_yy'):
            try:
                slender_yy_val = get_numeric(self.
                    effective_sr_yy)
            except Exception:
                slender_yy_val = None
        if slender_zz_val is None and hasattr(self, '
            effective_sr_zz'):
            try:
                slender_zz_val = get_numeric(self.
                    effective_sr_zz)
            except Exception:
                slender_zz_val = None
        slender_yy = safe_display(slender_yy_val) if
            slender_yy_val is not None else ''
        slender_zz = safe_display(slender_zz_val) if
            slender_zz_val is not None else ''
    out_list.append((KEY_SLENDER_YY, "Slenderness Ratio (YY)"
        , TYPE_TEXTBOX, slender_yy, True))
```

```
        out_list.append((KEY_SLENDER_ZZ, "Slenderness Ratio (ZZ)"
            , TYPE_TEXTBOX, slender_zz, True))

        # Design Values
        out_list.append((None, "Design Values", TYPE_TITLE, None,
            True))
        fcd = ''
        design_compressive = ''
        if flag:
            if hasattr(self, 'result_fcd') and self.result_fcd is
                not None:
                fcd = safe_display(self.result_fcd)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    fcd = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        FCD', ''))
            if hasattr(self, 'result_capacity') and self.
                result_capacity is not None:
                design_compressive = safe_display(self.
                    result_capacity)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    design_compressive = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        Capacity', ''))
```

```
        out_list.append((KEY_FCD, "Design Compressive Stress (fcd
            )", TYPE_TEXTBOX, fcd, True))
        out_list.append((KEY_DESIGN_COMPRESSIVE, "Design
            Compressive Strength", TYPE_TEXTBOX,
            design_compressive, True))

        # Utilization Ratio
        out_list.append((None, "Utilization Ratio", TYPE_TITLE,
            None, True))
        ur_value = ''
        if flag:
            if hasattr(self, 'result_UR') and self.result_UR is
                not None:
                ur_value = safe_display(self.result_UR)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    ur_value = safe_display(best_ur)
        out_list.append(("utilization_ratio", "Utilization Ratio"
            , TYPE_TEXTBOX, ur_value, True))

        # Section Classification (show as Plastic, Semi-Compact,
            etc.)
        out_list.append((None, "Section Classification",
            TYPE_TITLE, None, True))
        section_class = ''
        if flag:
            # Try self.result first
            if hasattr(self, 'result') and isinstance(self.result
                , dict):
```

```
                for k in ['section_class', 'Section class', '
                    Section_class', 'sectionClass']:
                    if k in self.result and self.result[k] not in
                        [None, '', 'a', 'A']:
                        section_class = str(self.result[k])
                        break
            # Fallback to attribute
            if not section_class and hasattr(self, '
                result_section_class') and self.
                result_section_class not in [None, '', 'a', 'A']:
                section_class = str(self.result_section_class)
            # Fallback to optimum_section_ur_results if still not
                found
            if not section_class and hasattr(self, '
                optimum_section_ur_results') and self.
                optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys())
                best_result = self.optimum_section_ur_results[
                    best_ur]
                for k in ['Section class', 'section_class', '
                    Section_class', 'sectionClass']:
                    if k in best_result and best_result[k] not in
                        [None, '', 'a', 'A']:
                        section_class = str(best_result[k])
                        break
        out_list.append(("section_class", "Section Class",
            TYPE_TEXTBOX, section_class, True))

        # Effective Area
        out_list.append((None, "Effective Area", TYPE_TITLE, None
            , True))
        effective_area = ''
        if flag:
```

```
            if hasattr(self, 'result_effective_area') and self.
               result_effective_area is not None:
                effective_area = safe_display(self.
                   result_effective_area)
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys()) if self.optimum_section_ur_results
                   else None
                if best_ur:
                    effective_area = safe_display(self.
                       optimum_section_ur_results[best_ur].get('
                       Effective area', ''))
        out_list.append(("effective_area", "Effective Area (mm )
           ", TYPE_TEXTBOX, effective_area, True))

        # Buckling Curve Classification
        out_list.append((None, "Buckling Curve Classification",
           TYPE_TITLE, None, True))
        bc_yy = ''
        bc_zz = ''
        if flag:
            # --- UI Patch: Always show the latest value from
               self.result for output dock fields ---
            if hasattr(self, 'result') and isinstance(self.result
               , dict):
                for k in ['buckling_curve_yy', 'Buckling_curve_yy
                   ', 'Buckling Curve YY']:
                    if k in self.result and self.result[k] not in
                        [None, '', 'a', 'A']:
                        bc_yy = str(self.result[k])
                        break
                for k in ['buckling_curve_zz', 'Buckling_curve_zz
                   ', 'Buckling Curve ZZ']:
```

```
                if k in self.result and self.result[k] not in
                    [None, '', 'a', 'A']:
                    bc_zz = str(self.result[k])
                    break
        # Fallback to attribute if not found in result
        if not bc_yy and hasattr(self, 'result_bc_yy') and
           self.result_bc_yy not in [None, '', 'a', 'A']:
            bc_yy = str(self.result_bc_yy)
        if not bc_zz and hasattr(self, 'result_bc_zz') and
           self.result_bc_zz not in [None, '', 'a', 'A']:
            bc_zz = str(self.result_bc_zz)
        # Fallback to optimum_section_ur_results if still not
            found
        if (not bc_yy or not bc_zz) and hasattr(self, '
           optimum_section_ur_results') and self.
           optimum_section_ur_results:
            best_ur = min(self.optimum_section_ur_results.
               keys())
            best_result = self.optimum_section_ur_results[
               best_ur]
            if not bc_yy:
                for k in ['Buckling_curve_yy', 'Buckling
                   Curve YY', 'buckling_curve_yy']:
                    if k in best_result and best_result[k]
                       not in [None, '', 'a', 'A']:
                        bc_yy = str(best_result[k])
                        break
            if not bc_zz:
                for k in ['Buckling_curve_zz', 'Buckling
                   Curve ZZ', 'buckling_curve_zz']:
                    if k in best_result and best_result[k]
                       not in [None, '', 'a', 'A']:
                        bc_zz = str(best_result[k])
                        break
```

```
            # If bc_zz is still 'A' (default), set to blank
            if bc_zz == 'A':
                bc_zz = ''
            out_list.append(("buckling_curve_yy", "Buckling Curve
                (YY)", TYPE_TEXTBOX, bc_yy, True))
            out_list.append(("buckling_curve_zz", "Buckling Curve
                (ZZ)", TYPE_TEXTBOX, bc_zz, True))

        # Imperfection Factor
        out_list.append((None, "Imperfection Factor", TYPE_TITLE,
            None, True))
        if_yy = ''
        if_zz = ''
        def is_numeric(val):
            try:
                float(val)
                return True
            except Exception:
                return False
        if flag:
            if hasattr(self, 'result_IF_yy') and self.
               result_IF_yy is not None and is_numeric(self.
               result_IF_yy):
                if_yy = safe_display(self.result_IF_yy)
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys()) if self.optimum_section_ur_results
                   else None
                if best_ur:
                    val = self.optimum_section_ur_results[best_ur
                       ].get('IF_yy', '')
                    if is_numeric(val):
                        if_yy = safe_display(val)
```

```
            # FINAL FALLBACK: use self.result dict if still blank
            if (not if_yy or if_yy == '') and hasattr(self, '
               result') and isinstance(self.result, dict):
                val = self.result.get('imperfection_factor_yy', '
                   ')
                if is_numeric(val):
                    if_yy = safe_display(val)
            if hasattr(self, 'result_IF_zz') and self.
               result_IF_zz is not None and is_numeric(self.
               result_IF_zz):
                if_zz = safe_display(self.result_IF_zz)
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys()) if self.optimum_section_ur_results
                   else None
                if best_ur:
                    val = self.optimum_section_ur_results[best_ur
                       ].get('IF_zz', '')
                    if is_numeric(val):
                        if_zz = safe_display(val)
            if (not if_zz or if_zz == '') and hasattr(self, '
               result') and isinstance(self.result, dict):
                val = self.result.get('imperfection_factor_zz', '
                   ')
                if is_numeric(val):
                    if_zz = safe_display(val)
        out_list.append(("imperfection_factor_yy", "Imperfection
           Factor (YY)", TYPE_TEXTBOX, if_yy, True))
        out_list.append(("imperfection_factor_zz", "Imperfection
           Factor (ZZ)", TYPE_TEXTBOX, if_zz, True))

        # Euler Buckling Stress
```

```
        out_list.append((None, "Euler Buckling Stress",
           TYPE_TITLE, None, True))
        ebs_yy = ''
        ebs_zz = ''
        if flag:
            if hasattr(self, 'result_ebs_yy') and self.
               result_ebs_yy is not None and is_numeric(self.
               result_ebs_yy):
                ebs_yy = safe_display(self.result_ebs_yy)
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys()) if self.optimum_section_ur_results
                   else None
                if best_ur:
                    val = self.optimum_section_ur_results[best_ur
                       ].get('EBS_yy', '')
                    if is_numeric(val):
                        ebs_yy = safe_display(val)
            if (not ebs_yy or ebs_yy == '') and hasattr(self, '
               result') and isinstance(self.result, dict):
                val = self.result.get('euler_buckling_stress_yy',
                    '')
                if is_numeric(val):
                    ebs_yy = safe_display(val)
            if hasattr(self, 'result_ebs_zz') and self.
               result_ebs_zz is not None and is_numeric(self.
               result_ebs_zz):
                ebs_zz = safe_display(self.result_ebs_zz)
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys()) if self.optimum_section_ur_results
                   else None
```

```
                if best_ur:
                    val = self.optimum_section_ur_results[best_ur
                        ].get('EBS_zz', '')
                    if is_numeric(val):
                        ebs_zz = safe_display(val)
            if (not ebs_zz or ebs_zz == '') and hasattr(self, '
                result') and isinstance(self.result, dict):
                val = self.result.get('euler_buckling_stress_zz',
                    '')
                if is_numeric(val):
                    ebs_zz = safe_display(val)
        out_list.append(("euler_buckling_stress_yy", "Euler
            Buckling Stress (YY)", TYPE_TEXTBOX, ebs_yy, True))
        out_list.append(("euler_buckling_stress_zz", "Euler
            Buckling Stress (ZZ)", TYPE_TEXTBOX, ebs_zz, True))

        # Non-dimensional Effective Slenderness Ratio
        out_list.append((None, "Non-dimensional Effective
            Slenderness Ratio", TYPE_TITLE, None, True))
        nd_esr_yy = ''
        nd_esr_zz = ''
        if flag:
            # --- UI Patch: Always show the latest value from
                self.result for output dock fields ---
            if hasattr(self, 'result') and isinstance(self.result
                , dict):
                for k in ['nd_esr_yy', 'ND_ESR_yy', 'ND ESR YY']:
                    if k in self.result and self.result[k] not in
                        [None, '', 'a', 'A']:
                        nd_esr_yy = safe_display(self.result[k])
                        break
                for k in ['nd_esr_zz', 'ND_ESR_zz', 'ND ESR ZZ']:
                    if k in self.result and self.result[k] not in
                        [None, '', 'a', 'A']:
```

```
                nd_esr_zz = safe_display(self.result[k])
                break
        # Fallback to attribute if not found in result
        if not nd_esr_yy and hasattr(self, 'result_nd_esr_yy'
            ) and self.result_nd_esr_yy not in [None, '', 'a',
             'A']:
            nd_esr_yy = safe_display(self.result_nd_esr_yy)
        if not nd_esr_zz and hasattr(self, 'result_nd_esr_zz'
            ) and self.result_nd_esr_zz not in [None, '', 'a',
             'A']:
            nd_esr_zz = safe_display(self.result_nd_esr_zz)
        # Fallback to optimum_section_ur_results if still not
             found
        if (not nd_esr_yy or not nd_esr_zz) and hasattr(self,
            'optimum_section_ur_results') and self.
            optimum_section_ur_results:
            best_ur = min(self.optimum_section_ur_results.
                keys())
            best_result = self.optimum_section_ur_results[
                best_ur]
            if not nd_esr_yy:
                for k in ['ND_ESR_yy', 'nd_esr_yy', 'ND ESR
                    YY']:
                    if k in best_result and best_result[k]
                        not in [None, '', 'a', 'A']:
                        nd_esr_yy = safe_display(best_result[
                            k])
                        break
            if not nd_esr_zz:
                for k in ['ND_ESR_zz', 'nd_esr_zz', 'ND ESR
                    ZZ']:
                    if k in best_result and best_result[k]
                        not in [None, '', 'a', 'A']:
```

```
                        nd_esr_zz = safe_display(best_result[
                            k])
                        break
            out_list.append(("nd_esr_yy", "ND ESR (YY)",
                TYPE_TEXTBOX, nd_esr_yy, True))
            out_list.append(("nd_esr_zz", "ND ESR (ZZ)",
                TYPE_TEXTBOX, nd_esr_zz, True))

        # Phi Values
        out_list.append((None, "Phi Values", TYPE_TITLE, None,
            True))
        phi_yy = ''
        phi_zz = ''
        if flag:
            if hasattr(self, 'result_phi_yy') and self.
                result_phi_yy is not None:
                 phi_yy = safe_display(self.result_phi_yy)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                 best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                 if best_ur:
                     phi_yy = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        phi_yy', ''))
            if hasattr(self, 'result_phi_zz') and self.
                result_phi_zz is not None:
                 phi_zz = safe_display(self.result_phi_zz)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                 best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
```

```
                if best_ur:
                    phi_zz = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        phi_zz', ''))
        out_list.append(("phi_yy", "Phi (YY)", TYPE_TEXTBOX,
            phi_yy, True))
        out_list.append(("phi_zz", "Phi (ZZ)", TYPE_TEXTBOX,
            phi_zz, True))

        # Stress Reduction Factor
        out_list.append((None, "Stress Reduction Factor",
            TYPE_TITLE, None, True))
        srf_yy = ''
        srf_zz = ''
        if flag:
            if hasattr(self, 'result_srf_yy') and self.
                result_srf_yy is not None:
                srf_yy = safe_display(self.result_srf_yy)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    srf_yy = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        SRF_yy', ''))
            if hasattr(self, 'result_srf_zz') and self.
                result_srf_zz is not None:
                srf_zz = safe_display(self.result_srf_zz)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
```

```
                else None
            if best_ur:
                srf_zz = safe_display(self.
                    optimum_section_ur_results[best_ur].get('
                    SRF_zz', ''))
        out_list.append(("stress_reduction_factor_yy", "SRF (YY)"
            , TYPE_TEXTBOX, srf_yy, True))
        out_list.append(("stress_reduction_factor_zz", "SRF (ZZ)"
            , TYPE_TEXTBOX, srf_zz, True))

        # Design Compressive Stress Values
        out_list.append((None, "Design Compressive Stress Values"
            , TYPE_TITLE, None, True))
        fcd_1_yy = ''
        fcd_1_zz = ''
        fcd_2 = ''
        if flag:
            if hasattr(self, 'result_fcd_1_yy') and self.
                result_fcd_1_yy is not None:
                fcd_1_yy = safe_display(self.result_fcd_1_yy)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    fcd_1_yy = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        FCD_1_yy', ''))
            if hasattr(self, 'result_fcd_1_zz') and self.
                result_fcd_1_zz is not None:
                fcd_1_zz = safe_display(self.result_fcd_1_zz)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
```

```
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    fcd_1_zz = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        FCD_1_zz', ''))
            if hasattr(self, 'result_fcd_2') and self.
                result_fcd_2 is not None:
                fcd_2 = safe_display(self.result_fcd_2)
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    fcd_2 = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        FCD_2', ''))
        out_list.append(("fcd_1_yy", "FCD_1 (YY)", TYPE_TEXTBOX,
            fcd_1_yy, True))
        out_list.append(("fcd_1_zz", "FCD_1 (ZZ)", TYPE_TEXTBOX,
            fcd_1_zz, True))
        out_list.append(("fcd_2", "FCD_2", TYPE_TEXTBOX, fcd_2,
            True))

        # --- Channel and Lacing Details Section ---
        out_list.append((None, "Channel and Lacing Details",
            TYPE_TITLE, None, True))
        spacing_channels = ''
        if flag:
            if hasattr(self, 'result') and self.result.get('
                channel_spacing') is not None:
```

```
                spacing_channels = safe_display(self.result.get('
                    channel_spacing'))
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    spacing_channels = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        channel_spacing', ''))
        out_list.append(("channel_spacing", "Spacing Between
            Channels (mm)", TYPE_TEXTBOX, spacing_channels, True))

        # --- Tie Plate Section ---
        out_list.append((None, "Tie Plate", TYPE_TITLE, None,
            True))
        tie_plate_d = ''
        tie_plate_t = ''
        tie_plate_l = ''
        if flag:
            if hasattr(self, 'result') and self.result.get('
                tie_plate_d') is not None:
                tie_plate_d = safe_display(self.result.get('
                    tie_plate_d'))
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    tie_plate_d = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        tie_plate_d', ''))
```

```
            if hasattr(self, 'result') and self.result.get('
               tie_plate_t') is not None:
                tie_plate_t = safe_display(self.result.get('
                   tie_plate_t'))
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys()) if self.optimum_section_ur_results
                   else None
                if best_ur:
                    tie_plate_t = safe_display(self.
                       optimum_section_ur_results[best_ur].get('
                       tie_plate_t', ''))
            if hasattr(self, 'result') and self.result.get('
               tie_plate_l') is not None:
                tie_plate_l = safe_display(self.result.get('
                   tie_plate_l'))
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys()) if self.optimum_section_ur_results
                   else None
                if best_ur:
                    tie_plate_l = safe_display(self.
                       optimum_section_ur_results[best_ur].get('
                       tie_plate_l', ''))
        out_list.append(("tie_plate_d", "Tie Plate Depth D (mm)",
            TYPE_TEXTBOX, tie_plate_d, True))
        out_list.append(("tie_plate_t", "Tie Plate Thickness t (
           mm)", TYPE_TEXTBOX, tie_plate_t, True))
        out_list.append(("tie_plate_l", "Tie Plate Length L (mm)"
           , TYPE_TEXTBOX, tie_plate_l, True))

        # --- Lacing Spacing Section ---
```

```
        out_list.append((None, "Lacing Spacing", TYPE_TITLE, None
            , True))
        lacing_spacing = ''
        if flag:
            if hasattr(self, 'result') and self.result.get('
                lacing_spacing') is not None:
                lacing_spacing = safe_display(self.result.get('
                    lacing_spacing'))
            elif hasattr(self, 'optimum_section_ur_results') and
                self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                    keys()) if self.optimum_section_ur_results
                    else None
                if best_ur:
                    lacing_spacing = safe_display(self.
                        optimum_section_ur_results[best_ur].get('
                        lacing_spacing', ''))
        out_list.append(("lacing_spacing", "Lacing Spacing (L0) (
            mm)", TYPE_TEXTBOX, lacing_spacing, True))

        return out_list
    def set_input_values(self, design_dictionary):
        # self.logger.info(f"set_input_values called with: {
            design_dictionary}")
        super(Member, self).set_input_values(design_dictionary)
        # section properties
        self.module = design_dictionary.get(KEY_DISP_LACEDCOL, ""
            )
        self.mainmodule = 'Columns with known support conditions'
        self.sec_profile = design_dictionary.get(
            KEY_LACEDCOL_SEC_PROFILE, "")
        self.sec_list = design_dictionary.get(KEY_SECSIZE, [])
        # Coerce sec_list to a list if it's a string
        if isinstance(self.sec_list, str):
```

```
            if self.sec_list and self.sec_list != 'Select Section
               ':
                self.sec_list = [self.sec_list]
            else:
                self.sec_list = []
        elif not isinstance(self.sec_list, list):
            self.sec_list = list(self.sec_list) if self.sec_list
               else []
        self.material = design_dictionary.get(KEY_SEC_MATERIAL, "
           ")
        # Defensive checks for required fields
        def is_valid_material(mat):
            if isinstance(mat, list):
                return any(m and m != 'Select Material' for m in
                   mat)
            return mat and mat != 'Select Material'
        if not is_valid_material(self.material):
            self.logger.error("Material is missing or invalid.")
            self.design_status = False
            return
        def is_valid_section(sec):
            if isinstance(sec, list):
                return any(s and s != 'Select Section' for s in
                   sec)
            return sec and sec != 'Select Section'
        if not is_valid_section(self.sec_list):
            self.logger.error(f"Section list is missing or
               invalid: {self.sec_list}")
            self.design_status = False
            return
        # section user data
        try:
            self.length_zz = float(design_dictionary.get(
               KEY_UNSUPPORTED_LEN_ZZ, 0))
```

```
            if self.length_zz <= 0:
                raise ValueError
        except:
            self.logger.error("Actual Length (z-z), mm is missing
                or invalid.")
            self.design_status = False
            return
        try:
            self.length_yy = float(design_dictionary.get(
               KEY_UNSUPPORTED_LEN_YY, 0))
            if self.length_yy <= 0:
                raise ValueError
        except:
            self.logger.error("Actual Length (y-y), mm is missing
                or invalid.")
            self.design_status = False
            return
        # end condition
        self.end_1_z = design_dictionary.get(KEY_END1, "")
        self.end_2_z = design_dictionary.get(KEY_END2, "")
        self.end_1_y = design_dictionary.get(KEY_END1_Y, "")
        self.end_2_y = design_dictionary.get(KEY_END2_Y, "")
        # factored loads
        try:
            axial_force = float(design_dictionary.get(KEY_AXIAL,
               0))
            if axial_force <= 0:
                raise ValueError
        except:
            self.logger.error("Axial Load (kN) is missing or
               invalid.")
            self.design_status = False
            return
```

```
        self.load = Load(axial_force=axial_force, shear_force
            =0.0, moment=0.0, moment_minor=0.0, unit_kNm=True)
        # design preferences
        try:
            self.allowable_utilization_ratio = float(
                design_dictionary.get(KEY_ALLOW_UR, 1.0))
        except:
            self.allowable_utilization_ratio = 1.0
        try:
            self.effective_area_factor = float(design_dictionary.
                get(KEY_EFFECTIVE_AREA_PARA, 1.0))
        except:
            self.effective_area_factor = 1.0
        try:
            self.optimization_parameter = design_dictionary[
                KEY_OPTIMIZATION_PARA]
        except:
            self.optimization_parameter = 'Utilization Ratio'
        try:
            self.steel_cost_per_kg = float(design_dictionary[
                KEY_STEEL_COST])
        except:
            self.steel_cost_per_kg = 50
        self.allowed_sections = ['Plastic', 'Compact', 'Semi-
            Compact', 'Slender']

        # Defensive: Only run if section list and material are
            valid
        if self.sec_list and self.material:
            # Clear material cache when material changes to
                ensure fresh properties
            self.material_lookup_cache = {}
```

```
            # Initialize material_property BEFORE
               section_classification
            self.material_property = Material(material_grade=self
               .material, thickness=0)
            self.flag = self.section_classification()
            if self.flag:
                self.design_column()
                self.results()

        # safety factors
        self.gamma_m0 = IS800_2007.cl_5_4_1_Table_5["gamma_m0"]["
           yielding"]

        # initialize the design status
        self.design_status_list = []
        self.design_status = False
        self.failed_design_dict = {}
        # Always perform calculations if required fields are
           present

    # Simulation starts here
    def section_classification(self):
        # Defensive: ensure material_property is set
        if not hasattr(self, 'material_property') or self.
           material_property is None:
            if hasattr(self, 'material') and self.material:
                try:
                    self.material_property = Material(
                       material_grade=self.material, thickness=0)
                except Exception as e:
                    self.logger.error(f"Failed to initialize
                       material_property: {e}")
                    self.design_status = False
                    return False
```

```
            else:
                self.logger.error("Material property not
                    initialized and material is missing.")
                self.design_status = False
                return False
        # Deduplicate section list to avoid repeated processing
        self.sec_list = list(dict.fromkeys(self.sec_list))
        local_flag = True
        self.input_section_list = []
        self.input_section_classification = {}

        slender_sections = []
        accepted_sections = []
        rejected_sections = []  # Track all rejected sections
            with reasons
        for section in self.sec_list:
            trial_section = section.strip("'")

            # Always define flange_ratio and web_ratio with safe
                defaults
            flange_ratio = None
            web_ratio = None

            # fetching the section properties
            if self.sec_profile ==
                KEY_LACEDCOL_SEC_PROFILE_OPTIONS[0]:  # Beams and
                columns
                try:
                    result = Beam(designation=trial_section,
                        material_grade=self.material)
                except:
                    result = Column(designation=trial_section,
                        material_grade=self.material)
                self.section_property = result
```

```
            elif self.sec_profile ==
                KEY_LACEDCOL_SEC_PROFILE_OPTIONS[1]:  # RHS and
                SHS
                 try:
                     result = RHS(designation=trial_section,
                        material_grade=self.material)
                 except:
                     result = SHS(designation=trial_section,
                        material_grade=self.material)
                 self.section_property = result
            elif self.sec_profile ==
                KEY_LACEDCOL_SEC_PROFILE_OPTIONS[2] and isinstance
                (self.section_property, CHS):  # CHS
                 self.section_property = CHS(designation=
                    trial_section, material_grade=self.material)
            else:
                 self.section_property = Column(designation=
                    trial_section, material_grade=self.material)

            # updating the material property based on thickness
                of the thickest element
            # Defensive checks and logging
            if not self.material or self.material in [None, '', '
                Select Material']:
                 error_msg = f"Material is missing or invalid
                    before database lookup: {self.material}"
                 self.logger.error(error_msg)
                 self.failed_reason = error_msg
                 self.design_status = False
                 rejected_sections.append((trial_section, '
                    Material properties not found'))
                 continue
```

```
            flange_thk = getattr(self.section_property, '
                flange_thickness', None)
            web_thk = getattr(self.section_property, '
                web_thickness', None)

            if flange_thk is None or web_thk is None:
                error_msg = f"Section property thickness missing
                    for {trial_section}: flange_thickness={
                    flange_thk}, web_thickness={web_thk}"
                self.logger.error(error_msg)
                self.failed_reason = error_msg
                self.design_status = False
                rejected_sections.append((trial_section, 'Section
                     property thickness missing'))
                continue

            try:
                max_thk = max(float(flange_thk), float(web_thk))
            except Exception as e:
                error_msg = f"Invalid thickness values for {
                    trial_section}: flange_thickness={flange_thk},
                     web_thickness={web_thk}, error={e}"
                self.logger.error(error_msg)
                self.failed_reason = error_msg
                self.design_status = False
                rejected_sections.append((trial_section, 'Invalid
                     thickness values'))
                continue

            cache_key = (self.material, round(max_thk, 1))
            if cache_key not in self.material_lookup_cache:
                self.material_property.
                    connect_to_database_to_get_fy_fu(self.material
                    , max_thk)
```

```
                self.material_lookup_cache[cache_key] = (self.
                    material_property.fy, self.material_property.
                    fu)
                # self.logger.info(f"Updated material properties
                    for {self.material}: fy={self.
                    material_property.fy}, fu={self.
                    material_property.fu}")
            else:
                self.material_property.fy, self.material_property
                    .fu = self.material_lookup_cache[cache_key]
                # self.logger.info(f"Using cached material
                    properties for {self.material}: fy={self.
                    material_property.fy}, fu={self.
                    material_property.fu}")

            # Defensive: Check if material properties were found
            if not self.material_property.fy or not self.
                material_property.fu:
                from ...Common import PATH_TO_DATABASE
                error_msg = f"Material properties not found for
                    grade '{self.material}' and thickness '{
                    max_thk}'. Check if the material exists in the
                     database at {PATH_TO_DATABASE}."
                self.logger.error(error_msg)
                self.failed_reason = error_msg
                self.design_status = False
                rejected_sections.append((trial_section, '
                    Material properties not found'))
                continue

            # section classification
            if self.sec_profile ==
                KEY_LACEDCOL_SEC_PROFILE_OPTIONS[0]:  # Beams and
                Columns
```

```
                if self.section_property.type == 'Rolled':
                    self.flange_class = IS800_2007.Table2_i((self
                        .section_property.flange_width / 2), self.
                        section_property.flange_thickness,
                                                            self.
                                                                material_prop
                                                                .
                                                                fy
                                                                ,
                                                                self
                                                                .
                                                                section_prope
                                                                .
                                                                type
                                                                )
                                                                [0]

                else:
                    self.flange_class = IS800_2007.Table2_i(((
                        self.section_property.flange_width / 2) -
                        (self.section_property.web_thickness / 2))
                        ,
                                                            self.
                                                                section_prope
                                                                .
                                                                flange_thickn
                                                                ,
                                                                self
                                                                .
                                                                section_prope
                                                                .
                                                                fy
                                                                ,
```

```
                                                    self.
                                                        section_prope
                                                        .
                                                        type
                                                        )
                                                        [0]

            # FIX: Use 'Neutral axis at mid-depth' for
                web_class
            self.web_class = IS800_2007.Table2_iii((self.
                section_property.depth - (2 * self.
                section_property.flange_thickness)),
                                                self.
                                                    section_property
                                                    .
                                                    web_thickness
                                                    , self.
                                                    material_property
                                                    .fy,
                                                classification_type
                                                    ='Axial

                                                    compression
                                                    ')

            # Calculate ratios for I-sections
            web_ratio = (self.section_property.depth - 2 * (
                        self.section_property.
                            flange_thickness + self.
                            section_property.root_radius)) /
                            self.section_property.
                            web_thickness
            flange_ratio = self.section_property.flange_width
                / 2 / self.section_property.flange_thickness
```

```
        elif self.sec_profile ==
            KEY_LACEDCOL_SEC_PROFILE_OPTIONS[1]:  # RHS and
            SHS
             self.flange_class = IS800_2007.Table2_iii((self.
                section_property.depth - (2 * self.
                section_property.flange_thickness)),
                                                       self.
                                                          section_property
                                                          .
                                                          flange_thickness
                                                          ,
                                                          self
                                                          .
                                                          material_proper
                                                          .fy,
                                                       classification_typ
                                                          ='
                                                          Axial
                                                          compression
                                                          ')
             self.web_class = self.flange_class

             # Calculate ratios for RHS/SHS
             web_ratio = (self.section_property.depth - 2 * (
                         self.section_property.
                            flange_thickness + self.
                            section_property.root_radius)) /
                            self.section_property.
                            web_thickness
             flange_ratio = self.section_property.flange_width
                 / 2 / self.section_property.flange_thickness
```

```
        elif self.sec_profile ==
            KEY_LACEDCOL_SEC_PROFILE_OPTIONS[2] and isinstance
            (self.section_property, CHS):  # CHS
                self.flange_class = IS800_2007.Table2_x(self.
                    section_property.out_diameter, self.
                    section_property.flange_thickness,
                                                        self.
                                                            material_property
                                                            .fy,
                                                            load_type
                                                            ='
                                                            axial
                                                            compression
                                                            ')
                self.web_class = self.flange_class
                # For CHS, use diameter to thickness ratio
                web_ratio = self.section_property.out_diameter /
                    self.section_property.flange_thickness
                flange_ratio = web_ratio  # Same ratio for
                    circular sections
        else:
            self.flange_class = self.web_class = None
            web_ratio = flange_ratio = None

        # Smart classification logic
        if self.flange_class == 'Slender' and self.web_class
            == 'Slender':
            self.section_class = 'Slender'
        elif 'Slender' in [self.flange_class, self.web_class
            ]:
            self.section_class = 'Semi-Compact'  # downgrade
                if only one is slender
        else:
```

```
                if self.flange_class == 'Plastic' and self.
                    web_class == 'Plastic':
                    self.section_class = 'Plastic'
                elif 'Plastic' in [self.flange_class, self.
                    web_class] or 'Compact' in [self.flange_class,
                    self.web_class]:
                    self.section_class = 'Compact'
                else:
                    self.section_class = 'Semi-Compact'

            # Optionally, upgrade borderline slender sections
            if self.section_class == 'Slender':
                if (flange_ratio is not None and web_ratio is not
                    None and
                    isinstance(flange_ratio, (int, float)) and
                        isinstance(web_ratio, (int, float)) and
                    flange_ratio <= 9.5 and web_ratio <= 79.5):
                    self.logger.info(f"Reclassifying borderline
                        Slender section {trial_section} to Semi-
                        Compact")
                    self.section_class = 'Semi-Compact'
            self.effective_length_zz = IS800_2007.
                cl_7_2_2_effective_length_of_prismatic_compression_members
                (
                 self.length_zz,
                 end_1=self.end_1_z,
                 end_2=self.end_2_z)
            self.effective_length_yy = IS800_2007.
                cl_7_2_2_effective_length_of_prismatic_compression_members
                (
                 self.length_yy,
                 end_1=self.end_1_y,
                 end_2=self.end_2_y)
```

```
            print(f"[DEBUG] Calculated effective_length_yy: {self
                .effective_length_yy}")

            # 2.3 - Effective slenderness ratio
            self.effective_sr_zz = self.effective_length_zz /
                self.section_property.rad_of_gy_z
            self.effective_sr_yy = self.effective_length_yy /
                self.section_property.rad_of_gy_y

            limit = IS800_2007.cl_3_8_max_slenderness_ratio(1)
            if self.effective_sr_zz > limit and self.
                effective_sr_yy > limit:
                error_msg = f"Length provided is beyond the limit
                    allowed for section {trial_section}. [
                    Reference: Cl 3.8, IS 800:2007]"
                self.logger.warning(error_msg)
                self.logger.error("Cannot compute. Given Length
                    does not pass.")
                self.failed_reason = error_msg
                slender_sections.append(trial_section)
                rejected_sections.append((trial_section, '
                    Slenderness ratio exceeded'))
                continue

            # Add section to input list if it passes
                classification filter
            if self.section_class in self.allowed_sections:
                self.input_section_list.append(trial_section)
                self.input_section_classification.update({
                    trial_section: [self.section_class, self.
                    flange_class, self.web_class, flange_ratio,
                    web_ratio]})
                accepted_sections.append(trial_section)
            else:
```

```
                self.logger.info(f"Section {trial_section}
                    classified as '{self.section_class}' but not
                    in allowed sections: {self.allowed_sections}")
                rejected_sections.append((trial_section, f"
                    Classified as '{self.section_class}', not in
                    allowed_sections"))
        # Check if any sections passed the classification filter
        if not self.input_section_list:
            error_msg = f"No sections passed the classification
                filter. Allowed sections: {self.allowed_sections}"
            self.logger.error(error_msg)
            self.failed_reason = error_msg
            self.design_status = False
            # Robust fallback: expand allowed_sections to all
                types and re-check
            self.logger.warning("No section passed classification
                . Expanding allowed_sections to include all types.
                ")
            self.allowed_sections = ['Plastic', 'Compact', 'Semi-
                Compact', 'Slender']
            for section in self.sec_list:
                trial_section = section.strip("'")
                if trial_section in self.
                    input_section_classification:
                     if self.input_section_classification[
                        trial_section][0] in self.allowed_sections
                        :
                         self.input_section_list.append(
                            trial_section)
                         accepted_sections.append(trial_section)
            if not self.input_section_list:
                self.logger.error("Design Failed. All sections
                    are too slender or do not meet requirements.")
                local_flag = False
```

```
        return local_flag


    def design_column(self):
        try:
            summary_lines = []
            # checking DP inputs
            if (self.allowable_utilization_ratio <= 0.10) or (
                self.allowable_utilization_ratio > 1.0):
                 logger.warning("The defined value of Utilization
                    Ratio in the design preferences tab is out of
                    the suggested range.")
                 logger.info("Provide an appropriate input and re-
                    design.")
                 logger.info("Assuming a default value of 1.0.")
                 self.allowable_utilization_ratio = 1.0
                 self.design_status = True
                 self.design_status_list.append(self.design_status
                    )

            if (self.effective_area_factor <= 0.10) or (self.
                effective_area_factor > 1.0):
                 logger.warning("The defined value of Effective
                    Area Factor in the design preferences tab is
                    out of the suggested range.")
                 logger.info("Provide an appropriate input and re-
                    design.")
                 logger.info("Assuming a default value of 1.0.")
                 self.effective_area_factor = 1.0
                 self.design_status = False
                 self.design_status_list.append(self.design_status
                    )
```

```
            self.epsilon = math.sqrt(250 / self.material_property
                .fy)
            self.optimum_section_ur_results = {}
            self.optimum_section_ur = []
            self.flag = self.section_classification()
            # Remove duplicate sections to avoid repeated
                calculations
            self.input_section_list = list(dict.fromkeys(self.
                input_section_list))
            if self.flag:
                for section in self.input_section_list:
                    ur_class = None
                    if section in self.
                        input_section_classification:
                        ur_class = self.
                            input_section_classification[section]
                    ur_value = None
                    for ur in self.optimum_section_ur_results:
                        if self.optimum_section_ur_results[ur].
                            get('Designation') == section:
                            ur_value = ur
                            break
                for section in self.input_section_list:  #
                    iterating the design over each section to find
                    the most optimum section

                    # fetching the section properties of the
                        selected section
                    if self.sec_profile == VALUES_SEC_PROFILE[0]:
                        # Beams and columns
                        try:
                            result = Beam(designation=section,
                                material_grade=self.material)
                        except:
```

```
                result = Column(designation=section,
                    material_grade=self.material)
            self.section_property = result
        elif self.sec_profile == VALUES_SEC_PROFILE
            [1]:  # RHS and SHS
            try:
                result = RHS(designation=section,
                    material_grade=self.material)
            except:
                result = SHS(designation=section,
                    material_grade=self.material)
            self.section_property = result

        elif self.sec_profile == VALUES_SEC_PROFILE
            [2]:  # CHS
            self.section_property = CHS(designation=
                section, material_grade=self.material)
            self.section_property.designation =
                section
        else:   #Why?
            self.section_property = Column(
                designation=section, material_grade=
                self.material)

        self.material_property.
            connect_to_database_to_get_fy_fu(self.
            material, max(self.section_property.
            flange_thickness,
```

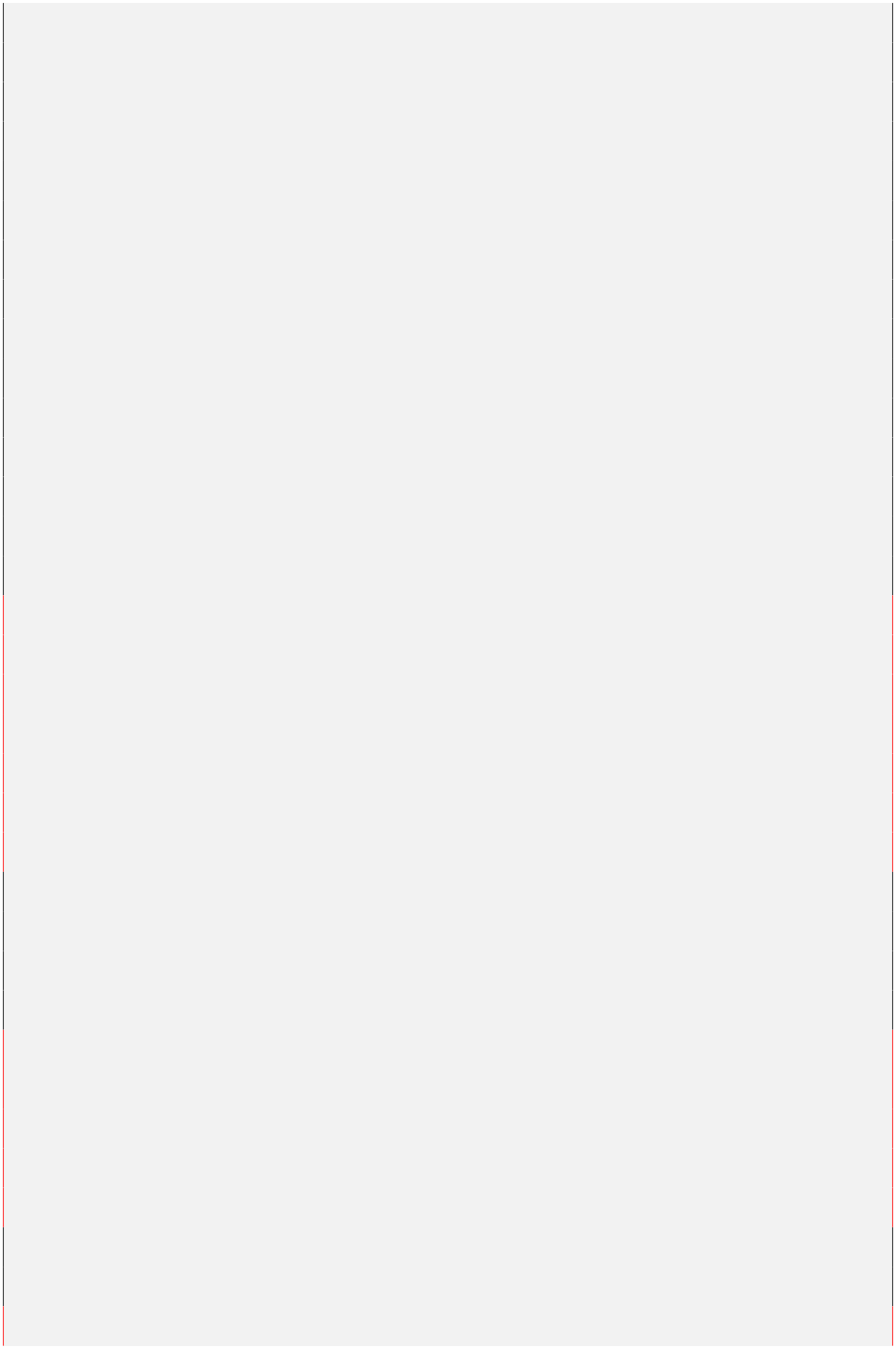
```
                self.epsilon = math.sqrt(250 / self.
                    material_property.fy)


                # initialize lists for updating the results
                    dictionary
                self.list_zz = []
                self.list_yy = []

                self.list_zz.append(section)
                self.list_yy.append(section)

                # Step 1 - computing the effective sectional
                    area
                self.section_class = self.
                    input_section_classification[section][0]

                if self.section_class == 'Slender':
                    if (self.sec_profile ==
                        VALUES_SEC_PROFILE[0]):  # Beams and
                        Columns
                        self.effective_area = (2 * ((31.4 *
                            self.epsilon * self.
                            section_property.flange_thickness)
                            *
                                                    self.
                                                        section_property
                                                        .
                                                        flange_thickness
                                                        )) + \
                                                (2 * ((21 * self.
                                                    epsilon * self
```

```
                                        .
                                        section_property
                                        .web_thickness
                                        ) * self.
                                        section_property
                                        .web_thickness
                                        ))
            elif (self.sec_profile ==
                VALUES_SEC_PROFILE[1]):
                 self.effective_area = (2 * 21 * self.
                    epsilon * self.section_property.
                    flange_thickness) * 2
        else:
            self.effective_area = self.
                section_property.area  # mm2


        if self.effective_area_factor < 1.0:
            self.effective_area = round(self.
                effective_area * self.
                effective_area_factor, 2)

        self.list_zz.append(self.section_class)
        self.list_yy.append(self.section_class)

        self.list_zz.append(self.effective_area)
        self.list_yy.append(self.effective_area)

        # Step 2 - computing the design compressive
            stress

        # 2.1 - Buckling curve classification and
            Imperfection factor
```

```
                    if (self.sec_profile == VALUES_SEC_PROFILE
                        [0]):  # Beams and Columns

                        if self.section_property.type == 'Rolled'
                            :
                            self.buckling_class_zz = IS800_2007.
                                cl_7_1_2_2_buckling_class_of_crosssections
                                (self.section_property.
                                flange_width,
```

```
                self.buckling_class_yy = IS800_2007.
                    cl_7_1_2_2_buckling_class_of_crosssections
                    (self.section_property.
                    flange_width,
```

```
                else:
                    self.buckling_class_zz = IS800_2007.
                        cl_7_1_2_2_buckling_class_of_crosssections
                        (self.section_property.
                        flange_width,
```



```
                    self.buckling_class_yy = IS800_2007.
                        cl_7_1_2_2_buckling_class_of_crosssections
                        (self.section_property.
                        flange_width,
```

```
                else:
                    self.buckling_class_zz = 'a'
                    self.buckling_class_yy = 'a'

                self.imperfection_factor_zz = IS800_2007.
                   cl_7_1_2_1_imperfection_factor(
                   buckling_class=self.buckling_class_zz)
                self.imperfection_factor_yy = IS800_2007.
                   cl_7_1_2_1_imperfection_factor(
                   buckling_class=self.buckling_class_yy)

                self.list_zz.append(self.buckling_class_zz)
                self.list_yy.append(self.buckling_class_yy)

                self.list_zz.append(self.
                   imperfection_factor_zz)
                self.list_yy.append(self.
                   imperfection_factor_yy)
```

```
                # Store imperfection factors for output
                self.result_IF_zz = float(self.
                    imperfection_factor_zz) if self.
                    imperfection_factor_zz is not None else
                    None
                self.result_IF_yy = float(self.
                    imperfection_factor_yy) if self.
                    imperfection_factor_yy is not None else
                    None
                self.result['imperfection_factor_yy'] = self.
                    result_IF_yy
                self.result['imperfection_factor_zz'] = self.
                    result_IF_zz

                # 2.2 - Effective length
                self.effective_length_zz = IS800_2007.
                    cl_7_2_2_effective_length_of_prismatic_compression_mem
                    (self.length_zz ,
```

```
                self.effective_length_yy = IS800_2007.
                    cl_7_2_2_effective_length_of_prismatic_compression_mem
                    (self.length_yy ,
                                                                    self.list_zz.append(self.effective_length_zz)
                self.list_yy.append(self.effective_length_yy)

                # 2.3 - Effective slenderness ratio
                self.effective_sr_zz = self.
                    effective_length_zz / self.
                    section_property.rad_of_gy_z
```

```
                self.effective_sr_yy = self.
                    effective_length_yy / self.
                    section_property.rad_of_gy_y

                self.list_zz.append(self.effective_sr_zz)
                self.list_yy.append(self.effective_sr_yy)

                # 2.4 - Euler buckling stress
                self.euler_bs_zz = (math.pi ** 2 * self.
                    section_property.modulus_of_elasticity) /
                    self.effective_sr_zz ** 2
                self.euler_bs_yy = (math.pi ** 2 * self.
                    section_property.modulus_of_elasticity) /
                    self.effective_sr_yy ** 2

                self.list_zz.append(self.euler_bs_zz)
                self.list_yy.append(self.euler_bs_yy)

                # Store euler buckling stress for output
                self.result_ebs_zz = float(self.euler_bs_zz)
                    if self.euler_bs_zz is not None else None
                self.result_ebs_yy = float(self.euler_bs_yy)
                    if self.euler_bs_yy is not None else None
                self.result['euler_buckling_stress_yy'] =
                    self.result_ebs_yy
                self.result['euler_buckling_stress_zz'] =
                    self.result_ebs_zz

                # 2.5 - Non-dimensional effective slenderness
                    ratio
                self.non_dim_eff_sr_zz = math.sqrt(self.
                    material_property.fy / self.euler_bs_zz)
                self.non_dim_eff_sr_yy = math.sqrt(self.
                    material_property.fy / self.euler_bs_yy)
```

```
        self.list_zz.append(self.non_dim_eff_sr_zz)
        self.list_yy.append(self.non_dim_eff_sr_yy)

        # 2.5 - phi
        self.phi_zz = 0.5 * (1 + (self.
            imperfection_factor_zz * (self.
            non_dim_eff_sr_zz - 0.2)) + self.
            non_dim_eff_sr_zz ** 2)
        self.phi_yy = 0.5 * (1 + (self.
            imperfection_factor_yy * (self.
            non_dim_eff_sr_yy - 0.2)) + self.
            non_dim_eff_sr_yy ** 2)


        self.list_zz.append(self.phi_zz)
        self.list_yy.append(self.phi_yy)

        # 2.6 - Design compressive stress
        self.stress_reduction_factor_zz = 1 / (self.
            phi_zz + (self.phi_zz ** 2 - self.
            non_dim_eff_sr_zz ** 2) ** 0.5)
        self.stress_reduction_factor_yy = 1 / (self.
            phi_yy + (self.phi_yy ** 2 - self.
            non_dim_eff_sr_yy ** 2) ** 0.5)

        self.list_zz.append(self.
            stress_reduction_factor_zz)
        self.list_yy.append(self.
            stress_reduction_factor_yy)

        self.f_cd_1_zz = (self.
            stress_reduction_factor_zz * self.
```

```
                material_property.fy) / self.gamma_m0
            self.f_cd_1_yy = (self.
                stress_reduction_factor_yy * self.
                material_property.fy) / self.gamma_m0
            self.f_cd_2 = self.material_property.fy /
                self.gamma_m0

            self.f_cd_zz = min(self.f_cd_1_zz, self.
                f_cd_2)
            self.f_cd_yy = min(self.f_cd_1_yy, self.
                f_cd_2)

            self.f_cd = min(self.f_cd_zz, self.f_cd_yy)

            self.list_zz.append(self.f_cd_1_zz)
            self.list_yy.append(self.f_cd_1_yy)

            self.list_zz.append(self.f_cd_2)
            self.list_yy.append(self.f_cd_2)

            self.list_zz.append(self.f_cd_zz)
            self.list_yy.append(self.f_cd_yy)

            self.list_zz.append(self.f_cd)
            self.list_yy.append(self.f_cd)

            # 2.7 - Capacity of the section

            self.section_capacity = self.f_cd * self.
                effective_area  # N

            self.list_zz.append(self.section_capacity)
            self.list_yy.append(self.section_capacity)
```

```
                # 2.8 - UR
                self.ur = round(self.load.axial_force / self.
                    section_capacity, 3)

                self.list_zz.append(self.ur)
                self.list_yy.append(self.ur)
                self.optimum_section_ur.append(self.ur)

                # --- Tie Plate, Spacing, and Lacing Angle
                    Calculations ---
                tie_plate_d = round(2 * self.section_property
                    .depth / 3, 2)          # mm
                tie_plate_t = round(self.section_property.
                    web_thickness, 2)           # mm
                tie_plate_l = round(self.section_property.
                    depth / 2, 2)               # mm
                spacing_between_channels = round(self.
                    section_property.depth + 2 * tie_plate_t,
                    2)  # mm
                lacing_angle = round(math.degrees(math.atan(
                    spacing_between_channels / (2 *
                    tie_plate_l))), 2)  # degrees

                # Store in self.result for output dock (for
                    the last/selected section)
                self.result['tie_plate_d'] = tie_plate_d
                self.result['tie_plate_t'] = tie_plate_t
                self.result['tie_plate_l'] = tie_plate_l
                self.result['channel_spacing'] =
                    spacing_between_channels
                self.result['lacing_spacing'] = lacing_angle

                # Store in optimum_section_ur_results for
                    output dock (for each section)
```

```
                    ur = self.ur
                    if ur in self.optimum_section_ur_results:
                        self.optimum_section_ur_results[ur]['
                            tie_plate_d'] = tie_plate_d
                        self.optimum_section_ur_results[ur]['
                            tie_plate_t'] = tie_plate_t
                        self.optimum_section_ur_results[ur]['
                            tie_plate_l'] = tie_plate_l
                        self.optimum_section_ur_results[ur]['
                            channel_spacing'] =
                            spacing_between_channels
                        self.optimum_section_ur_results[ur]['
                            lacing_spacing'] = lacing_angle

                    # Calculate and store cost for this section (
                        needed for cost-based optimization)
                    self.cost = (self.section_property.unit_mass
                        * self.section_property.area * 1e-4) * min
                        (self.length_zz, self.length_yy) * self.
                        steel_cost_per_kg
                    self.optimum_section_cost.append(self.cost)

                    #tieplate
                    # 2.X - Tie Plate Dimensions
                    self.tie_plate_d = round(2 * self.
                        section_property.depth / 3, 2)          #
                        mm
                    self.tie_plate_t = round(self.
                        section_property.web_thickness, 2)
                            # mm
                    self.tie_plate_l = round(self.
                        section_property.depth / 2, 2)
                                # mm
                    self.list_zz.append(self.tie_plate_d)
```

```
                    self.list_yy.append(self.tie_plate_d)
                    self.list_zz.append(self.tie_plate_t)
                    self.list_yy.append(self.tie_plate_t)
                    self.list_zz.append(self.tie_plate_l)
                    self.list_yy.append(self.tie_plate_l)

# 2.X - Lacing Spacing Between Channels
                    self.spacing_between_channels = round(self.
                       section_property.depth + 2 * self.
                       tie_plate_t, 2)  # mm
                    self.list_zz.append(self.
                       spacing_between_channels)
                    self.list_yy.append(self.
                       spacing_between_channels)

# 2.X - Lacing Angle
                    self.lacing_angle = round(math.degrees(math.
                       atan(self.spacing_between_channels / (2 *
                       self.tie_plate_l))), 2)  # degrees
                    self.list_zz.append(self.lacing_angle)
                    self.list_yy.append(self.lacing_angle)
                    self.store_additional_outputs(
                        d=self.tie_plate_d,
                        t=self.tie_plate_t,
                        l=self.tie_plate_l,
                        spacing=self.lacing_angle,
                        c_spacing=self.spacing_between_channels
                        )


                    # Step 3 - Storing the optimum results to a
                       list in descending order
                    list_1 = [
```

```
                    'Designation', 'Section class', '
                        Effective area', 'Buckling_curve_zz',
                        'IF_zz', 'Effective_length_zz', '
                        Effective_SR_zz',
                    'EBS_zz', 'ND_ESR_zz', 'phi_zz', 'SRF_zz'
                        , 'FCD_1_zz', 'FCD_2', 'FCD_zz', 'FCD'
                        , 'Capacity', 'UR', 'Cost', '
                        Designation',
                    'Section class', 'Effective area', '
                        Buckling_curve_yy', 'IF_yy', '
                        Effective_length_yy', 'Effective_SR_yy
                        ', 'EBS_yy',
                    'ND_ESR_yy', 'phi_yy', 'SRF_yy', '
                        FCD_1_yy', 'FCD_2', 'FCD_yy', 'FCD', '
                        Capacity', 'UR', 'Cost'
                ]


        try:
            for section in self.input_section_list:
                # perform all calculations for this section (
                    assumed already done)
                section_result = {
                    'Designation': section,
                    'Section class': self.section_class,
                    'Effective area': self.effective_area,
                    'Buckling_curve_zz': self.
                        buckling_class_zz,
                    'IF_zz': self.result_IF_zz,
                    'Effective_length_zz': self.
                        effective_length_zz,
                    'Effective_SR_zz': self.effective_sr_zz,
                    'EBS_zz': self.result_ebs_zz,
                    'ND_ESR_zz': self.non_dim_eff_sr_zz,
                    'phi_zz': self.phi_zz,
```

```
                    'SRF_zz': self.stress_reduction_factor_zz
                        ,
                    'FCD_1_zz': self.f_cd_1_zz,
                    'FCD_2': self.f_cd_2,
                    'FCD_zz': self.f_cd_zz,
                    'FCD': self.f_cd,
                    'Capacity': self.section_capacity,
                    'UR': self.ur,
                    'Cost': self.cost,
                    'Buckling_curve_yy': self.
                        buckling_class_yy,
                    'IF_yy': self.result_IF_yy,
                    'Effective_length_yy': self.
                        effective_length_yy,
                    'Effective_SR_yy': self.effective_sr_yy,
                    'EBS_yy': self.result_ebs_yy,
                    'ND_ESR_yy': self.non_dim_eff_sr_yy,
                    'phi_yy': self.phi_yy,
                    'SRF_yy': self.stress_reduction_factor_yy
                        ,
                    'FCD_1_yy': self.f_cd_1_yy,
                    'FCD_yy': self.f_cd_yy,
                    'tie_plate_d': self.tie_plate_d,
                    'tie_plate_t': self.tie_plate_t,
                    'tie_plate_l': self.tie_plate_l,
                    'channel_spacing': self.
                        spacing_between_channels,
                    'lacing_spacing': self.lacing_angle,
                }
                self.optimum_section_ur_results[self.ur] =
                    section_result

            # 2- Based on optimum cost
            self.optimum_section_cost_results[self.cost] = {}
```

```
                list_2 = self.list_zz + self.list_yy
                for j in list_1:
                    for k in list_2:
                        self.optimum_section_cost_results[self.
                            cost][j] = k
                        list_2.pop(0)
                        break

            except Exception as e:
                self.logger.error(f"Exception in design_column: {
                    e}")
                import traceback
                self.logger.error(traceback.format_exc())
                self.design_status = False
                self.failed_design_dict = {}
                return

            best_ur = None
            best_section_results = None
            if self.optimum_section_ur:
                best_ur = round(min(self.optimum_section_ur, key=
                    lambda x: abs(x-1.0)), 3)
                best_section_results = self.
                    optimum_section_ur_results.get(best_ur)
                if best_section_results is None:
                    # fallback: find the closest key within a
                        small tolerance
                    if self.optimum_section_ur_results:
                        closest_key = min(self.
                            optimum_section_ur_results.keys(), key
                            =lambda k: abs(k - best_ur))
                        if abs(closest_key - best_ur) < 1e-3:
                            best_section_results = self.
                                optimum_section_ur_results[
```

```
                                closest_key]
                    if best_section_results is None:
                        self.logger.error(f"Result UR {best_ur}
                            not found in
                            optimum_section_ur_results. No valid
                            design result to display.")
                        return
                summary_lines.append(f"Best UR: {best_ur}")
                summary_lines.append(f"Best Section Results: {
                    best_section_results}")

            summary_lines.append("======================")
            summary_text = "\n".join(summary_lines)

            self.design_summary = {
                'input_section_list': self.input_section_list,
                'optimum_section_ur': self.optimum_section_ur,
                'best_ur': best_ur,
                'best_section_results': best_section_results,
                'summary_text': summary_text
            }
        except Exception as e:
            self.logger.error(f"Exception in design_column: {e}")
            import traceback
            self.logger.error(traceback.format_exc())
            self.design_status = False
            self.failed_design_dict = {}
            return

    def store_additional_outputs(self, d=None, t=None, l=None,
        spacing=None, c_spacing=None, ur=None):
        """
        Store additional calculated outputs for tie plate, lacing
            , and channel spacing in self.result and, if ur is
```

```
            provided, in self.optimum_section_ur_results[ur].
        """
        if d is not None:
            self.result['tie_plate_d'] = d
        if t is not None:
            self.result['tie_plate_t'] = t
        if l is not None:
            self.result['tie_plate_l'] = l
        if spacing is not None:
            self.result['lacing_spacing'] = spacing
        if c_spacing is not None:
            self.result['channel_spacing'] = c_spacing
        # Also store in optimum_section_ur_results[ur] if ur is
            provided
        if ur is not None and hasattr(self, '
            optimum_section_ur_results') and ur in self.
            optimum_section_ur_results:
            if d is not None:
                self.optimum_section_ur_results[ur]['tie_plate_d'
                    ] = d
            if t is not None:
                self.optimum_section_ur_results[ur]['tie_plate_t'
                    ] = t
            if l is not None:
                self.optimum_section_ur_results[ur]['tie_plate_l'
                    ] = l
            if spacing is not None:
                self.optimum_section_ur_results[ur]['
                    lacing_spacing'] = spacing
            if c_spacing is not None:
                self.optimum_section_ur_results[ur]['
                    channel_spacing'] = c_spacing

    def calculate(self, design_dictionary):
```

```
        self.reset_state_for_new_design()
        # --- PATCH: Ensure end condition values are always
            present and correct in design_dictionary ---
        # Try to extract from possible keys, fallback to UI
            attributes if missing, and update dictionary
        # This ensures end1/end2 are always correct for
            calculation and output
        # 1. Try to get from dictionary as before
        end1 = (
            design_dictionary.get('End Condition 1', None)
            or design_dictionary.get('KEY_END1', None)
            or design_dictionary.get('end1', None)
            or design_dictionary.get('End_1', None)
        )
        end2 = (
            design_dictionary.get('End Condition 2', None)
            or design_dictionary.get('KEY_END2', None)
            or design_dictionary.get('end2', None)
            or design_dictionary.get('End_2', None)
        )
        # 2. If still missing, try to get from UI combo boxes if
            available
        if (not end1 or isinstance(end1, list)) and hasattr(self,
            'end1_combo'):
            try:
                end1_val = self.end1_combo.currentText() if
                    hasattr(self.end1_combo, 'currentText') else
                    None
                if end1_val and isinstance(end1_val, str):
                    end1 = end1_val
            except Exception:
                pass
        if (not end2 or isinstance(end2, list)) and hasattr(self,
            'end2_combo'):
```

```
            try:
                end2_val = self.end2_combo.currentText() if
                    hasattr(self.end2_combo, 'currentText') else
                    None
                if end2_val and isinstance(end2_val, str):
                    end2 = end2_val
            except Exception:
                pass
        # 3. If still missing, try to get from UI line edits (if
            used)
        if (not end1 or isinstance(end1, list)) and hasattr(self,
            'end1_lineedit'):
            try:
                end1_val = self.end1_lineedit.text() if hasattr(
                    self.end1_lineedit, 'text') else None
                if end1_val and isinstance(end1_val, str):
                    end1 = end1_val
            except Exception:
                pass
        if (not end2 or isinstance(end2, list)) and hasattr(self,
            'end2_lineedit'):
            try:
                end2_val = self.end2_lineedit.text() if hasattr(
                    self.end2_lineedit, 'text') else None
                if end2_val and isinstance(end2_val, str):
                    end2 = end2_val
            except Exception:
                pass
        # 4. If still missing, try to get from attributes set by
            UI (if any)
        if (not end1 or isinstance(end1, list)) and hasattr(self,
            'end1'):
            if isinstance(self.end1, str):
                end1 = self.end1
```

```
        if (not end2 or isinstance(end2, list)) and hasattr(self,
            'end2'):
            if isinstance(self.end2, str):
                end2 = self.end2
        # 5. Update the dictionary so the rest of the method
           works as expected
        if end1 and isinstance(end1, str):
            design_dictionary['End Condition 1'] = end1
            design_dictionary['End_1'] = end1
        if end2 and isinstance(end2, str):
            design_dictionary['End Condition 2'] = end2
            design_dictionary['End_2'] = end2
        for k in design_dictionary:
            print(f"    {k!r}: {design_dictionary[k]!r}")

        # --- Patch: Calculate and assign effective length YY
           using IS 800:2007 Table 11 logic ---
        try:
            # --- Patch: Forcefully push calculated values for
               output dock ---
            unsupported_length_yy = (
                design_dictionary.get('Unsupported Length YY',
                   None)
                or design_dictionary.get('KEY_UNSUPPORTED_LEN_YY'
                   , None)
                or design_dictionary.get('unsupported_length_yy',
                    None)
                or design_dictionary.get('Unsupported.Length_yy',
                    None)
            )
            # Warn if end1 or end2 is a list, not a string
            if isinstance(end1, list):
                end1 = None
            if isinstance(end2, list):
```

```
                end2 = None
            if not end1:
                print("[DEBUG][calculate] MISSING: end1 is not
                    set or empty!")
                pass
            if not end2:
                print("[DEBUG][calculate] MISSING: end2 is not
                    set or empty!")
                pass
            if not unsupported_length_yy:
                pass
                try:
                    unsupported_length_yy = float(
                        unsupported_length_yy)
                    eff_len_yy_calc = self.
                        calculate_effective_length_yy(end1, end2,
                        unsupported_length_yy)
                    self.effective_length_yy = eff_len_yy_calc
                    if not hasattr(self, 'result') or not
                        isinstance(self.result, dict):
                         self.result = {}
                    self.result['effective_length_yy'] =
                        eff_len_yy_calc
                    self.result['Effective_length_yy'] =
                        eff_len_yy_calc
                    self.result['Effective Length YY'] =
                        eff_len_yy_calc
                    print(f"[DEBUG] Calculated
                        effective_length_yy: {eff_len_yy_calc}")
                except Exception as e:
                    print('[DEBUG] Could not calculate
                        effective_length_yy:', e)
                pass
            # --- Buckling Curve ZZ ---
```

```
            bc_zz_val = None
            if hasattr(self, 'result_bc_zz') and self.
               result_bc_zz:
                bc_zz_val = self.result_bc_zz
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys())
                best_result = self.optimum_section_ur_results[
                   best_ur]
                for k in ['Buckling_curve_zz', 'Buckling Curve ZZ
                   ', 'buckling_curve_zz']:
                    if k in best_result:
                        bc_zz_val = best_result[k]
                        break
            if bc_zz_val is not None:
                self.result['buckling_curve_zz'] = bc_zz_val
                self.result['Buckling_curve_zz'] = bc_zz_val
                self.result['Buckling Curve ZZ'] = bc_zz_val
                self.result_bc_zz = bc_zz_val
            # --- ND ESR YY ---
            nd_esr_yy_val = None
            if hasattr(self, 'result_nd_esr_yy') and self.
               result_nd_esr_yy is not None:
                nd_esr_yy_val = self.result_nd_esr_yy
            elif hasattr(self, 'optimum_section_ur_results') and
               self.optimum_section_ur_results:
                best_ur = min(self.optimum_section_ur_results.
                   keys())
                best_result = self.optimum_section_ur_results[
                   best_ur]
                for k in ['ND_ESR_yy', 'nd_esr_yy', 'ND ESR YY']:
                    if k in best_result:
                        nd_esr_yy_val = best_result[k]
```

```
                    break
        if nd_esr_yy_val is not None:
            self.result['nd_esr_yy'] = nd_esr_yy_val
            self.result['ND_ESR_yy'] = nd_esr_yy_val
            self.result['ND ESR YY'] = nd_esr_yy_val
            self.result_nd_esr_yy = nd_esr_yy_val
    except Exception as e:
        print('[DEBUG] Error in effective_length_yy/
           buckling_curve_zz/nd_esr_yy patch:', e)
    """
    Perform all calculations for the laced column based on
       user input and assign results to output fields.
    This method is called explicitly from the UI after user
       input is collected.
    """
    try:
        # Set input values and run validation/classification
        self.set_input_values(design_dictionary)
        self.section_classification()
        # Print all section results for debug/verification
        self.print_all_section_results()
        # For the best section (lowest UR), extract and
           assign all output fields
        if hasattr(self, 'optimum_section_ur_results') and
           self.optimum_section_ur_results:
            # Find the best section (lowest UR) with all
               required results
            best_ur = None
            for ur in sorted(self.optimum_section_ur_results.
               keys()):
                res = self.optimum_section_ur_results[ur]
                # Check if all required keys are present and
                   not None
                required_keys = [
```

```
                'Effective Length YY', 'Effective Length
                    ZZ', 'Slenderness YY', 'Slenderness ZZ
                    ', 'FCD', 'Capacity',
                'Section class', 'Effective area', '
                    Buckling_curve_yy', 'Buckling_curve_zz
                    ', 'IF_yy', 'IF_zz',
                'EBS_yy', 'EBS_zz', 'ND_ESR_yy', '
                    ND_ESR_zz', 'phi_yy', 'phi_zz', '
                    SRF_yy', 'SRF_zz',
                'FCD_1_yy', 'FCD_1_zz', 'FCD_2', 'Cost',
                    'channel_spacing', 'tie_plate_d', '
                    tie_plate_t', 'tie_plate_l', '
                    lacing_spacing'
            ]
            if all(k in res and res[k] is not None for k
                in required_keys):
                best_ur = ur
                break
    if best_ur is None:
        # Fallback: just pick the lowest UR
        best_ur = min(self.optimum_section_ur_results
            .keys())
    best_result = self.optimum_section_ur_results[
        best_ur]
    # Assign all output fields for UI/terminal
    # Only assign actual calculated values for
        effective length and slenderness, never allow
        'mpc' or similar text
    def get_numeric_value(keys):
        for k in keys:
            v = best_result.get(k)
            if v is not None:
                # If value is a string and contains '
                    mpc' or is not a number, skip
```

```
                    if isinstance(v, str):
                        if 'mpc' in v.lower():
                            continue
                        try:
                            return float(v)
                        except Exception:
                            continue
                    elif isinstance(v, (int, float)):
                        return v
            return None

        # Only assign if not already set to a valid
            number
        if not (hasattr(self, 'effective_length_yy') and
            isinstance(self.effective_length_yy, (int,
            float)) and self.effective_length_yy > 0):
            self.effective_length_yy = get_numeric_value
                (['Effective_length_yy', 'Effective Length
                 YY', 'effective_length_yy'])
        self.effective_length_zz = get_numeric_value(['
            Effective_length_zz', 'Effective Length ZZ', '
            effective_length_zz'])
        self.effective_sr_yy = get_numeric_value(['
            Effective_sr_yy', 'Slenderness YY', '
            effective_sr_yy', 'Slenderness_yy'])
        self.effective_sr_zz = get_numeric_value(['
            Effective_sr_zz', 'Slenderness ZZ', '
            effective_sr_zz', 'Slenderness_zz'])
        self.result_fcd = best_result.get('FCD')
        self.result_capacity = best_result.get('Capacity'
            )
        self.result_UR = best_ur
        self.result_section_class = best_result.get('
            Section class')
```

```
                self.result_effective_area = best_result.get('
                    Effective area')
                self.result_bc_yy = best_result.get('
                    Buckling_curve_yy')
                self.result_bc_zz = best_result.get('
                    Buckling_curve_zz')
                self.result_IF_yy = best_result.get('IF_yy')
                self.result_IF_zz = best_result.get('IF_zz')
                self.result_ebs_yy = best_result.get('EBS_yy')
                self.result_ebs_zz = best_result.get('EBS_zz')
                self.result_nd_esr_yy = best_result.get('
                    ND_ESR_yy')
                self.result_nd_esr_zz = best_result.get('
                    ND_ESR_zz')
                self.result_phi_yy = best_result.get('phi_yy')
                self.result_phi_zz = best_result.get('phi_zz')
                self.result_srf_yy = best_result.get('SRF_yy')
                self.result_srf_zz = best_result.get('SRF_zz')
                self.result_fcd_1_yy = best_result.get('FCD_1_yy'
                    )
                self.result_fcd_1_zz = best_result.get('FCD_1_zz'
                    )
                self.result_fcd_2 = best_result.get('FCD_2')
                self.result_cost = best_result.get('Cost')
                self.result_channel_spacing = best_result.get('
                    channel_spacing')
                self.result_tie_plate_d = best_result.get('
                    tie_plate_d')
                self.result_tie_plate_t = best_result.get('
                    tie_plate_t')
                self.result_tie_plate_l = best_result.get('
                    tie_plate_l')
                self.result_lacing_spacing = best_result.get('
                    lacing_spacing')
```

```
                # Print all calculated values for debug/
                    verification
                print("\n[DEBUG] All calculated values for best
                    section:")
                for k, v in best_result.items():
                    print(f"  {k}: {v}")
                print("\n[DEBUG] Attribute values set on self:")
                attrs = [
                    'effective_length_yy', 'effective_length_zz',
                        'effective_sr_yy', 'effective_sr_zz', '
                        result_fcd', 'result_capacity',
                    'result_UR', 'result_section_class', '
                        result_effective_area', 'result_bc_yy', '
                        result_bc_zz', 'result_IF_yy', '
                        result_IF_zz',
                    'result_ebs_yy', 'result_ebs_zz', '
                        result_nd_esr_yy', 'result_nd_esr_zz', '
                        result_phi_yy', 'result_phi_zz', '
                        result_srf_yy',
                    'result_srf_zz', 'result_fcd_1_yy', '
                        result_fcd_1_zz', 'result_fcd_2', '
                        result_cost', 'result_channel_spacing',
                    'result_tie_plate_d', 'result_tie_plate_t', '
                        result_tie_plate_l', '
                        result_lacing_spacing'
                ]
                for attr in attrs:
                    print(f"  {attr}: {getattr(self, attr, None)}
                        ")
        except Exception as e:
            print(traceback.format_exc())

    def results(self):
        # Prevent duplicate logs in a single calculation
```

```
        if not hasattr(self, 'design_status_list') or self.
           design_status_list is None or not isinstance(self.
           design_status_list, list):
            self.design_status_list = []
        if hasattr(self, '_already_logged_failure'):
            del self._already_logged_failure

        if not self.optimum_section_ur:
            error_msg = "No sections available for design. Please
                check your input or section list."
            self.logger.error(error_msg)
            self.failed_reason = error_msg
            self.design_status = False
            self.failed_design_dict = {}
            return

        if len(self.optimum_section_ur) == 0:  # no design was
           successful
            if not hasattr(self, '_already_logged_failure'):
                self._already_logged_failure = True
                error_msg = "The sections selected by the solver
                   from the defined list of sections did not
                   satisfy the Utilization Ratio (UR) criteria"
                self.failed_reason = error_msg
            self.design_status = False
            if self.failed_design_dict is None or not isinstance(
               self.failed_design_dict, dict):
                self.failed_design_dict = {}
            if self.failed_design_dict and isinstance(self.
               failed_design_dict, dict) and len(self.
               failed_design_dict) > 0:
                self.logger.info("The details for the best
                   section provided is being shown")
```

```
                self.result_UR = self.failed_design_dict.get('UR'
                    , None)
                self.common_result(
                    list_result=self.failed_design_dict,
                    result_type=None,
                )
                self.logger.warning("Re-define the list of
                    sections or check the Design Preferences
                    option and re-design.")
                return
            self.failed_design_dict = {}  # Always a dict for
                downstream code
            return

        _ = [i for i in self.optimum_section_ur if i > 1.0]

        if len(_)==1:
            temp = _[0]
        elif len(_)==0:
            temp = None
        else:
            temp = sorted(_)[0]
        self.failed_design_dict = self.optimum_section_ur_results
            [temp] if temp is not None else None

        # results based on UR
        if self.optimization_parameter == 'Utilization Ratio':

            filter_UR = filter(lambda x: x <= min(self.
                allowable_utilization_ratio, 1.0), self.
                optimum_section_ur)
            self.optimum_section_ur = list(filter_UR)
            self.optimum_section_ur.sort()
```

```
            # selecting the section with most optimum UR
            if len(self.optimum_section_ur) == 0:  # no design
                was successful
                error_msg = f"The sections selected by the solver
                    from the defined list of sections did not
                    satisfy the Utilization Ratio (UR) criteria.
                    Allowable UR: {self.
                    allowable_utilization_ratio}"
                self.failed_reason = error_msg
                self.design_status = False

                # Fallback: If we have results but they were
                    filtered out, show the best one anyway
                if hasattr(self, 'optimum_section_ur_results')
                    and self.optimum_section_ur_results:
                    self.logger.info("Showing best available
                        result despite UR filter failure")
                    best_ur = min(self.optimum_section_ur_results
                        .keys())
                    self.result_UR = best_ur
                    self.common_result(
                        list_result=self.
                            optimum_section_ur_results,
                        result_type=best_ur,
                    )
                    return

                if self.failed_design_dict and isinstance(self.
                    failed_design_dict, dict) and len(self.
                    failed_design_dict) > 0:
                    self.logger.info(
                    "The details for the best section provided is
                        being shown"
                )
```

```
                self.result_UR = self.failed_design_dict.get(
                    'UR', None) #temp
                self.common_result(
                    list_result=self.failed_design_dict,
                    result_type=None,
                )
                self.logger.warning(
                "Re-define the list of sections or check the
                   Design Preferences option and re-design."
            )
                return

        self.failed_design_dict = {}
        self.result_UR = self.optimum_section_ur[-1]  #
           optimum section which passes the UR check

        self.design_status = True
        if self.result_UR in self.optimum_section_ur_results:
            self.common_result(
                list_result=self.optimum_section_ur_results,
                result_type=self.result_UR,
            )
        else:
            error_msg = f"Result UR {self.result_UR} not
               found in optimum_section_ur_results. No valid
               design result to display."
            self.logger.error(error_msg)
            self.failed_reason = error_msg
            self.design_status = False
    else:  # results based on cost
        self.optimum_section_cost.sort()

        # selecting the section with most optimum cost
        self.result_cost = self.optimum_section_cost[0]
```

```
            self.design_status = True

        for status in self.design_status_list:
            if status is False:
                self.design_status = False
                break
            else:
                self.design_status = True

    def common_result(self, list_result, result_type):
        # Defensive: handle None or wrong type for list_result
        if not isinstance(list_result, dict) or not list_result:
            self.logger.error("No valid results to display.
               Calculation did not yield any results.")
            # Set all result attributes to None or a safe default
            self.result_designation = None
            self.section_class = None
            self.result_section_class = None
            self.result_effective_area = None
            self.result_bc_zz = None
            self.result_bc_yy = None
            self.result_IF_zz = None
            self.result_IF_yy = None
            self.result_eff_len_zz = None
            self.result_eff_len_yy = None
            self.result_eff_sr_zz = None
            self.result_eff_sr_yy = None
            self.result_ebs_zz = None
            self.result_ebs_yy = None
            self.result_nd_esr_zz = None
            self.result_nd_esr_yy = None
            self.result_phi_zz = None
            self.result_phi_yy = None
            self.result_srf_zz = None
```

```
            self.result_srf_yy = None
            self.result_fcd_1_zz = None
            self.result_fcd_1_yy = None
            self.result_fcd_2 = None
            self.result_fcd_zz = None
            self.result_fcd_yy = None
            self.result_fcd = None
            self.result_capacity = None
            self.result_cost = None
            return

        # Defensive: handle None or missing result_type
        if result_type is None:
            # Try to get the first key if possible
            if list_result:
                result_type = next(iter(list_result.keys()))
            else:
                self.logger.error("No result type found in
                   results.")
                return

        # Defensive: check if result_type exists in list_result
        if result_type not in list_result:
            self.logger.error(f"Result type '{result_type}' not
               found in results.")
            return

        # Now safe to access
        try:
            self.result_designation = list_result[result_type].
               get('Designation', None)
            self.section_class = self.
               input_section_classification.get(self.
               result_designation, [None])[0]
```

```
        if self.section_class == 'Slender':
            self.logger.warning(f"The trial section ({self.
                result_designation}) is Slender. Computing the
                 Effective Sectional Area as per Sec. 9.7.2,
                Fig. 2 (B & C) of The National Building Code
                of India (NBC), 2016.")
        if getattr(self, 'effective_area_factor', 1.0) < 1.0:
            self.effective_area = round(self.effective_area *
                 self.effective_area_factor, 2)
            self.logger.info(f"The actual effective area is {
                round((self.effective_area / self.
                effective_area_factor), 2)} mm2 and the
                reduced effective area is {self.effective_area
                } mm2 [Reference: Cl. 7.3.2, IS 800:2007]")
        else:
            if self.result_designation in self.
                input_section_classification:
                def safe_round(value, decimals=2):
                    if value is None:
                        return None
                    try:
                        return round(float(value), decimals)
                    except (ValueError, TypeError):
                        return None

            classification = self.
                input_section_classification[self.
                result_designation]
            flange_value = safe_round(classification[3] if
                len(classification) > 3 else None)
            web_value = safe_round(classification[4] if len(
                classification) > 4 else None)
```

```
                self.logger.info(
                    "The section is {}. The {} section  has  {}
                       flange({}) and  {} web({}).  [Reference:
                       Cl 3.7, IS 800:2007].".format(
                        classification[0] if len(classification)
                           > 0 else 'Unknown',
                        self.result_designation,
                        classification[1] if len(classification)
                           > 1 else 'Unknown', flange_value,
                        classification[2] if len(classification)
                           > 2 else 'Unknown', web_value
                    ))

            self.result_section_class = list_result[result_type].
               get('Section class', None)
            self.result_effective_area = list_result[result_type
               ].get('Effective area', None)
            self.result_bc_zz = list_result[result_type].get('
               Buckling_curve_zz', None)
            self.result_bc_yy = list_result[result_type].get('
               Buckling_curve_yy', None)
            self.result_IF_zz = list_result[result_type].get('
               IF_zz', None)
            self.result_IF_yy = list_result[result_type].get('
               IF_yy', None)
            self.result_eff_len_zz = list_result[result_type].get
               ('Effective_length_zz', None)
            self.result_eff_len_yy = list_result[result_type].get
               ('Effective_length_yy', None)
            self.result_eff_sr_zz = list_result[result_type].get(
               'Effective_SR_zz', None)
            self.result_eff_sr_yy = list_result[result_type].get(
               'Effective_SR_yy', None)
```

```
            self.result_ebs_zz = list_result[result_type].get('
               EBS_zz', None)
            self.result_ebs_yy = list_result[result_type].get('
               EBS_yy', None)
            self.result_nd_esr_zz = list_result[result_type].get(
               'ND_ESR_zz', None)
            self.result_nd_esr_yy = list_result[result_type].get(
               'ND_ESR_yy', None)
            self.result_phi_zz = list_result[result_type].get('
               phi_zz', None)
            self.result_phi_yy = list_result[result_type].get('
               phi_yy', None)
            self.result_srf_zz = list_result[result_type].get('
               SRF_zz', None)
            self.result_srf_yy = list_result[result_type].get('
               SRF_yy', None)
            self.result_fcd_1_zz = list_result[result_type].get('
               FCD_1_zz', None)
            self.result_fcd_1_yy = list_result[result_type].get('
               FCD_1_yy', None)
            self.result_fcd_2 = list_result[result_type].get('
               FCD_2', None)
            self.result_fcd_zz = list_result[result_type].get('
               FCD_zz', None)
            self.result_fcd_yy = list_result[result_type].get('
               FCD_yy', None)
            self.result_fcd = list_result[result_type].get('FCD',
                None)
            self.result_capacity = list_result[result_type].get('
               Capacity', None)
            self.result_cost = list_result[result_type].get('Cost
               ', None)
        except Exception as e:
            # Set all result attributes to None or a safe default
```

```
            self.result_designation = None
            self.section_class = None
            self.result_section_class = None
            self.result_effective_area = None
            self.result_bc_zz = None
            self.result_bc_yy = None
            self.result_IF_zz = None
            self.result_IF_yy = None
            self.result_eff_len_zz = None
            self.result_eff_len_yy = None
            self.result_eff_sr_zz = None
            self.result_eff_sr_yy = None
            self.result_ebs_zz = None
            self.result_ebs_yy = None
            self.result_nd_esr_zz = None
            self.result_nd_esr_yy = None
            self.result_phi_zz = None
            self.result_phi_yy = None
            self.result_srf_zz = None
            self.result_srf_yy = None
            self.result_fcd_1_zz = None
            self.result_fcd_1_yy = None
            self.result_fcd_2 = None
            self.result_fcd_zz = None
            self.result_fcd_yy = None
            self.result_fcd = None

    def save_design(self, popup_summary):
        # Safe rounding function for all round operations
        def safe_round(value, decimals=2):
            if value is None:
                return None
            try:
                return round(float(value), decimals)
```

```
            except (ValueError, TypeError):
                return None

        # Safe access to classification values
        def safe_classification_value(designation, index, default
            =None):
            if (designation in self.input_section_classification
                and
                isinstance(self.input_section_classification[
                    designation], (list, tuple)) and
                len(self.input_section_classification[designation
                    ]) > index):
                return self.input_section_classification[
                    designation][index]
            return default

        if self.design_status:
            if (self.design_status and self.failed_design_dict is
                None) or (not self.design_status and self.
                failed_design_dict is not None and hasattr(self.
                failed_design_dict, '__len__') and len(self.
                failed_design_dict) > 0):
                if self.sec_profile=='Columns' or self.
                    sec_profile=='Beams' or self.sec_profile ==
                    VALUES_SEC_PROFILE[0]:
                    try:
                        result = Beam(designation=self.
                            result_designation, material_grade=
                            self.material)
                    except:
                        result = Column(designation=self.
                            result_designation, material_grade=
                            self.material)
                    self.section_property = result
```

```
                self.report_column = {KEY_DISP_SEC_PROFILE: "
                    ISection",
                                      KEY_DISP_SECSIZE: (self.
                                          section_property.
                                          designation, self.
                                          sec_profile),
                                      KEY_DISP_COLSEC_REPORT:
                                          self.section_property.
                                          designation,
                                      KEY_DISP_MATERIAL: self.
                                          section_property.
                                          material,
            #
                KEY_DISP_APPLIED_AXIAL_FORCE: self.
                section_property.,
                                      KEY_REPORT_MASS: self.
                                          section_property.mass,
                                      KEY_REPORT_AREA:
                                          safe_round(self.
                                          section_property.area
                                          * 1e-2, 2),
                                      KEY_REPORT_DEPTH: self.
                                          section_property.depth
                                          ,
                                      KEY_REPORT_WIDTH: self.
                                          section_property.
                                          flange_width,
                                      KEY_REPORT_WEB_THK: self.
                                          section_property.
                                          web_thickness,
                                      KEY_REPORT_FLANGE_THK:
                                          self.section_property.
                                          flange_thickness,
```

```
                KEY_DISP_FLANGE_S_REPORT:
                    self.section_property
                    .flange_slope,
                KEY_REPORT_R1: self.
                    section_property.
                    root_radius,
                KEY_REPORT_R2: self.
                    section_property.
                    toe_radius,
                KEY_REPORT_IZ: round(self
                    .section_property.
                    mom_inertia_z * 1e-4,
                    2),
                KEY_REPORT_IY: round(self
                    .section_property.
                    mom_inertia_y * 1e-4,
                    2),
                KEY_REPORT_RZ: round(self
                    .section_property.
                    rad_of_gy_z * 1e-1, 2)
                    ,
                KEY_REPORT_RY: round(self
                    .section_property.
                    rad_of_gy_y * 1e-1, 2)
                    ,
                KEY_REPORT_ZEZ: round(
                    self.section_property.
                    elast_sec_mod_z * 1e
                    -3, 2),
                KEY_REPORT_ZEY: round(
                    self.section_property.
                    elast_sec_mod_y * 1e
                    -3, 2),
```

```
                                    KEY_REPORT_ZPZ: round(
                                        self.section_property.
                                        plast_sec_mod_z * 1e
                                        -3, 2),
                                    KEY_REPORT_ZPY: round(
                                        self.section_property.
                                        plast_sec_mod_y * 1e
                                        -3, 2)}
            else:
                #Update for section profiles RHS and SHS, CHS
                    by making suitable elif condition.
                self.report_column = {KEY_DISP_COLSEC_REPORT:
                    getattr(self.section_property, '
                   designation', None),
                                    KEY_DISP_MATERIAL:
                                        getattr(self.
                                        section_property, '
                                        material', ''),
                                    #
                                        KEY_DISP_APPLIED_AXIAL_FORCE
                                        : getattr(self.
                                        section_property, '
                                        applied_axial_force',
                                        ''),
                                    KEY_REPORT_MASS: getattr(
                                        self.section_property,
                                         'mass', ''),
                                    KEY_REPORT_AREA:
                                        safe_round(getattr(
                                        self.section_property,
                                         'area', 0) * 1e-2, 2)
                                        ,
```

```
                                    KEY_REPORT_DEPTH: getattr
                                       (self.section_property
                                       , 'depth', ''),
                                    KEY_REPORT_WIDTH: getattr
                                       (self.section_property
                                       , 'flange_width', ''),
                                    KEY_REPORT_WEB_THK:
                                       getattr(self.
                                       section_property, '
                                       web_thickness', ''),
                                    KEY_REPORT_FLANGE_THK:
                                       getattr(self.
                                       section_property, '
                                       flange_thickness', '')
                                       ,
                                    KEY_DISP_FLANGE_S_REPORT:
                                        getattr(self.
                                       section_property, '
                                       flange_slope', '')}


            self.report_input = \
                {#KEY_MAIN_MODULE: self.mainmodule,
                KEY_MODULE: self.module, #"Axial load on
                    column "
                     KEY_DISP_AXIAL: self.load.axial_force *
                        10 ** -3,
                     KEY_DISP_ACTUAL_LEN_ZZ: self.length_zz,
                     KEY_DISP_ACTUAL_LEN_YY: self.length_yy,
                     KEY_DISP_SEC_PROFILE: self.sec_profile,
                     KEY_DISP_SECSIZE: self.
                        result_section_class,
                     KEY_DISP_END1: self.end_1_z,
                     KEY_DISP_END2: self.end_2_z,
```

```
                KEY_DISP_END1_Y: self.end_1_y,
                KEY_DISP_END2_Y: self.end_2_y,
                "Column Section - Mechanical Properties":
                    "TITLE",
            KEY_MATERIAL: self.material,
                KEY_DISP_ULTIMATE_STRENGTH_REPORT: self.
                   material_property.fu,
                KEY_DISP_YIELD_STRENGTH_REPORT: self.
                   material_property.fy,
                KEY_DISP_EFFECTIVE_AREA_PARA: self.
                   effective_area_factor, #To Check
                KEY_DISP_SECSIZE:  str(self.sec_list),
                "Selected Section Details": self.
                   report_column,
            }

        self.report_check = []
        t1 = ('Selected', 'Selected Member Data', '|p{5cm
           }|p{2cm}|p{2cm}|p{2cm}|p{4cm}|')
        self.report_check.append(t1)

        self.h = (self.section_property.depth - 2 * (self
           .section_property.flange_thickness + self.
           section_property.root_radius))
        self.h_bf_ratio = self.h / self.section_property.
           flange_width


        # 2.2 CHECK: Buckling Class - Compatibility Check
        t1 = ('SubSection', 'Buckling Class -
           Compatibility Check', '|p{4cm}|p{3.5cm}|p{6.5
           cm}|p{2cm}|')
        self.report_check.append(t1)
```

```
                # YY axis row
                t1 = (
                    "h/bf and tf for YY Axis",
                    comp_column_class_section_check_required(self
                        .h, self.section_property.flange_width,
                        self.section_property.flange_thickness, "
                        YY"),
                    comp_column_class_section_check_provided(self
                        .h, self.section_property.flange_width,
                        self.section_property.flange_thickness,
                        round(self.h_bf_ratio, 2), "YY"), '
                        Compatible'
                )
                self.report_check.append(t1)

                # ZZ axis row
                t1 = (
                    "h/bf and tf for ZZ Axis",
                    comp_column_class_section_check_required(self
                        .h, self.section_property.flange_width,
                        self.section_property.flange_thickness, "
                        ZZ"),
                    comp_column_class_section_check_provided(self
                        .h, self.section_property.flange_width,
                        self.section_property.flange_thickness,
                        round(self.h_bf_ratio, 2), "ZZ"), '
                        Compatible'
                )
                self.report_check.append(t1)

                t1 = ('SubSection', 'Section Classification', '|p
                    {3cm}|p{3.5cm}|p{8.5cm}|p{1cm}|')
                self.report_check.append(t1)
                t1 = ('Web Class', 'Axial Compression',
```

```
                    cl_3_7_2_section_classification_web(round
                        (self.h, 2), round(self.
                        section_property.web_thickness, 2),
                                                    safe_round
                                                        (
                                                        safe_classifica
                                                        (
                                                        self
                                                        .
                                                        result_designati
                                                        , 4)
                                                        ),
                                                    self.
                                                        epsilon
                                                        ,
                                                        self
                                                        .
                                                        section_property
                                                        .
                                                        type
                                                        ,
                                                    safe_classificatio
                                                        (
                                                        self
                                                        .
                                                        result_designati
                                                        , 2)
                                                        ),
                            ' ')
                self.report_check.append(t1)
                t1 = ('Flange Class', self.section_property.type,
                            cl_3_7_2_section_classification_flange(
                                round(self.section_property.
                                flange_width/2, 2),
```

```
                                                    round
                                                        (
                                                        self
                                                        .
                                                        section_prope
                                                        .
                                                        flange_thickne
                                                        ,
                                                        2)
                                                        ,
                                    safe_round(
                                        safe_classification_value(
                                        self.result_designation,
                                        3)),
                                                    self.
                                                        epsilon
                                                        ,
                                                    safe_classificat
                                                        (
                                                        self
                                                        .
                                                        result_designa
                                                        ,
                                                        1)
                                                        ),
                                ' ')
                        self.report_check.append(t1)
                        t1 = ('Section Class', ' ',
                                cl_3_7_2_section_classification(
                                                    self.
                                                        input_section
                                                        [
                                                        self
                                                        .
```

```
                                                                result_designa
                                                                ][0])
                                                                ,
                    ' ')
            self.report_check.append(t1)


            t1 = ('NewTable', 'Imperfection Factor', '|p{3cm
               }|p{5 cm}|p{5cm}|p{3 cm}|')
            self.report_check.append(t1)

            t1 = (
                'YY',
                self.list_yy[3].upper(),
                self.list_yy[4], ''
            )
            self.report_check.append(t1)

            t1 = (
                'ZZ',
                self.list_zz[3].upper(),
                self.list_zz[4], ''
            )
            self.report_check.append(t1)


            # Defensive checks for None before division/round
            if self.result_eff_len_yy is not None and self.
               length_yy:
                K_yy = self.result_eff_len_yy / self.
                   length_yy
            else:
                K_yy = None
```

```
                if self.result_eff_len_zz is not None and self.
                    length_zz:
                    K_zz = self.result_eff_len_zz / self.
                        length_zz
                else:
                    K_zz = None
                t1 = ('SubSection', 'Slenderness Ratio', '|p{4cm
                    }|p{2 cm}|p{7cm}|p{3 cm}|')
                self.report_check.append(t1)
                val_yy = safe_float(self.result_eff_sr_yy)
                val_zz = safe_float(self.result_eff_sr_zz)
                val_yy_rounded = round(val_yy if val_yy is not
                    None else 0.0, 2)
                val_zz_rounded = round(val_zz if val_zz is not
                    None else 0.0, 2)
                t1 = ("Effective Slenderness Ratio (For YY Axis)"
                    , ' ',
                        cl_7_1_2_effective_slenderness_ratio(K_yy,
                            self.length_yy, self.section_property.
                            rad_of_gy_y, val_yy_rounded),
                        ' ')
                self.report_check.append(t1)
                t1 = ("Effective Slenderness Ratio (For ZZ Axis)"
                    , ' ',
                        cl_7_1_2_effective_slenderness_ratio(K_zz,
                            self.length_zz, self.section_property.
                            rad_of_gy_z, val_zz_rounded),
                        ' ')
                self.report_check.append(t1)



                t1 = ('SubSection', 'Checks', '|p{4cm}|p{2 cm}|p
                    {7cm}|p{3 cm}|')
```

```
                self.report_check.append(t1)

                t1 = (r'$\phi_{yy}$', ' ',
                    cl_8_7_1_5_phi(self.result_IF_yy, safe_round(
                        self.non_dim_eff_sr_yy, 2), safe_round(
                        self.result_phi_yy, 2)),
                    ' ')
                self.report_check.append(t1)

                t1 = (r'$\phi_{zz}$', ' ',
                    cl_8_7_1_5_phi(self.result_IF_zz, safe_round(
                        self.non_dim_eff_sr_zz, 2), safe_round(
                        self.result_phi_zz, 2)),
                    ' ')
                self.report_check.append(t1)

                t1 = (r'$F_{cd,yy} \, \left( \frac{N}{\text{mm
                    }^2} \right)$', ' ',
                    cl_8_7_1_5_Buckling(
                        str(self.material_property.fy) if self.
                            material_property.fy is not None else
                            '',
                        str(self.gamma_m0) if self.gamma_m0 is
                            not None else '',
                        str(safe_round(self.non_dim_eff_sr_yy, 2)
                            ),
                        str(safe_round(self.result_phi_yy, 2)),
                        str(safe_round(self.result_fcd_2, 2)),
                        str(safe_round(self.result_fcd_yy, 2)),
                    ),
                    ' ')
                self.report_check.append(t1)
```

```
                t1 = (r'$F_{cd,zz} \, \left( \frac{N}{\text{mm
                    }^2} \right)$', ' ',
                     cl_8_7_1_5_Buckling(
                         str(self.material_property.fy) if self.
                             material_property.fy is not None else
                             '',
                         str(self.gamma_m0) if self.gamma_m0 is
                             not None else '',
                         str(safe_round(self.non_dim_eff_sr_zz, 2)
                             ),
                         str(safe_round(self.result_phi_zz, 2)),
                         str(safe_round(self.result_fcd_2, 2)),
                         str(safe_round(self.result_fcd_zz, 2)),
                     ),
                     ' ')
                self.report_check.append(t1)

                # Defensive: check for None before division/round
                    for result_capacity and result_fcd
                cap = self.result_capacity if self.
                    result_capacity is not None else 0.0
                fcd = self.result_fcd if self.result_fcd is not
                    None else 0.0
                area = self.section_property.area if self.
                    section_property and hasattr(self.
                    section_property, 'area') else 0.0
                t1 = (r'Design Compressive Strength (\( P_d \)) (
                    For the most critical value of \( F_{cd} \))',
                     self.load.axial_force * 10 ** -3,
                     cl_7_1_2_design_compressive_strength(
                        safe_round(cap / 1000, 2), area,
                        safe_round(fcd, 2), self.load.axial_force
                        * 10 ** -3),
```

```
                get_pass_fail(self.load.axial_force * 10 **
                    -3, safe_round(cap, 2), relation="leq"))
            self.report_check.append(t1)


        else:
            self.report_input = \
                {#KEY_MAIN_MODULE: self.mainmodule,
                KEY_MODULE: self.module, #"Axial load on
                    column "
                    KEY_DISP_AXIAL: self.load.axial_force *
                        10 ** -3,
                    KEY_DISP_ACTUAL_LEN_ZZ: self.length_zz,
                    KEY_DISP_ACTUAL_LEN_YY: self.length_yy,
                    KEY_DISP_SEC_PROFILE: self.sec_profile,
                    KEY_DISP_SECSIZE:  str(self.sec_list),
                    #KEY_DISP_SECSIZE: self.
                        result_section_class,
                    KEY_DISP_END1: self.end_1_z,
                    KEY_DISP_END2: self.end_2_z,
                    KEY_DISP_END1_Y: self.end_1_y,
                    KEY_DISP_END2_Y: self.end_2_y,
                    "Column Section - Mechanical Properties":
                        "TITLE",
                KEY_MATERIAL: self.material,
                    KEY_DISP_ULTIMATE_STRENGTH_REPORT: self.
                        material_property.fu,
                    KEY_DISP_YIELD_STRENGTH_REPORT: self.
                        material_property.fy,
                    KEY_DISP_EFFECTIVE_AREA_PARA: self.
                        effective_area_factor, #To Check

                    # "Failed Section Details": self.
                        report_column,
                }
```

```
                self.report_check = []

                t1 = ('Selected', 'All Members Failed', '|p{5cm}|
                    p{2cm}|p{2cm}|p{2cm}|p{4cm}|')
                self.report_check.append(t1)


            Disp_2d_image = []
            Disp_3D_image = "/ResourceFiles/images/3d.png"


            rel_path = str(sys.path[0])
            rel_path = os.path.abspath(".") # TEMP
            rel_path = rel_path.replace("\\", "/")
            fname_no_ext = popup_summary['filename']
            CreateLatex.save_latex(CreateLatex(), self.
                report_input, self.report_check, popup_summary,
                fname_no_ext,
                                    rel_path, Disp_2d_image,
                                        Disp_3D_image, module=self.
                                        module)

    def get_end_conditions(self, *args):
        """
        Returns the list of standard end conditions for both y-y
            and z-z axes.
        These values are used in dropdowns for End 1 and End 2.
        """
        return ["Fixed", "Pinned", "Free"]
    def show_dialog(self, dialog):
        """
        Show a dialog modally, but only if not already open.
            Track it for later closing.
        """
```

```
        if dialog in self.dialogs:
            if dialog.isVisible():
                dialog.raise_()
                dialog.activateWindow()
                return
        self.dialogs.append(dialog)
        dialog.setModal(True)
        dialog.exec_()
        if dialog in self.dialogs:
            self.dialogs.remove(dialog)

    def reset_state_for_new_design(self):
        """
        Reset only calculation/output state for a new design,
           without closing dialogs or clearing input widgets.
        """
        self.reset_output_state()
        self.design_status = False
        self.failed_reason = None
        self.result = {}
        self.utilization_ratio = 0
        self.area = 0
        self.epsilon = 1.0
        self.fy = 0
        self.section = None
        self.weld_size = ''
        self.weld_type = ''
        self.weld_strength = 0
        self.lacing_incl_angle = 0
        self.lacing_section = ''
        self.lacing_type = ''
        self.allowed_utilization = ''
        self.section_designation = None
        self.output_title_fields = {}
```

```
        self.material_lookup_cache = {}
        self.optimum_section_cost_results = {}
        self.optimum_section_cost = []
```

Chapter 4

Debugging and Documentation

4.1 Problem Statement

The objective is to validate and enhance the accuracy, reliability, and standard compliance of structural steel design software modules. This involves three key tasks:

1. **Verification and Report Generation:** Generate detailed verification reports for Column-to-Column Cover Plate Welded and Bolted modules. The reports are used to evaluate whether the computational logic, formulae, and design checks implemented within the software align with the methodologies and provisions outlined in established civil engineering references, particularly *Design of Steel Structures* by N. Subramanian.

2. **Development of Design and detailing checklists (DDCLs):** Prepare comprehensive DDCLs for the following modules — (a) Column-to-Column Cover Plate Welded and (b) Column-to-Column Cover Plate Bolted connections. Each checklist ensures the correct sequence and completeness of structural checks, design steps, and code compliance as per IS 800:2007 standards.

3. **Generation of OSI Files:** Translate example problems from N. Subramanian's textbook chapters — *Bolted Connections*, *Welded Connections*, *Design of Tension Members*, and *Design of Compression Members* — into OSI format files. These files are structured inputs for the design software, facilitating automated testing and validation of design cases.

4.2 Tasks Done

The following tasks were successfully completed as a part of the above task:

1. **Verification Report Development:**
    - Reviewed the design outputs of relevant modules.
    - Cross-checked calculation steps and formulae against *Design of Steel Structures* by N. Subramanian and IS 800:2007.
2. **Design and Detailing Checklist (DDCL) Preparation:**
    - Drafted detailed DDCLs for both Column-to-Column Cover Plate Welded and Bolted modules.
    - Ensured all checks—such as section classification, force transfer mechanisms, connection detailing, and code compliance—were logically ordered and complete.
    - Incorporated IS code references and conditional validation steps in the checklist.
3. **OSI File Generation:**
    - Extracted example problems from the textbook chapters on *Bolted Connections*, *Welded Connections*, *Tension Members*, and *Compression Members*.
    - Converted these problems into structured OSI input files for the design software's internal testing and validation.

Chapter 5

Conclusions

5.1 Tasks Accomplished

- Designed a reimagined version of the Graphical User Interface (GUI) for *Osdag*, focusing on improved usability and modern aesthetics.
- Contributed to the development of core functions for the *Laced Column* module, enabling programmable execution of individual design and verification tasks as per IS 800:2007.
- Reviewed and validated the design calculation reports for the *Column-to-Column Bolted* and *Welded Cover Plate* modules to ensure accuracy in both functional implementation and numerical results.
- Authored the **Design and Detailing Checklists (DDCL)** for both bolted and welded cover plate connection modules, based on standard design practices and codal provisions.
- Prepared structured `.osi` files by extracting questions from key chapters of N. Subramanian's textbook, including Bolted Connections, Welded Connections, Design of Tension Members and Design of Compression Members.

5.2 Skills Developed

- Canva

- LaTeX
- Teamwork
- Communication
- Python
- IS 800 code

Chapter A

Appendix

A.1 Work Reports

Internship Work Report

Name: Rajesh Dalai
Project: Osdag Module Development and Bug Fixing
Internship: FOSSEE Summer Fellowship 2025

Date	Day	Task	Hours Worked
15/05/2025	Thursday	Attended the first meeting with the team and mentor. Roles and responsibilities were explained. Joined the communication channel on Discord.	8
16/05/2025	Friday	Participated in the initial meeting with the module development team to discuss the workflow. Installed Osdag, Anaconda, GitBash, and PyCharm.	8
17/05/2025	Saturday	Set up the development environment and ensured all files were installed. Raised doubts on Discord for clarification.	8
18/05/2025	Sunday	Familiarized with the environment, studied the repository, and began work on Task-X.	8
19/05/2025	Monday	Completed Task-X: Re-designed GUI for the homepage and sample module page. Studied the Base Plate and Anchor Bolt documentation.	8
20/05/2025	Tuesday	Reviewed *OSDAG_DDCL_CompressionMembers_Strut.pdf* and matched the algorithm with *DrawBoard - OSDAG.pdf* and *DDCL Laced Compound Column.pdf*.	8
21/05/2025	Wednesday	Analyzed the algorithm and referred to IS 800:2007 to check for inconsistencies.	8
22/05/2025	Thursday	Participated in a technical discussion on the algorithm and structural aspects.	8
23–26/05/2025	Fri–Mon	Continued development of the Laced Column module.	32
27–28/05/2025	Tue–Wed	Attended meetings to give updates and continued module development.	16
29/05–02/06/2025	Thu–Mon	Development of the Laced Column module.	8
03/06/2025	Tuesday	Meeting to share progress and clarify doubts.	8
04–05/06/2025	Wed–Thu	Continued module development and attended a clarification session.	16
06/06/2025	Friday	Modified functions to align with the format used in *IS800:2007.py*.	8
07–09/06/2025	Sat–Mon	Continued working on the Laced Column module.	24
10/06/2025	Tuesday	Meeting to review progress and address doubts.	8
11/06/2025	Wednesday	Understood the procedure for reviewing calculation reports.	8
12–15/06/2025	Thu–Sun	Reviewed calculation reports to verify accuracy and check for discrepancies.	32
16/06/2025	Monday	Participated in a review meeting to update on report verification.	8
17–18/06/2025	Tue–Wed	Authored the Design and Detailing Checklist (DDCL) for assigned modules.	16
19/06/2025	Thursday	Met to give updates on DDCL task and was assigned to generate OSI files.	8
20–22/06/2025	Fri–Sun	Continued drafting the DDCLs for the modules.	24
23–24/06/2025	Mon–Tue	Generated OSI files using examples from N. Subramanian’s *Design of Steel Structures*.	16
25/06/2025	Wednesday	Final meeting to review tasks completed and begin submission checks.	8

26/06/2025	Thursday	Final corrections and submission of all assigned tasks.	8

Bibliography

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[3] FOSSEE Project. Osdag website. Accessed: 2024-12-05.