Osdag®
Open steel design and graphics

FOSSEE SEMESTER LONG INTERNSHIP - 2021

Rutvik Nitin Joshi
Veermata Jijabai Technoligical Institute
3rd Year Civil Engineering

Fellowship Work Progress -
FOSSEE, IIT Bombay
August 2021

Introduction to Osdag

- Osdag is a cross-platform free open source software for the design and detailing of steel structures.
- It follows the guidelines, clauses based on Indian Standard(IS) 808:2007 code book.
- It allows the user to design steel connections, members which is typically optimised by following the industry best practices using a graphical user interface(GUI).
- GUI provides a 3D visualisation of the designed component, allows the user to create 2D drawings which can be imported into autocad.
- It also allows the user to create a detailed professional design report with standard views of the designed component.
- Osdag is primarily built upon Python and Python based floss tools such as PyQt , PythonOCC , OpenCascade etc.

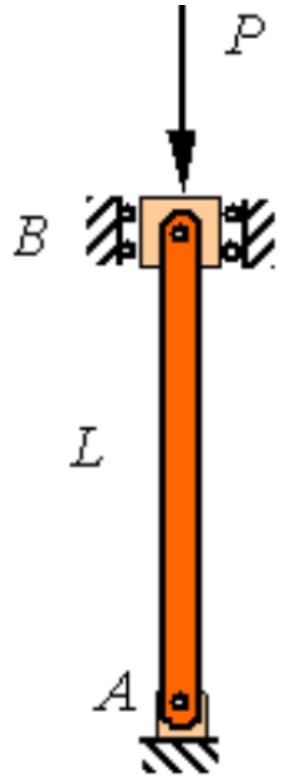
Home page of OSDAG

COMPRESSION MEMBERS

A compression member is a structural member which is straight and subjected to two equal and opposite compressive forces applied at its ends.. It depends on which type of structure we are using as a compression element, for example if we are using it in a building to support the incoming gravity load we call it a column and if used in a truss it is called a strut as it is generally in an inclined position

Stability plays an important role in the design of compression members. Ordinary structural analysis is based on the condition of stable equilibrium between internal and external forces, and a linear relationship is assumed to exist between stress and strain. However when buckling is involved, it is necessary to investigate the potentially unstable equilibrium between the external and internal responses that are further complicated by the complex stress-strain relationship of the material extending from elastic to inelastic range.

In general columns carrying axial or eccentric loads, I-sections are usually preferred. It should be noted that the flanges or web portion of I-section can be easily connected to the beams they support and also cover plates can be used to strengthen it further.



Description of the task(s) allotted

Selection for the Semester Long Internship was based on Screening task which was additive to the actual problem statements.

The list of tasks which were alloted to me are mentioned below:

1. **Development of Python module for Compression members.**
   - **Axial load on columns**
   - **Axial and Bending Load on Columns**
2. **Testing of developed module**
   1. **Checking various cases and dealing with errors and bugs/Issues.**
3. **Specific function additions to existing file of IS 800:2007**
4. **Graphical User Interface layout**
5. **Documentation and Technical report**

References followed:

1. Ghosh S et al. (2021) Osdag: A Software for Structural Steel Design Using IS 800:700. In: Adhikari S., Dutta A., Choudhury S. (eds) Advances in Structural Technologies. Lecture Notes in Civil Engineering, vol 81. Springer, Singapore.

2. IS 800:2007, General Construction in Steel-Code of Practice, Third Revision, Bureau of Indian Standards (BIS), New Delhi .

3. Design of Steel Structures (2013), N. Subramanian, 12th Impression, Oxford University Press .

4. Design of Steel Structures, S. Ramamrutham, Dhanpat Rai Publishing Company.

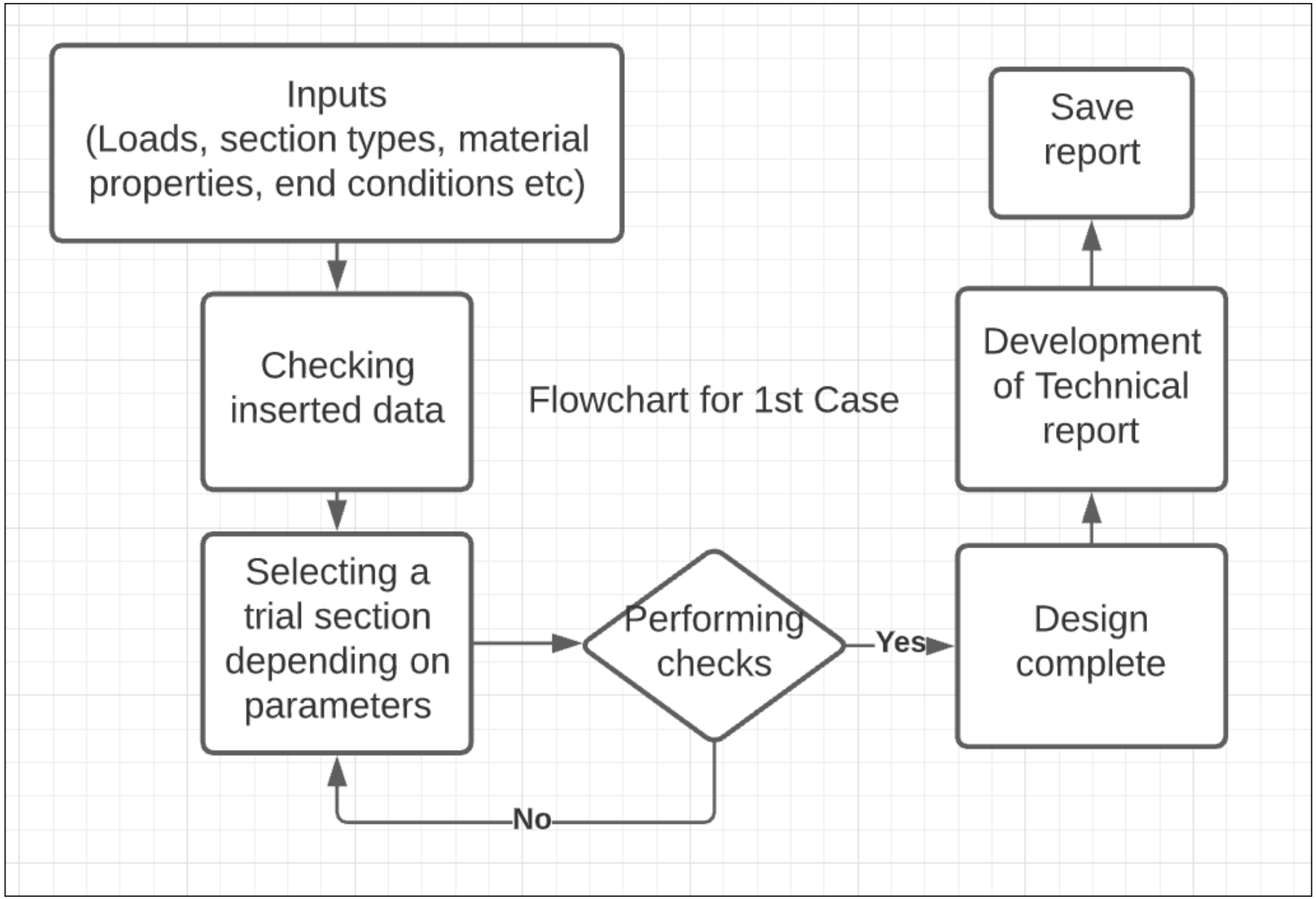
My contribution towards the project

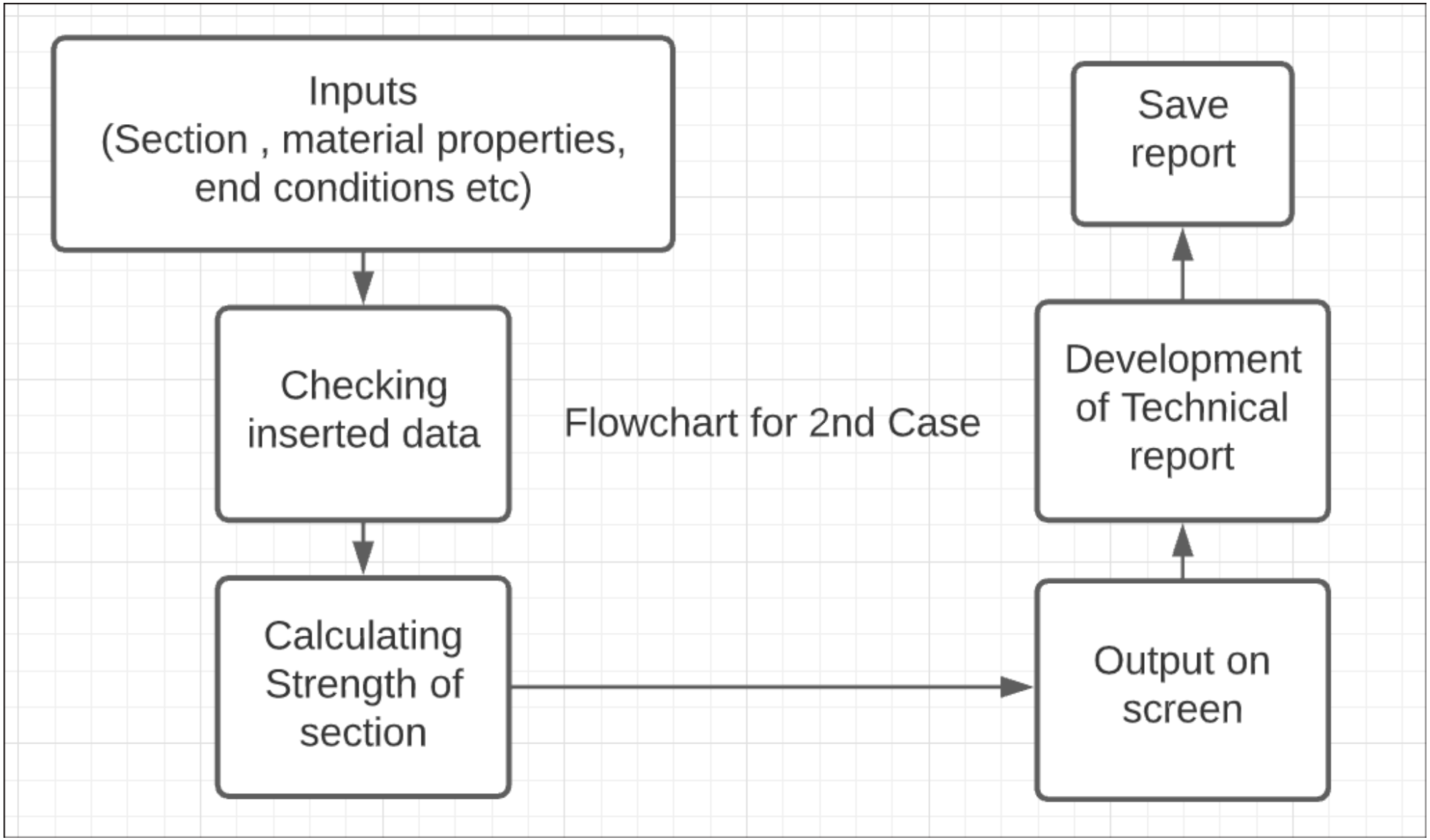
Development of Python module for Compression members.

Axial Load or Axial and Bending Load on Columns

- Case 1: The user is provided with series of Indian Standard steel sections as per IS code. The user enters axial load to be subjected by the section and also selects desired list of sections. After pressing the design tab, the code gives output stating the section from the provided list which is optimized for the given load and thus increasing efficiency.
- Case 2: The user is required to pick a section from the available IS code database and after running the program the software provides the maximum compression load-carrying capacity of the selected section. This helps the user to check compatibility and operationality for the selected section

Both the cases are compiled in a single python file using multiple classes, functions and loops thus increasing the usability of code while reducing space needed


Inputs
(Loads, section types, material properties, end conditions etc)
Checking inserted data
Selecting a trial section depending on parameters
Performing checks
Yes
No
Design complete
Development of Technical report
Save report
Flowchart for 1st Case


Inputs
(Section , material properties,
end conditions etc)
Checking
inserted data
Calculating
Strength of
section
Flowchart for 2nd Case
Output on
screen
Development
of Technical
report
Save
report

- Went through several standard textbooks and understood the detailed working procedure of different cases possible.
- Developed workable programme referring IS 800:2007concerning two cases.
- Solved various different examples to make sure the developed programme is working fine.
- Adding functions in order to reuse code which help to optimize and increase efficiency.
- Uploaded the completed programme on GitHub so teammates could collaborate.

Specific function additions to existing file of IS 800:2007

Functions releating to compression which would be required to be imported in the module was developed referring to IS 800:2007

The functions were developed for:

1. Design Compressive Strength Of A Member
2. The Effective Length Of Prismatic Compression Member
3. Design Compressive Stress
4. Buckling Class Of Cross-sections

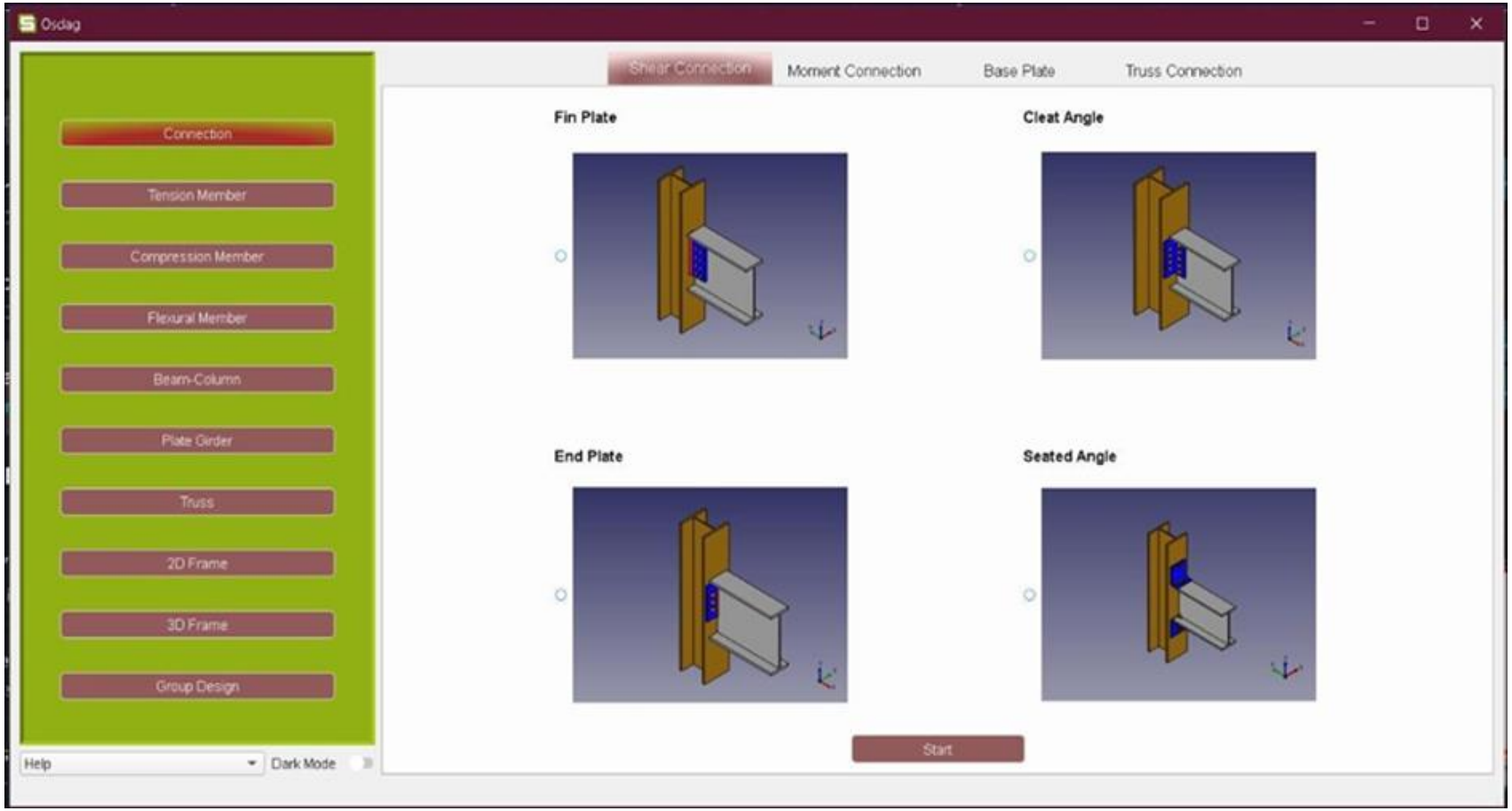
Documentation and Technical report

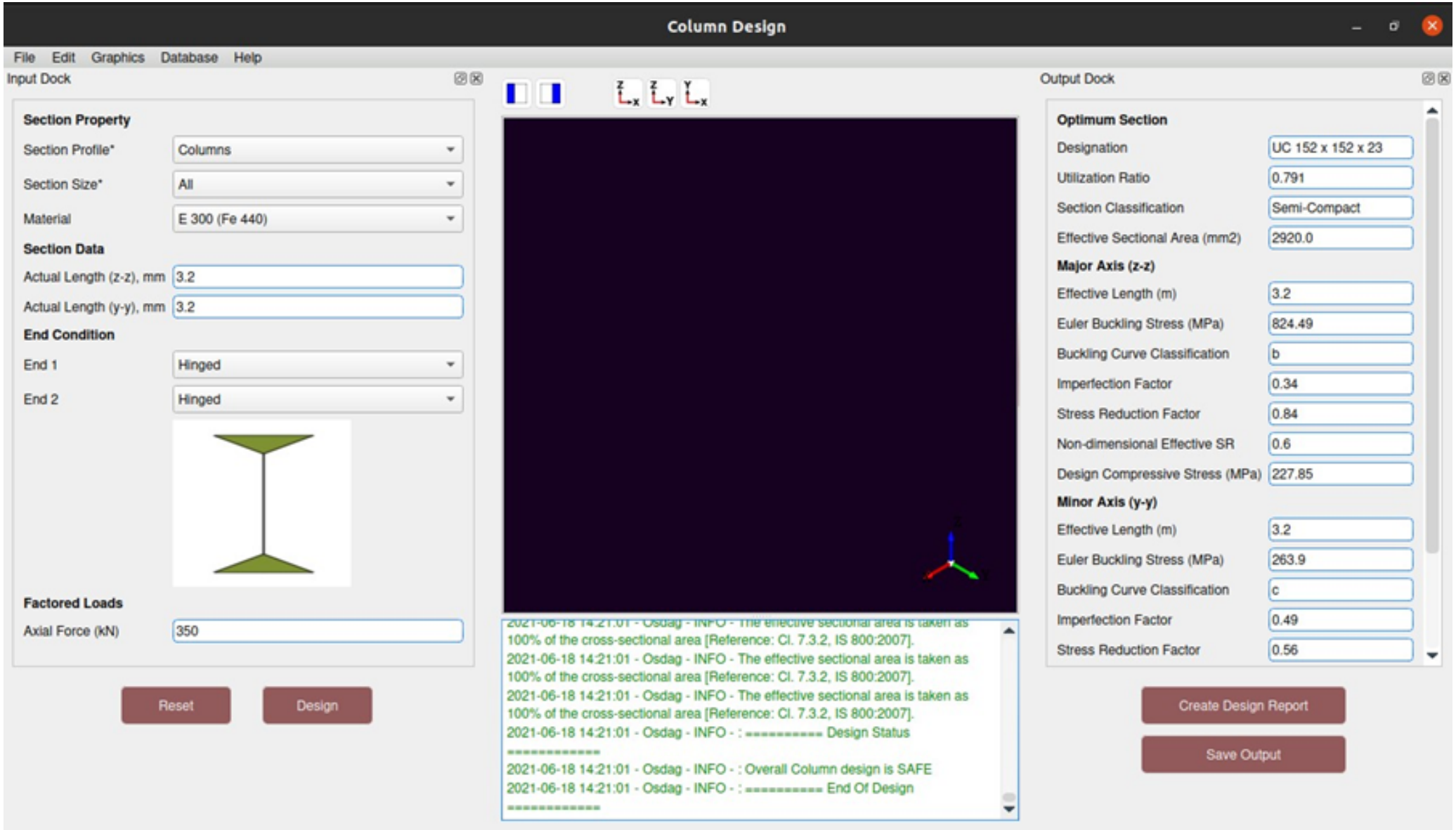
Technical reports are a necessary medium to communicate information from designer to the engineers. Simplicity, Clarity and Effective Formatting helps to deliver precise information in short time.Keeping this in mind LaTeX system was used in document development with integrated python dynamics .

LaTeX is a high-quality typesetting system; it includes features designed for the production of technical and scientific documentation. LaTeX is the de facto standard for the communication and publication of scientific documents. LaTeX is available as free software. All these provide LaTeX as the most suitable medium to create a technical report

GRAPHICAL USER INTERFACE

GUI in OSDAG has been developed in such a way that it can be easily understood while performing design. All the input and output parameters have been presented in simple words so that there won't be any confusion to anyone who is using OSDAG




Column Design
File Edit Graphics Database Help
Input Dock
Section Property
Section Profile* Columns
Section Size* All
Material E 300 (Fe 440)
Section Data
Actual Length (z-z), mm 3.2
Actual Length (y-y), mm 3.2
End Condition
End 1 Hinged
End 2 Hinged
Factored Loads
Axial Force (kN) 350
Reset
Design
2021-06-18 14:21:01 - Osdag - INFO - The effective sectional area is taken as 100% of the cross-sectional area [Reference: Cl. 7.3.2, IS 800:2007].
2021-06-18 14:21:01 - Osdag - INFO - The effective sectional area is taken as 100% of the cross-sectional area [Reference: Cl. 7.3.2, IS 800:2007].
2021-06-18 14:21:01 - Osdag - INFO - The effective sectional area is taken as 100% of the cross-sectional area [Reference: Cl. 7.3.2, IS 800:2007].
2021-06-18 14:21:01 - Osdag - INFO - : ========== Design Status ==========
2021-06-18 14:21:01 - Osdag - INFO - : Overall Column design is SAFE
2021-06-18 14:21:01 - Osdag - INFO - : ========== End Of Design ==========
Output Dock
Optimum Section
Designation UC 152 x 152 x 23
Utilization Ratio 0.791
Section Classification Semi-Compact
Effective Sectional Area (mm2) 2920.0
Major Axis (z-z)
Effective Length (m) 3.2
Euler Buckling Stress (MPa) 824.49
Buckling Curve Classification b
Imperfection Factor 0.34
Stress Reduction Factor 0.84
Non-dimensional Effective SR 0.6
Design Compressive Stress (MPa) 227.85
Minor Axis (y-y)
Effective Length (m) 3.2
Euler Buckling Stress (MPa) 263.9
Buckling Curve Classification c
Imperfection Factor 0.49
Stress Reduction Factor 0.56
Create Design Report
Save Output

Input Dock

Section Property

Section Profile* Columns

Section Size* All

Material E 250 (Fe 410 W)A

Section Data

Actual Length (z-z), mm 3

Actual Length (y-y), mm 3

End Condition

End 1 Free

End 2 Fixed

Factored Loads

Axial Force (kN) 300

Reset Design

Input dock

2021-08-26 14:10:43 - Osdag - INFO - The flange of the trial section (HB 150) is Plastic and web is Semi-Compact. The section is Semi-Compact [Reference: Cl 3.7, IS 800:2007].
2021-08-26 14:10:44 - Osdag - INFO - The flange of the trial section (HB 150*) is Plastic and web is Semi-Compact. The section is Semi-Compact [Reference: Cl 3.7, IS 800:2007].
2021-08-26 14:10:44 - Osdag - INFO - The flange of the trial section (HB 150*) is Plastic and web is Semi-Compact. The section is Semi-Compact [Reference: Cl 3.7, IS 800:2007].
2021-08-26 14:10:44 - Osdag - INFO - The flange of the trial section (HB 200) is Semi-Compact and web is Semi-Compact. The section is Semi-Compact [Reference: Cl 3.7, IS 800:2007].
2021-08-26 14:10:44 - Osdag - INFO - The flange of the trial section (HB 200*) is Semi-Compact and web is Semi-Compact. The section is Semi-Compact [Reference: Cl 3.7, IS 800:2007].
2021-08-26 14:10:44 - Osdag - INFO - The flange of the trial section (HB 225) is Semi-

Log messages console

Output Dock

Optimum Section

Designation	HB 200
Utilization Ratio	0.81
Section Classification	Semi-Compact
Effective Sectional Area (mm2)	4750.0
Major Axis (z-z)	
Effective Length (m)	6.0
Euler Buckling Stress (MPa)	415.97
Buckling Curve Classification	b
Imperfection Factor	0.34
Stress Reduction Factor	0.74
Non-dimensional Effective SR	0.78
Design Compressive Stress (MPa)	168.09
Minor Axis (y-y)	
Effective Length (m)	6.0
Euler Buckling Stress (MPa)	111.53
Buckling Curve Classification	c
Imperfection Factor	0.49
Stress Reduction Factor	0.34
Non-dimensional Effective SR	1.5
Design Compressive Stress (MPa)	78.02
Design Results	

Create Design Report

Save Output

Output dock