

EDITOR OF THIS ISSUE

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The focus of this issue is on

Osdag

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The main objective of the FOSSEE team at IIT Bombay is to help promote the use of free and open source software in educational institutions. The FOSSEE team creates useful instructional content that will help students easily learn useful open source software. It also helps academic institutions to migrate to open source software systems. While most groups under FOSSEE's umbrella focus on the promotion of established open-source software (such as Scilab, Python, OpenFOAM, DWSIM, and R), there are a few groups working towards the development of new free and open source software. One of the new software created by FOSSEE is Osdag.

Osdag: An Introduction

Osdag is a free and open-source software for the design of steel structures, such as buildings, bridges, and towers, that are built with steel (more in the next section on steel structures). Therefore, the primary expected user base of Osdag comprises professionals from the (steel) construction industry and students and teachers of Civil Engineering departments in engineering colleges. In its development, Osdag relies heavily on other FOSSEE favourites, such as Python, Spoken Tutorials, GitHub, Bash, LaTeX/Mathematics and Django.

Steel and Steel Structures

Over the past one and half centuries, steel has emerged as probably the most trusted building material. Modern architectural marvels make significant use of steel as the primary building material. Of these, many bridges, buildings, stadia, etc. are built with what is known as 'structural steel' in the domains of construction industry, structural engineering and building architecture. The Forth Bridge near Edinburgh, Scotland, is one of the earliest examples of such technical marvels, which has been serving rail traffic from 1890 till date. From the Pre-

World War II skyscrapers (such as the Chrysler Building and the Empire State Building in New York, USA) to modern technologically advanced masterpieces (such as the "Gherkin" in London, UK), structural steel has been valued for the necessary qualities it provides: strength to weight ratio, durability, sustainability, and ductility. Steel also allows a designer the flexibility to use it in versatile ways. Construction with structural steel is significantly faster — and with better quality control — than most common building materials. Steel buildings can be modular and can efficiently adapt to changes in the use pattern during a building's life cycle. At the end of the cycle, with about 90% or more of steel being fully recyclable, steel appears to be the best choice for sustainable design of structures.

Steel Structures in India

Even with all these advantages, we hardly see steel structures in India, except for industrial sheds, railway bridges and transmission towers. India ranks among the major steel producing countries, whereas, in terms of the domestic consumption rate, India lags far behind all major steel producers. In the fast growing construction sector of India, reinforced concrete structures outnumber steel structures by a very large margin. The reasons for this disparity are diverse; let us take a quick look at the technological and (technical) education related aspects.

The Indian standard IS 800 provides general guidelines and the standard specifications for the design of structures using structural steel. It was first published in 1956 with the goal of achieving "economy in the use of structural steel." This was last revised in 2007, shifting the design philosophy from the Working Stress Method (WSM) to the Limit State Method (LSM) and bringing our design specifications closer to those of the modern steel design standards.

Why Osdag

After the release of the 2007 revision, the Institute for Steel Development and Growth (INSDAG) along with academics and experienced professionals, conducted training programmes for college teachers and design engineers across the country. Although this has resulted in some confidence building in the academia and in the industry, till date most college teachers and design professionals are not comfortable in steel design. Also, experienced professionals resist the transition from a design code they are already very familiar with to a new one. Besides, there are complaints against too many specifications to learn and implement and too few helpful resources to make use of.

The industry and academia's adaption to revised British and American steel design codes was eased by making design software/tools available for the new standards. Availability of such design tools have been too few and too late for IS 800:2007. For example, the popular structural design software ETABS (<https://www.csiamerica.com/products/etabs>) incorporated the latest Indian steel design specifications only 2013 (version 13.2.0) onwards. Commercial software such as this are costly and beyond the affordable range of many design professionals. This results in piracy of the licensed software both in the industry and the academia, without the user many a times realising that he/she is committing a criminal offense. Those who stay away from the piracy route rely on in-house (handed down) spreadsheet like solutions or hand calculations, that are not validated and/or are very tedious. The issue of non-validated solutions is most evident in the design of steel connections. Many of the common structural design software do not include modules for steel connection design, for which one typically relies on specialised connection design and detailing software, such as RAM Connection (<https://www.bentley.com/en/products/product-line/structural-analysis-software/ram-connection>).

These are costly software. For example, a single license of a single connection (beam-to-column shear connection using a fin plate) design module of the Praxis software (<http://www.gsi-eng.eu/index.asp?mod=articles&id=106>) costs Euro 150.00 (approximately INR 11,300.00, as per the current exchange rates) exclusive of taxes.

Considering this state-of-practice, we thought that a software dedicated to structural steel design and detailing as per the Indian standard(s), which does not make a big dent in the user's pocket, can be one simple and effective solution to bring forth the necessary confidence among steel designers, college teachers and students of civil engineering.

About Osdag

Osdag is a cross-platform, free and open-source software being developed by the FOSSEE/Osdag team at IIT Bombay, for the design (and detailing) of steel structures, following the Indian Standard IS 800:2007. It allows the user to design steel connections, members and systems using an interactive graphical user interface. The interactive GUI provides a 3D visualisation of the designed component and creates images for construction drawings. The design is typically optimised following industry best practices.

Osdag is primarily built upon Python and other Python based FOSS tools, such as, PyQt, Open Cascade & svgwrite.

It uses SQLite for managing steel section databases.

The emphasis of Osdag in its first phase is on the design of connections, which is a part typically ignored in most commercially available structural steel design software. In future, Osdag modules will include modules for the design of tension members, compression members, flexural members, trusses and frames.

It should be noted here that the goal of this project is not to cover the entire gamut of provisions of IS 800, but rather to help its users gaining confidence in using certain aspects of this design standard.

Advantages of Osdag

Osdag is expected to:

- Provide hands-on design experience for college students, and thus creating tomorrow's designers familiar and confident with steel design
- Provide practical design experience for (new) practising engineers
- Work as a teaching tool helping technical/engineering college teachers teaching undergraduate and postgraduate courses on steel design
- Integrate easily with modern ICT-based teaching techniques and distant learning methods.
- Bring the necessary standardisation and quality control in design and detailing of steel structures
- Reduce the recurring costs of licensing commercial software, in big structural design consultancy firms

Modules

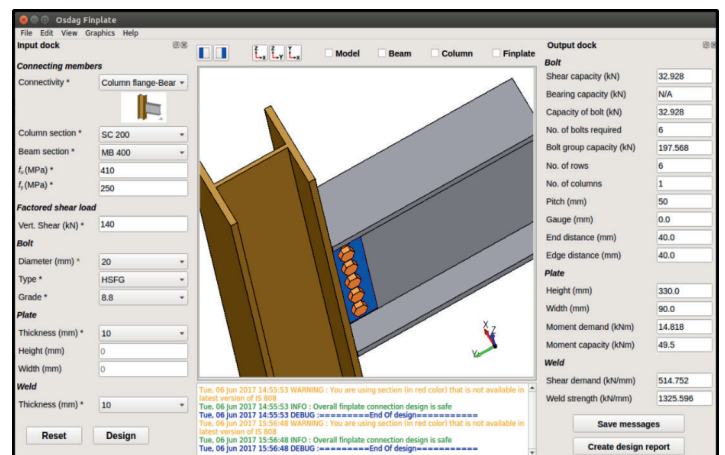
Osdag is being developed module-by-module. When fully developed, Osdag is expected to provide full-fledged steel design solutions for

- Connections (Shear, Moment and Truss)
- Tension members
- Compression members
- Flexural members
- Beam-columns
- Plate girders
- Trusses
- 2D frames
- 3D frames
- Group/batch design

Features

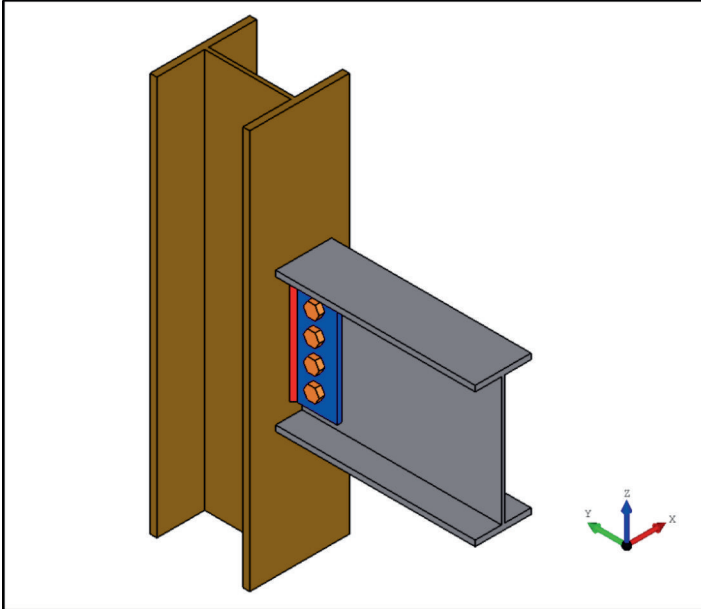
Osdag GUI

Osdag has an interactive graphical user interface with text-validated fields grouped according to the design flow. The design window GUI consists of 'Input dock', 'Output dock', 'CAD window' and 'Message window' along with a menu bar at the top.



CAD Model

The interactive 'CAD window' displays a 3D CAD model, which provides a clear visualisation of the designed component. You can pan, zoom and rotate the model or view each of the sub-components separately. The created CAD model can be saved into various formats such as IGS, STL, STEP, and BREP. This CAD can be later imported to other CAD software (such as AutoCAD, FreeCAD, or SolidWorks).



Design Preferences

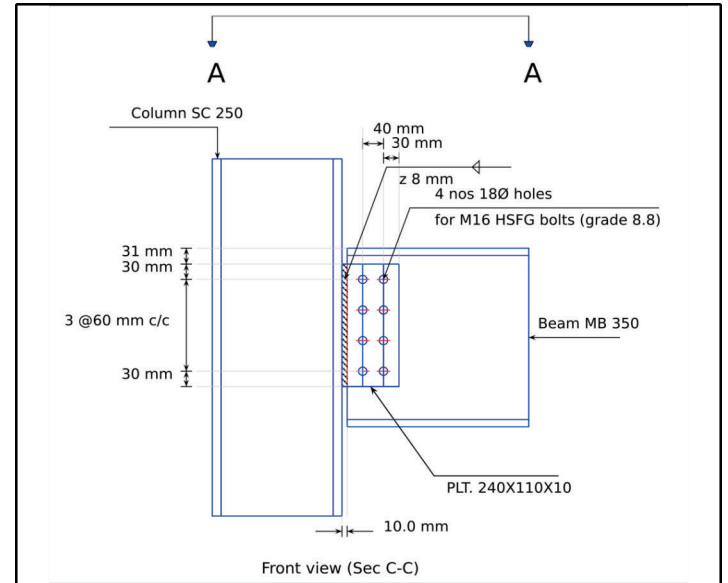
Detailed design preferences (user choices or specific design based requirements) can be set using the 'Design preference toolbox'. For a novice user, default values can be used in the design process in lieu of these preferences.

Design Report

Osdag creates a professional design report for each component/structure design containing all the design and detailing checks as per IS 800:2007, as well as an overall design summary, standard views, a customisable header, designer's remarks, and other useful information.

Structural Drawings

2D views for typical construction drawings are created in Osdag with standard detailing practices followed by the designers and fabricators. These 2D images can be used to create construction/fabrication drawings, in a professional design report, or as teaching aid by teachers. These images are created both in vector (SVG) and raster (PNG) formats.





Message Log

A text window for message display provides the status of the design, but more importantly it also suggests necessary changes if a trial design is found unsafe. This part of the GUI displays colour-coded error/warning messages and also suggests possible rectifications, all of which can be saved for a design session.

```

Wed, 13 Sep 2017 15:45:42 WARNING : You are using a section (in red color)
that is not available in latest version of IS 808
Wed, 13 Sep 2017 15:45:42 ERROR : Weld thickness is not sufficient [cl. 10.5.7;
INSDAG Detailing Manual, 2002]
Wed, 13 Sep 2017 15:45:42 WARNING : Minimum weld thickness required is
10.00 mm
Wed, 13 Sep 2017 15:45:42 INFO : Increase the weld thickness or length of
weld/fin plate
Wed, 13 Sep 2017 15:45:42 ERROR : Design is not safe
Wed, 13 Sep 2017 15:45:42 DEBUG : =====END of design=====
    
```

			
		Created with	
Company Name	IIT Bombay	Project Title	Connection Design Examples
Group/Team Name	Osdag	Subtitle	Fin Plate shear connection
Designer	Engineer #1	Job Number	1.1.1.1.1
Date	18 /06 /2017	Client	
Design Check			
Check	Required	Provided	Remark
Bolt shear capacity (kN)		$V_{dsf} = ((0.3 \cdot 1 \cdot 1.0 \cdot 47.208) / (1.25)) = 11.32992$ [cl. 10.4.3]	
Bolt bearing capacity (kN)		N/A	
Bolt capacity (kN)		11.32992	Pass
No. of bolts	140/11.32992 = 12.4	14	Pass

Outreach

The Osdag team reaches out to prospective users by conducting training workshops, by presenting at conferences and symposia, and presenting to professional societies, industry professionals, engineering students, and college teachers. Two main arms of our outreach activities are the Osdag website (osdag.fossee.in) and the Osdag YouTube channel (<http://tinyurl.com/OsdagVideos>).

In the last three years, presentations on Osdag have been made at various fora including SciPy India Conference in Mumbai, Steel Construction Summit in Mumbai, and to diverse audiences at INSDAG (Kolkata), at The Institution of Engineers (Mumbai), in Tribhuvan University (Kathmandu, Nepal), etc.

Resources

Adhering to today's learning/education techniques, Osdag provides a variety of self-learning tools and contents through its website: <https://osdag.fossee.in>. Besides Osdag installers for different operating systems, these web pages come with diverse user tools, developer tools, video tutorials on different aspects of installing and operating the software, design examples, discussion forum, etc. The video tutorials are also available on Osdag's YouTube channel (<http://tinyurl.com/OsdagVideos>). While these videos and design examples are excellent self-learning materials, these can also be used in conducting training programmes on Osdag efficiently.

Expert Reviewers

It was essential to identify a way to validate the design algorithms (including code specified checks and industry best practices for both design and detailing) implemented in Osdag. To this end, a committee was established consisting of domain experts from the academia and the industry, some of whom were instrumental in creating the latest Indian standard on steel design, IS 800:2007. Through a web-based interface, the expert review committee validates all the steel design algorithms and detailing checks implemented in each and every Osdag module, and suggests necessary modifications if needed.

Official Release of Osdag



The beta version of Osdag was officially released to the general public on June 21, 2017. Mr. Sushim Banerjee, Director General, INSDAG, Kolkata and Prof. K.V. Krishna Rao, Head, Dept. of Civil Engineering, IIT Bombay released the installation DVD along with an updated version of the Osdag website. The installers of Osdag for Ubuntu Linux and Windows operating systems were made available to

everyone free of cost. The released version of Osdag has four shear connection modules.

Development Process

The development process in Osdag begins with identifying the most common and useful steel design modules (more specifically, the branches under a design module), considering their use in real construction. Based on a thorough review of existing Indian and other countries' design standards, design guidelines, detailing guidelines, and textbook examples on the specific design module, the 'Design and Detailing Checklist' (DDCL) and the 'Design and Detailing Query' (DDQ) are prepared. Using a web-based interface, the feedback of the Expert Reviewers are collected on these two documents. The feedback received are incorporated into the design and detailing algorithm. The necessary codes are then written for design calculation, log messages, GUI, CAD model, 2D drawings, report file, etc. The codes are maintained using GitHub as a version control system and are integrated to the main branch. After a new design module goes through the necessary rounds of tests, contents such as design examples, video tutorials, and (updated) installers are developed and published through the Osdag website.

The Osdag team plans to continue in this mode of development for the upcoming modules, however with a greater participation of non-IIT Bombay developers/contributors and a more decentralised development.

Contact Us:

We would like to receive your feedback.

Email us: osdag@fossee.in

Visit our website: <http://osdag.fossee.in/>

See video tutorials: <http://tinyurl.com/OsdagVideos>

Participate in the development:

<https://github.com/osdag-admin/Osdag>



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