



STROBE

Stronger Steels in the Built Environment

Quick User Guide

SCI (the Steel Construction Institute) has been a trusted, independent source of information and engineering expertise globally for over 30 years, and is one of the leading, independent providers of technical expertise and disseminator of best practice to the steel construction sector.

We support everyone involved in steel construction; from manufacturers, consulting and design engineers, architects, product developers to industry groups.

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1		19/03/2020	Software release	RJP		
2		17/06/2020	Software release	RJP		

Although all care has been taken to ensure that all the information contained herein is accurate, The Steel Construction Institute assumes no responsibility for any errors or misinterpretations or any loss or damage arising therefrom.

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1. Introduction

This software has been engineered and developed by SCI - The Steel Construction Institute and HOCHTIEF Engineering for Research Programme of the Research Fund for Coal and Steel STROBE. The software performs the design of bare steel beam-column elements and offers an optimization tool. The design tool covers standard hot-rolled profiles and fabricated steel sections with normal and high strength steels up to S690. For fabricated sections, different steel grades may be specified for flanges and web plates (hybrid profiles). The optimization can be carried out for hot rolled sections (UK and Euro-standard profiles) and welded sections based on user inputs. The tool covers the design of class 1, 2, 3 and 4 cross sections. Core Eurocode, UK, German and Portuguese national annexes to Eurocode 3 are available.

2. Disclaimer

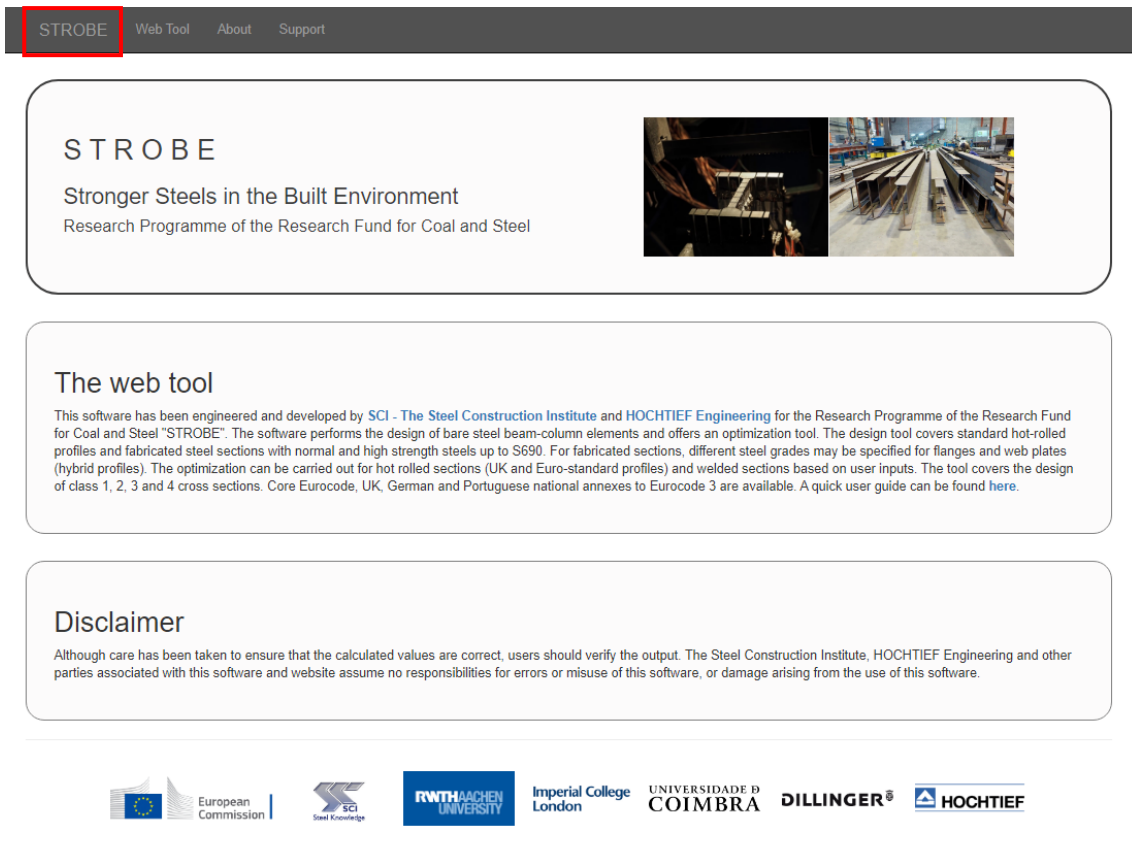
Although care has been taken to ensure that the calculated values are correct, users should verify the output. The Steel Construction Institute, HOCHTIEF Engineering and other parties associated with this software and website assume no responsibilities for errors or misuse of this software, or damage arising from the use of this software.

3. The User Interface

The functionalities of the software are grouped under separate tabs. Below is quick guide for each tab and the main buttons on each tab.

3.1 The “STROBE” tab

The “STROBE” tab gives a quick introduction about the project and explains the functionalities of the design tool.



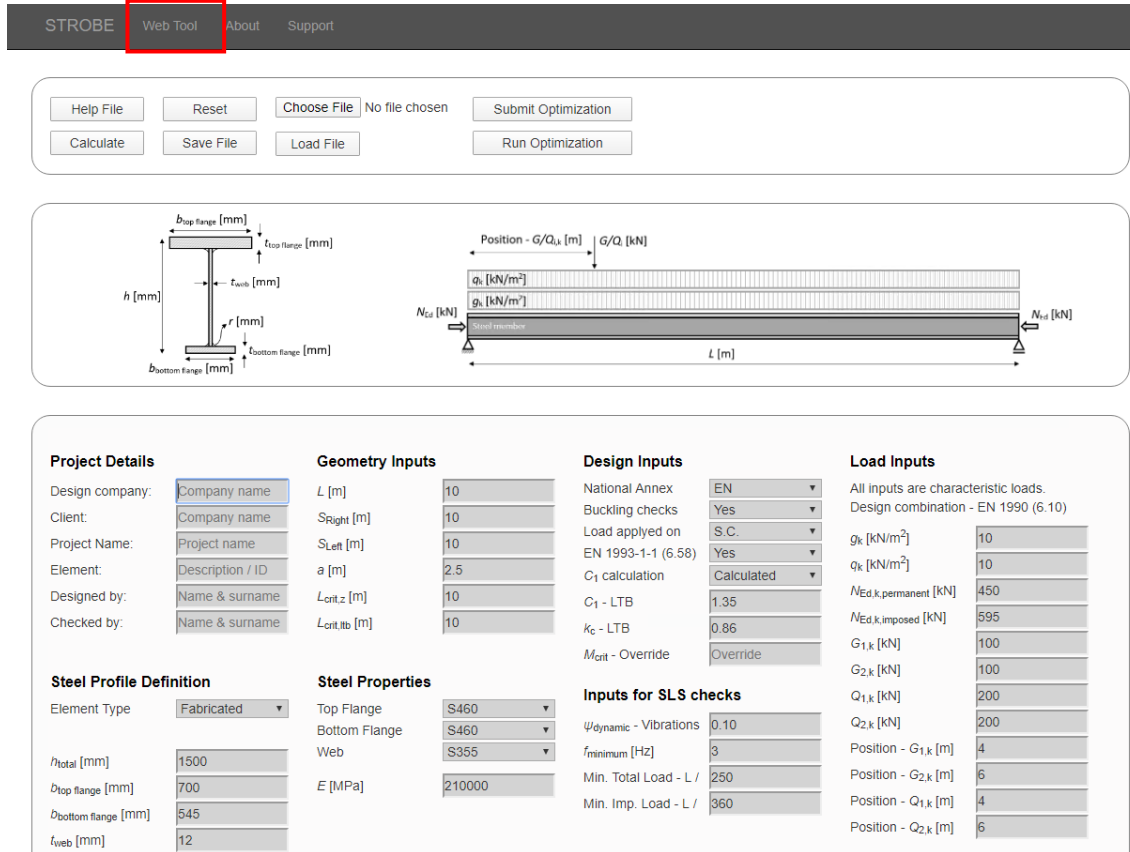
The screenshot shows the STROBE web interface. At the top, there is a navigation bar with tabs: STROBE (highlighted with a red box), Web Tool, About, and Support. Below the navigation bar, the main content area is divided into three sections:

- STROBE**: Stronger Steels in the Built Environment
Research Programme of the Research Fund for Coal and Steel. This section includes an image of steel beams in a factory.
- The web tool**: This software has been engineered and developed by SCI - The Steel Construction Institute and HOCHTIEF Engineering for the Research Programme of the Research Fund for Coal and Steel "STROBE". The software performs the design of bare steel beam-column elements and offers an optimization tool. The design tool covers standard hot-rolled profiles and fabricated steel sections with normal and high strength steels up to S690. For fabricated sections, different steel grades may be specified for flanges and web plates (hybrid profiles). The optimization can be carried out for hot rolled sections (UK and Euro-standard profiles) and welded sections based on user inputs. The tool covers the design of class 1, 2, 3 and 4 cross sections. Core Eurocode, UK, German and Portuguese national annexes to Eurocode 3 are available. A quick user guide can be found [here](#).
- Disclaimer**: Although care has been taken to ensure that the calculated values are correct, users should verify the output. The Steel Construction Institute, HOCHTIEF Engineering and other parties associated with this software and website assume no responsibilities for errors or misuse of this software, or damage arising from the use of this software.

At the bottom of the page, there is a footer with logos for the European Commission, SCI Steel Knowledge, RWTH AACHEN UNIVERSITY, Imperial College London, UNIVERSIDADE DE COIMBRA, DILLINGER, and HOCHTIEF.

3.2 The “Web Tool” tab

The “Web Tool” tab shows the user interface for the design tool.



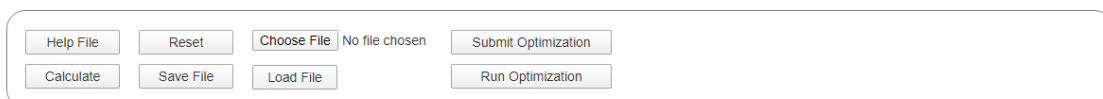
The screenshot shows the STROBE Web Tool interface. At the top, there are navigation tabs: STROBE, Web Tool (highlighted with a red box), About, and Support. Below the tabs is a control bar with buttons: Help File, Reset, Choose File (No file chosen), Submit Optimization, Calculate, Save File, Load File, and Run Optimization.

Below the control bar are two diagrams. The left diagram shows the cross-section of a steel I-beam with dimensions: $b_{top\ flange}$ [mm], $t_{top\ flange}$ [mm], t_{web} [mm], r [mm], $t_{bottom\ flange}$ [mm], $b_{bottom\ flange}$ [mm], and h [mm]. The right diagram shows a longitudinal view of a beam of length L [m] with a point load G/Q_k [kN] at position G/Q_k [m]. It also shows distributed loads q_k [kN/m²] and g_k [kN/m²], and reaction forces N_{ed} [kN] and M_{ed} [kN].

The main input area is divided into several sections:

- Project Details:** Design company, Client, Project Name, Element, Designed by, Checked by.
- Geometry Inputs:** L [m], S_{Right} [m], S_{Left} [m], a [m], $L_{crit,z}$ [m], $L_{crit,tib}$ [m].
- Design Inputs:** National Annex, Buckling checks, Load applied on, EN 1993-1-1 (6.58), C_1 calculation, $C_1 - LTB$, $K_c - LTB$, $M_{crit} - Override$.
- Load Inputs:** All inputs are characteristic loads. Design combination - EN 1990 (6.10). q_k [kN/m²], g_k [kN/m²], $N_{Ed,k,permanent}$ [kN], $N_{Ed,k,imposed}$ [kN], $G_{1,k}$ [kN], $G_{2,k}$ [kN], $Q_{1,k}$ [kN], $Q_{2,k}$ [kN].
- Steel Profile Definition:** Element Type, h_{total} [mm], $t_{top\ flange}$ [mm], $t_{bottom\ flange}$ [mm], t_{web} [mm].
- Steel Properties:** Top Flange, Bottom Flange, Web, E [MPa].
- Inputs for SLS checks:** $\psi_{dynamic} - Vibrations$, $f_{minimum}$ [Hz], Min. Total Load - $L /$, Min. Imp. Load - $L /$.

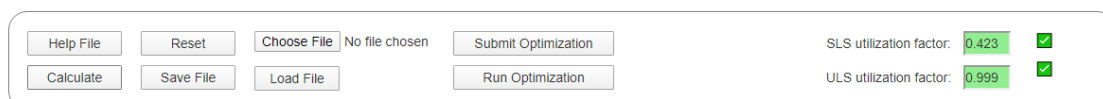
On top of the “Web Tool” tab, the user can find a group of buttons to run the web application:



This image shows a close-up of the control buttons: Help File, Reset, Choose File (No file chosen), Submit Optimization, Calculate, Save File, Load File, and Run Optimization.

- The “User Guide” button: allows user to download the user guide for the web tool;
- The “Calculate” button: performs the calculations based on the user input variables. This button will make design outputs available;

After pressing the “Calculate” button, user will find a design output summary on the top right area of the web interface for ULS and SLS limit states:



This image shows the design output summary. It includes the same control buttons as before, plus the following utilization factors:

- SLS utilization factor: 0.423 (green checkmark)
- ULS utilization factor: 0.999 (green checkmark)

There is a section called “Calculation Messages” that will be populated after completing the calculations.

Section properties, resistances, ULS outputs, SLS outputs and design loads will be also displayed.

Calculation Messages


Material Standard - Top Flange: EN10025-3
 Material Standard - Web: EN10025-2
 Material Standard - Bottom Flange: EN10025-3

Gross Section properties		Design properties & resistances		ULS Outputs		Design Loads	
A_{gross} [mm ²]	40164	Top Flange class	4	UF - Bending & Axial	0.743	N_{Ed} [kN]	1500
Self-weight [kg/m]	315.29	Web class	4	UF - Shear	0.984	$M_{Ed,max}$ [kNm]	5355.7
A_{vz} [mm ²]	16704	A_{eff} [mm ²]	37737	UF - M+N+V	0.000	$x - M_{Ed,max}$ [m]	5
$I_{y,gross}$ [mm ⁴]	13891237158	$I_{y,eff}$ [mm ⁴]	13266941658	UF - EC3-1-1 (6.61)	0.867	V_{Ed} at $M_{Ed,max}$ [kN]	57.85
I_z [mm ⁴]	605934948	$M_{Rd,design}$ [kNm]	8328	UF - EC3-1-1 (6.62)	0.999	$V_{Ed,max}$ [kN]	1881.28
I_t [mm ⁴]	4840472	$V_{Rd,design}$ [kN]	1913	UF - EC3-1-1 (6.54)	0.810	$x - V_{Ed,max}$ [m]	0
I_{w} [mm ⁶]	231156793976043	$N_{Rd,design}$ [kN]	15273	SLS Outputs		M_{Ed} at $V_{Ed,max}$ [kNm]	0
$W_{el,y}$ [mm ³]	16734334	X_y	0.874	Total Deflection: $L/$	728	$M_{y,Ed}$ von Mises [kNm]	5211.08
$W_{el,z}$ [mm ³]	2019783	X_z	0.483	Imposed Load: $L/$	1334	V_{Ed} von Mises [kN]	724.26
$W_{pl,y}$ [mm ³]	21564802	X_{LTB}	0.796	δ Total load [mm]	14	$x -$ von Mises [m]	6
$W_{pl,z}$ [mm ³]	3294162			δ Imposed Load [mm]	7	$M_{Ed,excentricity}$ [kNm]	14.04
				f [Hz]	6.74		

- The “Reset” button: reset default input for the web tool;
- The “Save File” button: allow users to download an input file that can be later uploaded to the web tool; the file has a clear XML structure that can be manually edited;
- The “Choose File” button: allows users to browse and select an input file previous downloaded from the web tool using the button “Save File”;
- The “Load File” button: allows users to load the selected file through the “Choose File” button to the web tool;
- The “Submit Optimization” button: submits the optimization options to the engine and reports an estimated calculation time. For an optimization using standard profiles (say HEB or UC profiles) this is not critical, but for “Fabricated”/welded/custom profiles, depending on the user defined optimization inputs, the calculation time may be unreasonable; the following message will be displayed:

Help File Reset Choose File No file chosen Submit Optimization Calculate Save File Load File Run Optimization

Number of possible Solutions: 14580. Calculation time: < 1min.
 Press 'Run Optimization' to proceed and wait for results. For long calculation times, re-define geometry constraints and re-submit.




The user can judge if the calculation time is acceptable. If the calculation time is too high, user can re-define optimization inputs and re-submit the optimization.

- The “Run Optimization” button: triggers the optimization engine. After pressing the button, the following message will be displayed:

Help File Reset Choose File No file chosen Submit Optimization Calculate Save File Load File Run Optimization

Optimization Running.
 Please wait (this may take a while).



After completing the Optimization calculation, the following message will be displayed:

No file chosen

Results available!

Check output table.

The user can find the optimization outputs if the following table (scroll down in the web page to find it):

Optimization Outputs

ID	H [mm]	tw [mm]	b,top [mm]	tf,top [mm]	b,bottom [mm]	tf, bottom [mm]	SW [kg/m]	UF - M+N	UF - V	UF - M+N+V	UF - 6.54	UF - 6.61	UF - 6.62	Total - L	Imposed - L	f - [Hz]
12020	1500	12	600	25	500	15	314.16	0.72	0.97	0	0.79	0.84	0.98	770	1410	6.93
11667	1500	12	600	25	525	15	317.1	0.72	0.97	0	0.79	0.84	0.97	783	1434	6.98
11559	1500	12	600	25	500	16	317.99	0.71	0.97	0	0.78	0.83	0.97	786	1440	7

There is a section called “Optimization Messages” where the user can find output messages related with the optimization process. As an example, if user selects a certain profile type for which there are no solution available, a message will be displayed referring that “No solution for XX section type” exist.

Optimization Outputs

ID	Name	H [mm]	b [mm]	SW [kg/m]	UF - M+N	UF - V	UF - M+N+V	UF - 6.54	UF - 6.61	UF - 6.62	Total - L	Imposed - L	f - [Hz]
7	HL1100 R	1118	405	498.64	0.67	0.32	0	0.82	0.81	0.99	706	1301	6.61
1	UB 1100 x 400 x 499	1118	405	502.01	0.66	0.31	0	0.81	0.81	0.98	712	1312	6.64
2	UB 920 x 420 x 537	965	425	535.75	0.7	0.34	0	0.78	0.77	0.92	581	1071	5.99
3	UB 1000 x 400 x 539	1030	407	539.43	0.66	0.3	0	0.76	0.76	0.92	655	1209	6.37
8	HL1000 X 554	1032	408	554.06	0.64	0.29	0	0.74	0.74	0.89	671	1239	6.44
9	HL1000 X 642	1048	412	641.85	0.55	0.25	0	0.62	0.61	0.75	788	1458	6.97
10	HD400 X 990	550	448	990.99	0.8	0.3	0	0.76	0.74	0.82	278	522	4.12
4	UC 356 x 406 x 990	550	448	990.99	0.8	0.3	0	0.76	0.74	0.82	278	522	4.12
11	HD400 X 1086	569	454	1087.81	0.71	0.27	0	0.68	0.66	0.74	319	599	4.4
5	UC 356 x 406 x 1086	569	454	1087.81	0.71	0.27	0	0.68	0.66	0.74	319	599	4.4
6	UC 356 x 406 x 1202	580	471	1201.55	0.65	0.23	0	0.62	0.6	0.67	354	667	4.63

Optimization Messages

No solutions for 'HEA' section type.
 No solutions for 'HEAA' section type.
 No solutions for 'HEB' section type.
 No solutions for 'HEM' section type.
 No solutions for 'HP' section type.
 No solutions for 'IPE' section type.
 No solutions for 'IPEA' section type.
 No solutions for 'IPEO' section type.
 No solutions for 'IPEV' section type.

For “Fabricated” profiles, the optimization message “Geometry constraints changed to fulfil design requirements.” means that the minimum flange width was adapted so that existing rules for buckling curves according to Eurocode are applicable.

Optimization Outputs

ID	H [mm]	tw [mm]	b,top [mm]	tf,top [mm]	b,bottom [mm]	tf, bottom [mm]	SW [kg/m]	UF - M+N	UF - V	UF - M+N+V	UF - 6.54	UF - 6.61	UF - 6.62	Total - L	Imposed - L	f - [Hz]
12020	1500	12	600	25	500	15	314.16	0.72	0.97	0	0.79	0.84	0.98	770	1410	6.93
11667	1500	12	600	25	525	15	317.1	0.72	0.97	0	0.79	0.84	0.97	783	1434	6.98
11559	1500	12	600	25	500	16	317.99	0.71	0.97	0	0.78	0.83	0.97	786	1440	7

Optimization Messages

Geometry constraints changed to fulfil design requirements.

User input cells are highlighted with a light grey background. There are two groups of inputs:

I. General inputs for the design tool containing the following sections:

Project Details		Geometry Inputs		Design Inputs		Load Inputs	
Design company:	Company name	L [m]	10	National Annex	EN	All inputs are characteristic loads. Design combination - EN 1990 (6.10)	
Client:	Company name	Sright [m]	10	Buckling checks	Yes	g_k [kN/m ²]	10
Project Name:	Project name	Sleft [m]	10	Load applied on	S.C.	q_k [kN/m ²]	10
Element:	Description / ID	a [m]	2.5	EN 1993-1-1 (6.58)	Yes	$N_{Ed,k,permanent}$ [kN]	450
Designed by:	Name & surname	$L_{crit,z}$ [m]	10	C_1 calculation	Calculated	$N_{Ed,k,imposed}$ [kN]	595
Checked by:	Name & surname	$L_{crit,lb}$ [m]	10	C_1 - LTB	1.35	$G_{1,k}$ [kN]	100
				k_C - LTB	0.86	$G_{2,k}$ [kN]	100
				M_{crit} - Override	Override	$Q_{1,k}$ [kN]	200
Steel Profile Definition		Steel Properties		Inputs for SLS checks		$Q_{2,k}$ [kN]	200
Element Type	Fabricated	Top Flange	S460	$\psi_{dynamic}$ - Vibrations	0.10	Position - $G_{1,k}$ [m]	4
h_{total} [mm]	1500	Bottom Flange	S460	$f_{minimum}$ [Hz]	3	Position - $G_{2,k}$ [m]	6
$D_{top\ flange}$ [mm]	700	Web	S355	Min. Total Load - L /	250	Position - $Q_{1,k}$ [m]	4
$D_{bottom\ flange}$ [mm]	545	E [MPa]	210000	Min. Imp. Load - L /	360	Position - $Q_{2,k}$ [m]	6
t_{web} [mm]	12						
$t_{top\ flange}$ [mm]	25						
$t_{bottom\ flange}$ [mm]	15						

II. Inputs for the optimization tool:

Optimization Inputs		General Inputs		Geometry Constraints Inputs	
Number of solutions:	3	Max. Profile Depth	1500	$t_{w,min}$ [mm]	8
Max. UF M+N	1.00	Web Step	50	$t_{w,max}$ [mm]	16
Max. UF Shear	1.00	Web class	4	$D_{top,min}$ [mm]	450
Max. M+N+V	1.00	Top flange Class	4	$D_{top,max}$ [mm]	700
Max. EC3-1-1 (6.54)	1.00	Bottom Flange Class	4	$t_{top,min}$ [mm]	15
Max. EC3-1-1 (6.61)	1.00	Equal flanges?	No	$t_{top,max}$ [mm]	30
Max. EC3-1-1 (6.62)	1.00	Web optimization:	1 - Maximum d_e	$D_{bottom,min}$ [mm]	450
Sort results by:	Weight			$D_{bottom,max}$ [mm]	700
				$t_{bottom,min}$ [mm]	15
				$t_{bottom,max}$ [mm]	30

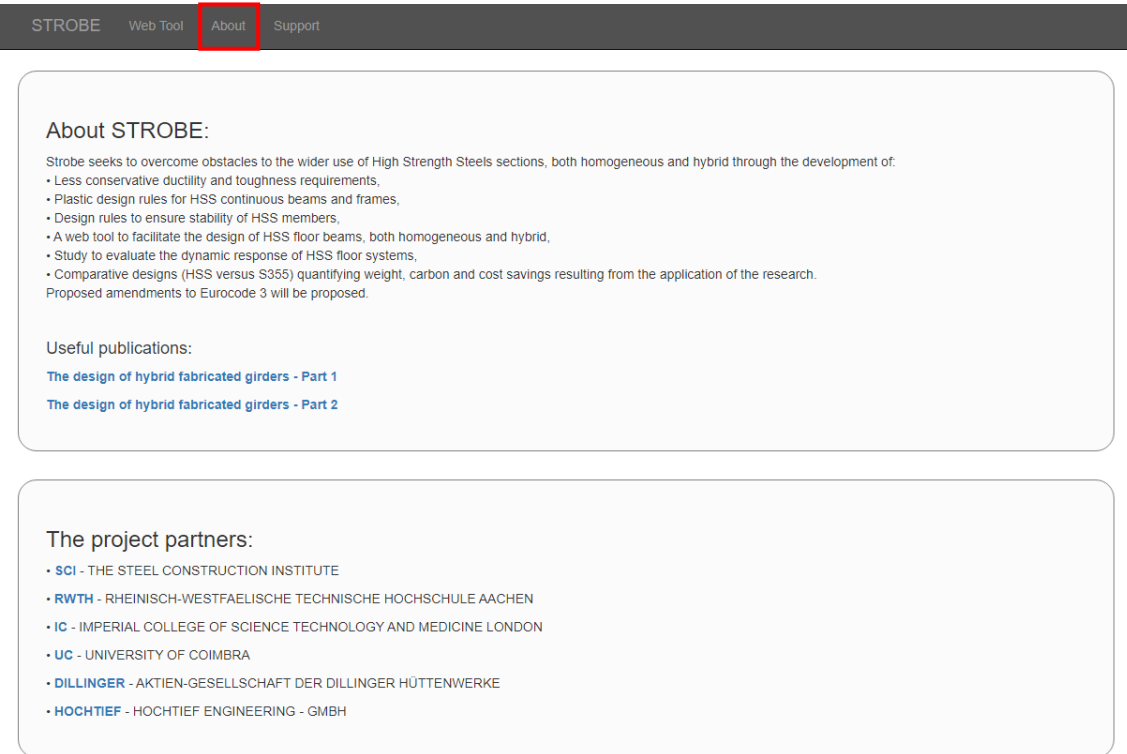
Most of the general inputs are also used for the optimization tool. The only inputs that are not used for the optimization tool are the ones that define the section geometry under the “Steel Profile Definition” group of inputs.

The “Element Type” input will change the options available in the interface.

Most of the input or output text boxes have a “ToolTip” option which provides useful information about the input/output. To trigger tis option please pass the cursor over the text box.

3.3 The “About” tab

The “About” tab gives more information about the project and the project and the project partners. Users can find two useful technical publications about the design of hybrid girders.



The screenshot shows the 'About' tab selected in a navigation bar. The main content area is divided into two sections: 'About STROBE:' and 'The project partners:'. The 'About STROBE:' section lists several objectives and design goals, followed by two links to technical publications. The 'The project partners:' section lists six partner organizations with their full names.

STROBE Web Tool **About** Support

About STROBE:

Strobe seeks to overcome obstacles to the wider use of High Strength Steels sections, both homogeneous and hybrid through the development of:

- Less conservative ductility and toughness requirements,
- Plastic design rules for HSS continuous beams and frames,
- Design rules to ensure stability of HSS members,
- A web tool to facilitate the design of HSS floor beams, both homogeneous and hybrid,
- Study to evaluate the dynamic response of HSS floor systems,
- Comparative designs (HSS versus S355) quantifying weight, carbon and cost savings resulting from the application of the research.

Proposed amendments to Eurocode 3 will be proposed.

Useful publications:

- [The design of hybrid fabricated girders - Part 1](#)
- [The design of hybrid fabricated girders - Part 2](#)

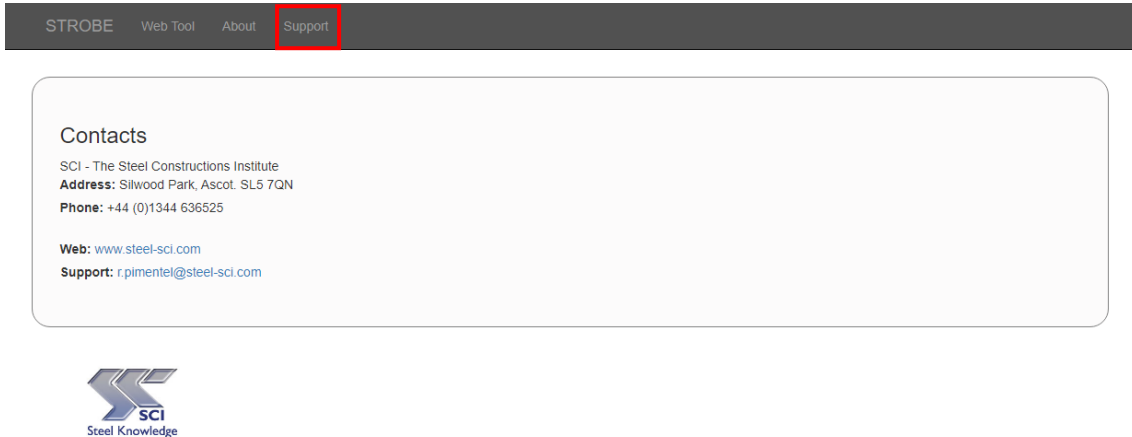
The project partners:

- **SCI** - THE STEEL CONSTRUCTION INSTITUTE
- **RWTH** - RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN
- **IC** - IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE LONDON
- **UC** - UNIVERSITY OF COIMBRA
- **DILLINGER** - AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE
- **HOCHTIEF** - HOCHTIEF ENGINEERING - GMBH



3.4 The “Support” tab

The “Support” tab gives the contacts that can be used to report any issues found related to the web tool as well as to request any further clarification about the project or the web tool.




STROBE Web Tool About Support

Contacts

SCI - The Steel Construction Institute
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Web: www.steel-sci.com
Support: r.pimentel@steel-sci.com



SCI
Steel Knowledge

Contact SCI for more details:

<https://steel-sci.com/contact/>

