QUICK START GUIDE 6: OPTIMISER

This document has been prepared to guide users on how to use the optimisation module within Quantifire. This feature is designed to assist users to implement a cost-benefit analysis to find the most economical solution by considering the combined price of steel, PFP material and application. It can also be useful to propose alternate section sizes when the parent section cannot be protected, e.g., in the case a high section factor and/or a low critical temperature.

1. OVERVIEW

Steel structures are typically designed for normal conditions with relatively little consideration given to their performance in fire, let alone their relationship with applied fire protection. A more comprehensive assessment would consider the costs of steel, PFP material and the application combined. This is illustrated in Figure 1. This process allows for consideration of alternate structural sections that may either permit sections to be protected or to rationalise the associated thickness and resultant application costs. From an ambient perspective, the cheapest solution may be the lightest steel section, however when fire protection is considered, a slight increase in steel weight may bring significant economical savings.

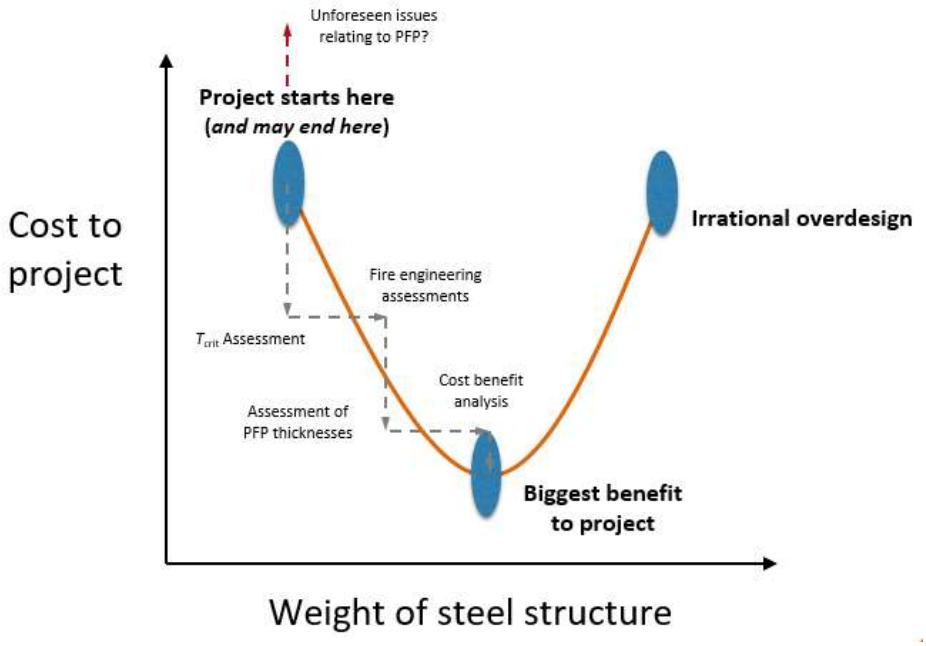


Figure 1: Concept of a cost-benefit assessment to find the optimum section size when accounting for PFP

The optimisation module within Quantifire allows fire protection estimators have an informed discussion with designers. It can also be used directly by designers. This quick guide introduces the key features with an example.

2. ACCESSING THE OPTIMISER

The Optimiser can be accessed via the 'Optimise section' button in the Quantifire main menu, see Figure 2. Alternatively, it can be accessed via the 'Project statistics' display, see Figure 3.

Access to the optimiser is a permission set on an individual-user basis with access disabled by default. Contact your primary internal administrator to request access.

The optimiser allows users to consider a single section at a time. Therefore at least one section should be in the take-off on the MTO Builder screen to start. Note that at the time of writing, solid rods and "Custom" sections (defined by section factor or weight or heated perimeter alone) cannot be optimised.

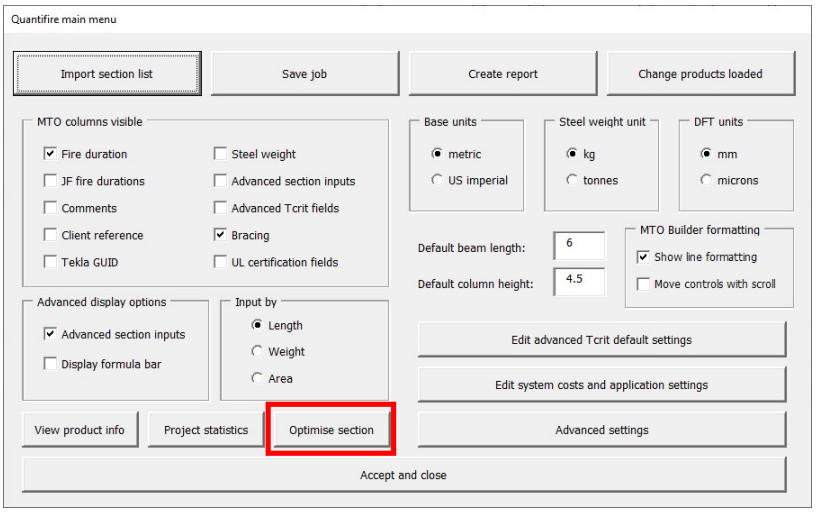


Figure 2: Accessing the Optimiser via the main menu

Figure 3: Assessing the Optimiser via the Project Statistics display

3. ENTERING COST INFORMATION

On first use, unless they have been previously set, the Optimiser will prompt the user that the cost settings are incomplete, see Figure 4. To undertake the cost-benefit analysis, costs associated with steel, PFP product and application are required.

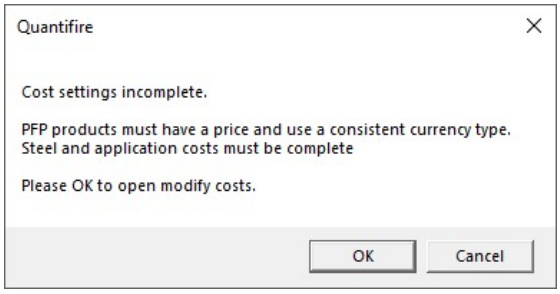


Figure 4: User prompt to remind that cost settings need to be entered

The steel and application cost settings window is shown in Figure 5. Example cost values are set in the textbox placeholders, but these should be modified to suit the project needs accordingly. The PFP material cost is entered by clicking the 'Edit material costs' button. This opens the 'Product and system details' window as shown in Figure 6. From this dialogue box, the cost per unit can be entered, together with the associated currency. Each loaded product must have a unit cost set, and the currency across all products must be consistent.

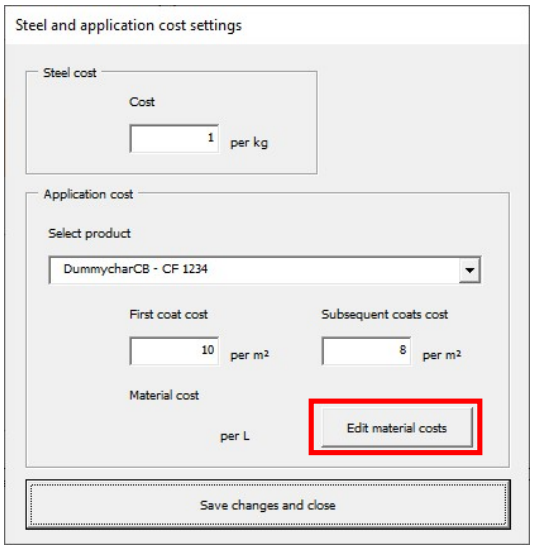


Figure 5: Steel and application cost settings – values shown are illustrative examples only. PFP material costs are set via the 'Edit material costs' button as highlighted

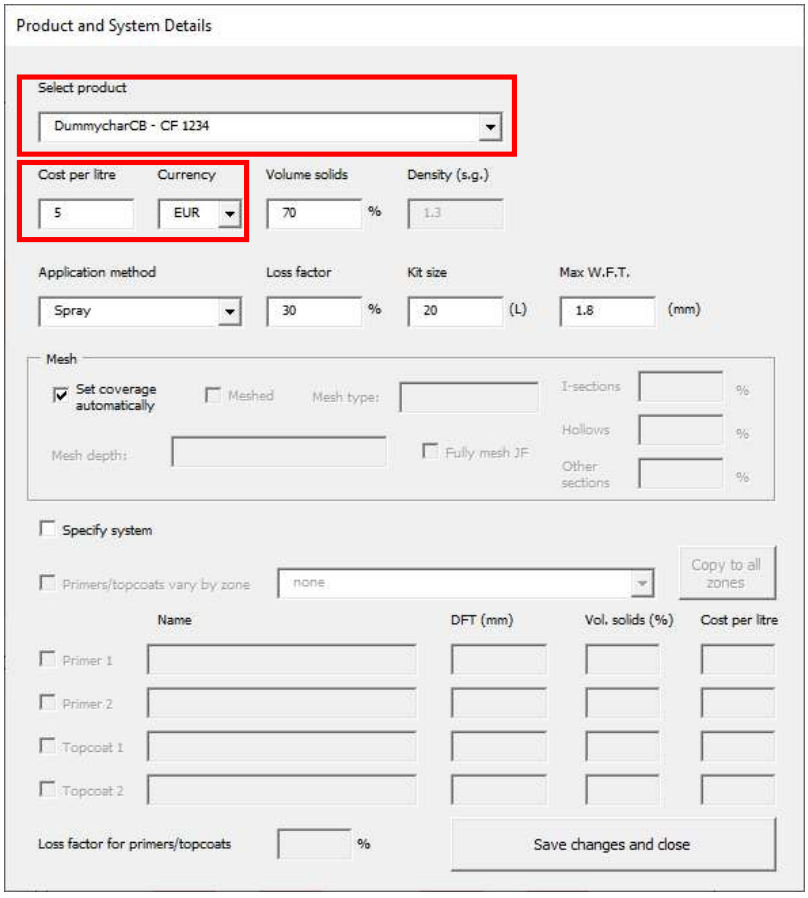


Figure 6: Product-specific cost inputs on the Product and System Details dialogue box

4. OPTIMISING A SECTION

When all costs inputs have been entered, the software prompts the user to identify which section ID from the MTO Builder screen is to be used as the parent section, see Figure 7

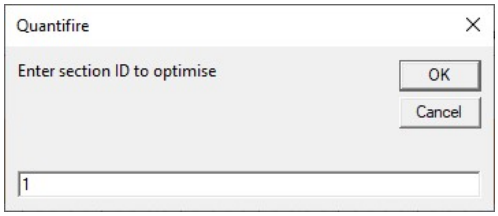


Figure 7: Enter the section ID to optimise

The Optimiser screen then opens, and the parent section and its associated properties are shown, as depicted in Figure 8. In the example in the figure, the parent section is an SHS 100x100x3.6. Note that the critical temperature (T_{crit}) is shown as 223°C following an advanced calculation assessment and as a result, no thickness can be evaluated as this value is too low for the certified limits of the product (<Tcrit).

Figure 8: Optimiser display screen and associated control buttons

5. DEFINING ALTERNATE SECTIONS FOR CONSIDERATION

Alternate sections can now be generated using the 'Generate alternate sections' button. The user is prompted as to whether this should be done automatically or manually, as shown in Figure 9.

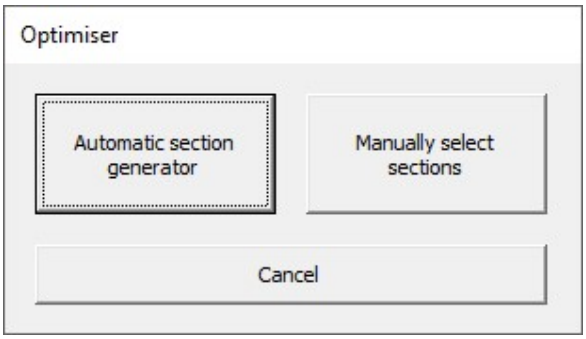


Figure 9: Choose whether to let Quantifire determine the alternate sections or whether to select them manually

6. MANUALLY SELECTING ALTERNATIVE SECTIONS

This method allows the user to directly pick appropriate sections for consideration. In the example in Figure 10, the user has selected the range of serial sizes associated with an SHS 100x100, i.e., the range of wall thicknesses associated with that size. The '>>' button copies the relevant sections into the selected section list. The user can the choose to analyse all listed sections or highlight a select few and analyse those only.

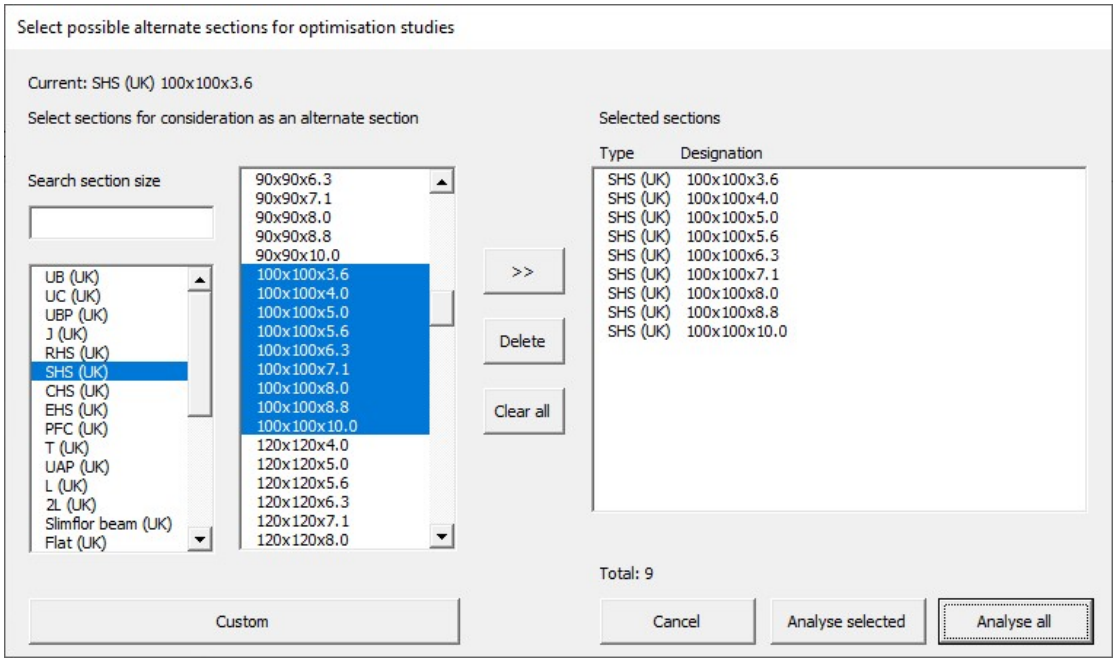


Figure 10: Manual selection of alternate sections for consideration

7. AUTOMATICALLY SELECTING ALTERNATIVE SECTIONS

Quantifire has built-in algorithms to determine potentially appropriate sections for consideration. These are compatible with I-sections, RHS, SHS, CHS and cellular beams only.

The user has significant control over the basis by which sections are generated, as depicted in Figure 11. In the example in the figure, the following settings have been applied (set by default based on the parent section): -

1. Serial sections only
2. RHS/SHS shapes
3. Overall depth and overall width dimensions fixed

Clicking on 'Generate sections' produces the list of proposed alternate sections for consideration. Only sections with an overall surface area equal to or greater than the parent section are generated.

Where the overall dimensions are permitted to change, the user can specific the deviation as a percentage from the parent section and the number of intervals to consider.

Where fabricated sections are to be generated, the user has control over permitted dimension deviations for flange thicknesses, web thicknesses and wall thicknesses.

For cellular beams, the user has control over whether the section is fabricated from two serial sections and/or from plate sections. They can also control the opening shapes and their positioning/spacing.

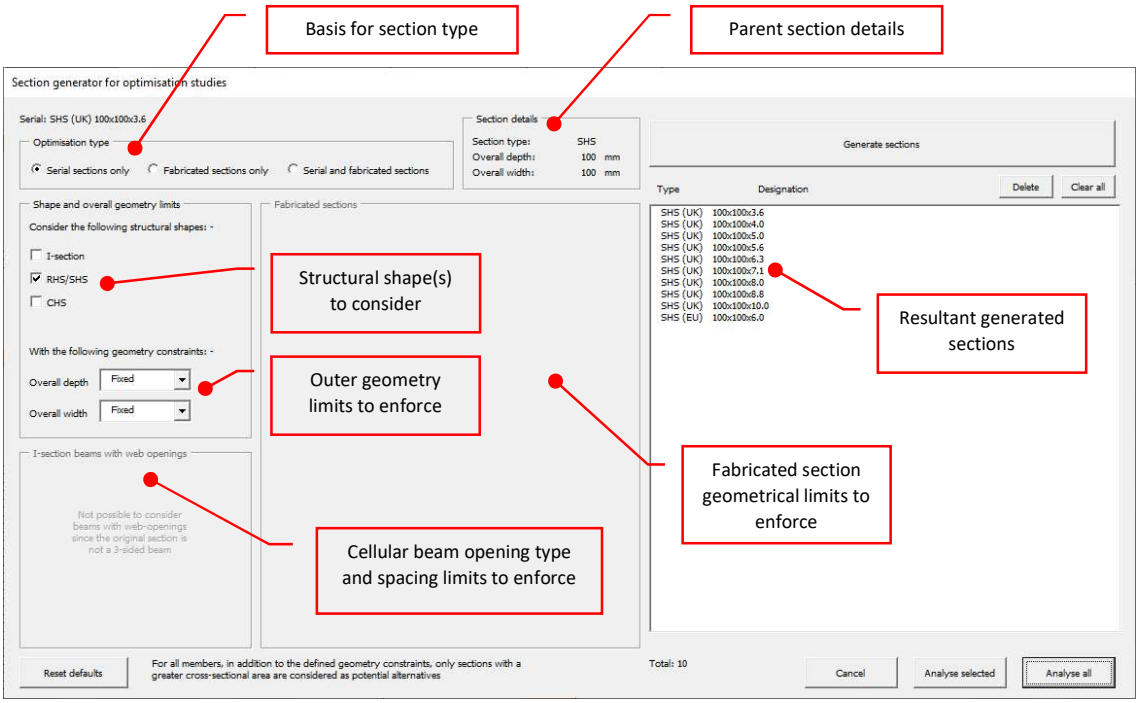


Figure 11: Automatic selection of alternate sections for consideration

8. ASSESSING THE PROPOSED ALTERNATE SECTIONS

Once the sections for consideration have been defined, the user must select the assessment type, as shown in Figure 12. The assessment types are:

- **Retain temperature**: available in all assessments, unless the section is a cellular beam and has been assessed using an advanced method which maps product specific temperatures onto the member.
- **Advanced calculation**: available only when the parent section is based on an advanced calculation assessment from within Quantifire (T_{crit} assessment)

The advanced calculation method takes the load used for the parent section and applies it to all other sections for consideration. This can be advantageous since benefit is not only gained from different section factors, but also from additional capacity of the sections which can result in higher critical temperatures.

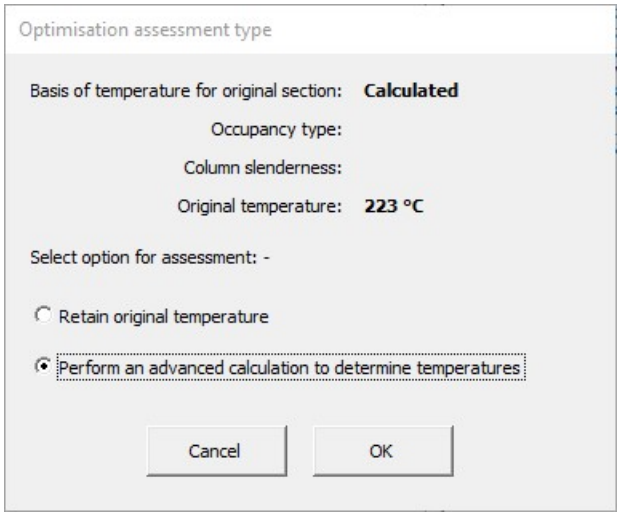


Figure 12: Optimisation assessment type, i.e., to retain the original section ID's critical temperature to calculate it directly for each alternative section

9. OPTIMISER OUTPUT

Figure 13 shows an example output following an optimisation assessment which uses an advanced calculation approach. A series of plots are presented with respect to weight (mass) of the respective sections. The red markers on the plots indicate the parent section.

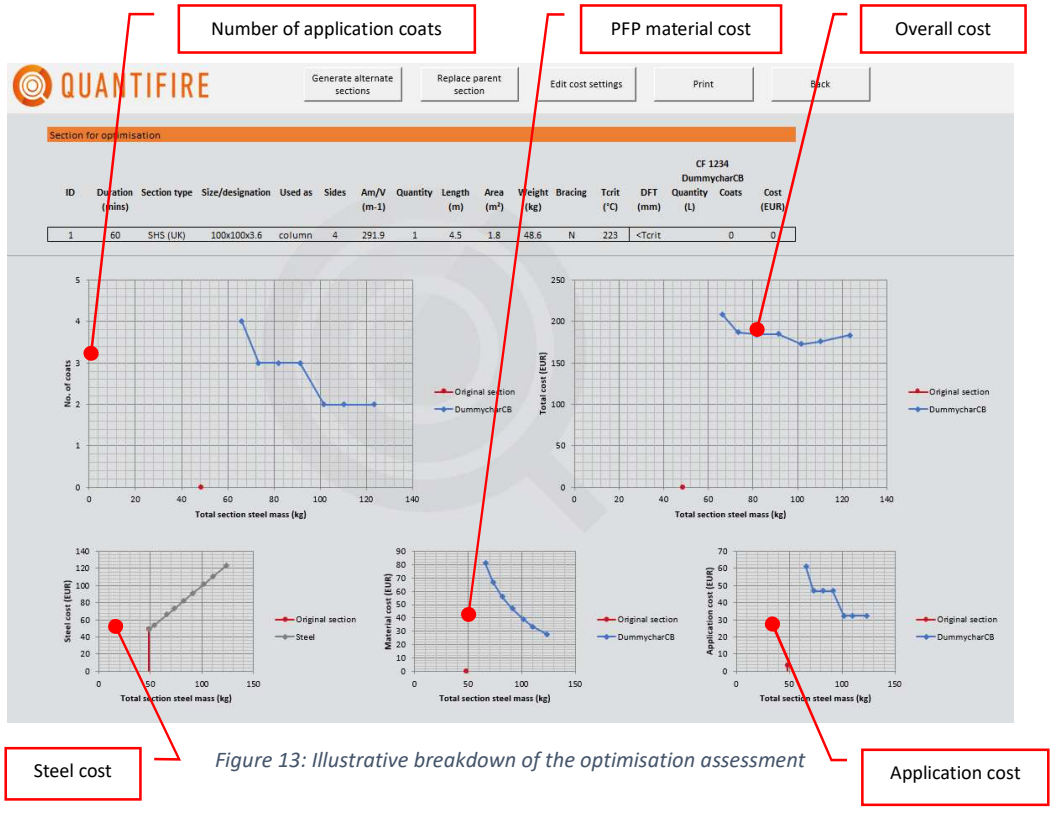
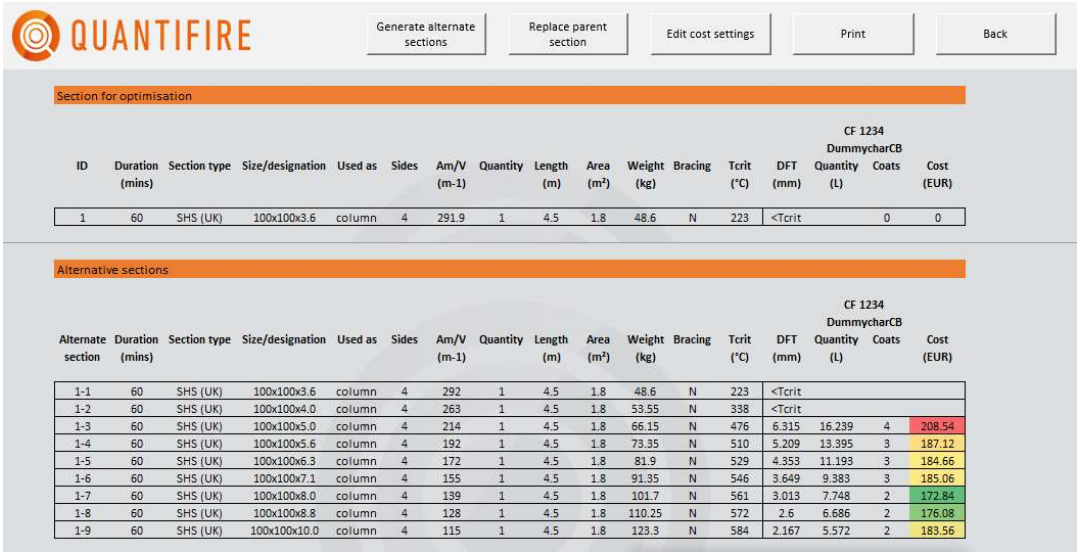


Figure 13: Illustrative breakdown of the optimisation assessment

Underneath the plots is detail relating to each potential alternate section. This is shown as an example in Figure 14. It is evident from the plots and the detailed output that, alternate section number 7, i.e., an SHS 100x100x8.0 can be protected and has the lowest overall cost of all sections considered.



ID	Duration (mins)	Section type	Size/designation	Used as	Sides	Am/V (m-1)	Quantity	Length (m)	Area (m²)	Weight (kg)	Bracing	Tcrit (°C)	DFT (mm)	CF 1234 DummycharCB Quantity (L)	Coats	Cost (EUR)
1	60	SHS (UK)	100x100x3.6	column	4	291.9	1	4.5	1.8	48.6	N	223	<Tcrit		0	0

Alternate section	Duration (mins)	Section type	Size/designation	Used as	Sides	Am/V (m-1)	Quantity	Length (m)	Area (m²)	Weight (kg)	Bracing	Tcrit (°C)	DFT (mm)	CF 1234 DummycharCB Quantity (L)	Coats	Cost (EUR)
1-1	60	SHS (UK)	100x100x3.6	column	4	292	1	4.5	1.8	48.6	N	223	<Tcrit			
1-2	60	SHS (UK)	100x100x4.0	column	4	263	1	4.5	1.8	53.55	N	338	<Tcrit			
1-3	60	SHS (UK)	100x100x5.0	column	4	214	1	4.5	1.8	66.15	N	476	6.315	16.239	4	208.54
1-4	60	SHS (UK)	100x100x5.6	column	4	192	1	4.5	1.8	73.35	N	510	5.209	13.395	3	187.12
1-5	60	SHS (UK)	100x100x6.3	column	4	172	1	4.5	1.8	81.9	N	529	4.353	11.193	3	184.66
1-6	60	SHS (UK)	100x100x7.1	column	4	155	1	4.5	1.8	91.35	N	546	3.649	9.383	3	185.06
1-7	60	SHS (UK)	100x100x8.0	column	4	139	1	4.5	1.8	101.7	N	561	3.013	7.748	2	172.84
1-8	60	SHS (UK)	100x100x8.8	column	4	128	1	4.5	1.8	110.25	N	572	2.6	6.686	2	176.08
1-9	60	SHS (UK)	100x100x10.0	column	4	115	1	4.5	1.8	123.3	N	584	2.167	5.572	2	183.56

Figure 14: Detail associated with breakdown of each alternate section considered

10. REPLACING A PARENT SECTION IN THE TAKE-OFF

To substitute a parent section, click on 'Replace parent section' at the top of the Optimiser screen. The user can then select which alternate section is to be brought back into the main take-off. When this is done, the original parent section is displayed in the comments for informative purposes, see Figure 15. This can be edited or deleted if required, using the edit function (pen icon) on the MTO Builder screen.

Comment	ID	Duration	Section type	Size/designation	Used as	Sides	A_m/V (m^{-1})	Quantity	Length (m)	Area (sum) (m^2)	Bracing	Tcrit (°C)	CF 1234 DummycharCB DFT (mm)	CF 1234 DummycharCB Volume (L)
Modified from SHS (UK) 100x100x3.6	1	60	SHS (UK)	100x100x8.0	column	4	139	1	4.5	1.8	N	561	3.013	7.75

Figure 15: MTO Builder screen after adopting an alternate section – note the 'Comments' column now displays a message to indicate that it has been modified