NTNU

June 04, 2023

Results from the Design Tool

Project name: Case Study 1

Construction site located at: 63.4154, 10.3995

Summary of results

Total score	Score without reuse	Savings	Substitutions
8 333 kgCO2eq	73 037 kgCO2eq	88.59%	90.1%

The best results was obtained by the following algorithm: Greedy Algorithm Plural. This algorithm sucessfully substituted 901/1000 (90.1%) of the demand elements with reusable elements. Using 'GWP' as the optimization metric, a total score of 8 333 kgCO2eq was achieved. For comparison, a score of 73 037 kgCO2eq would have been obtained by employing exclusively new materials. This resulted in a total saving of 88.59%, which corresponds to 64 704 kgCO2eq. The savings is equivalent to 628 flights for one person between Oslo and Trondheim. Note that impacts of transporting the materials to the construction site was not accounted for. Open the Excel file "Case_Study_1_substitutions.xlsx" to examine the substitutions.

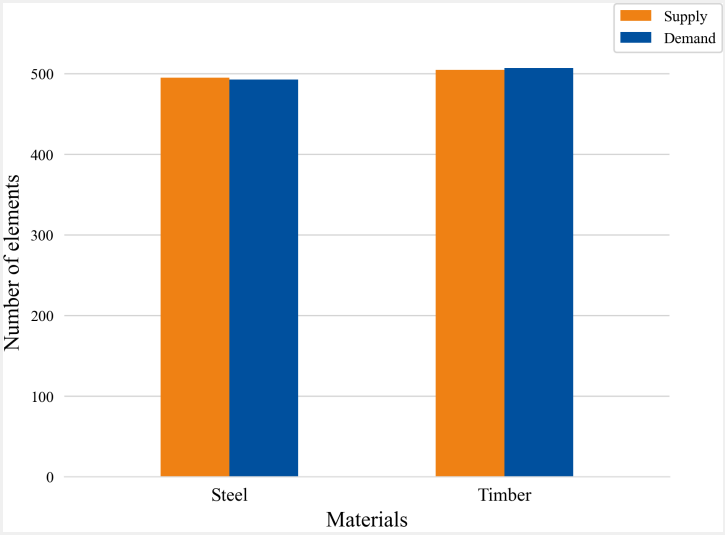
Constants used in the calculations

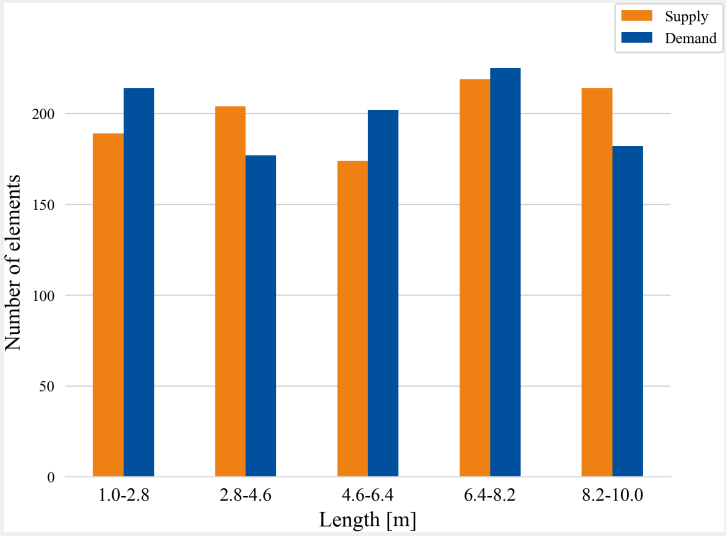
Constant	Value	Unit
Density timber	491.0	kg/m^3
Density steel	7850.0	kg/m^3
GWP new timber	28.9	kgCO2eq/m^3
GWP reusable timber	2.25	kgCO2eq/m^3
GWP new steel	9263.0	kgCO2eq/m^3
GWP reusable steel	278.0	kgCO2eq/m^3

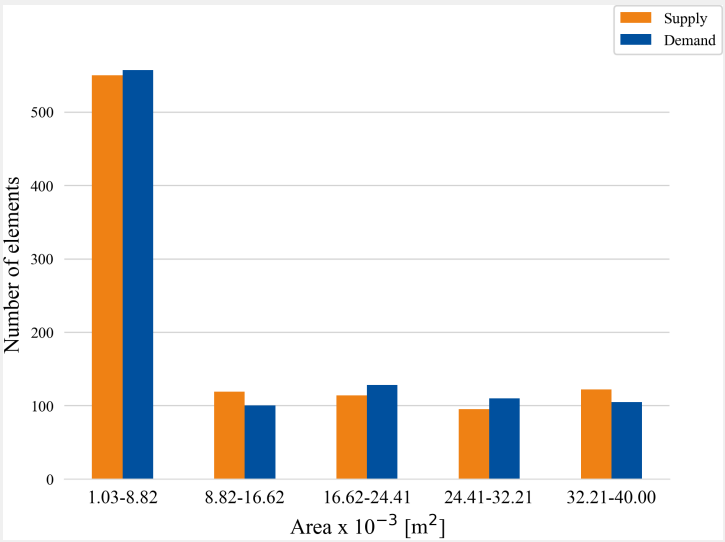
Information about the datasets

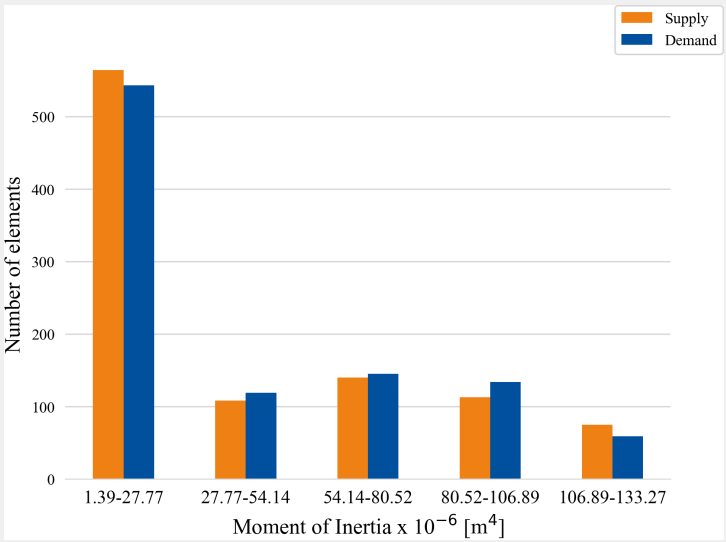
Elements	Filename	Number of elements
Supply	master_thesis_supply.xlsx	1000
Demand	master_thesis_demand.xlsx	1000

The datasets contains 1000 supply elements and 1000 demand elements. The graphs below depicts the distribution of some of the properties of the elements, including the material, length, area, and moment of inertia.









Performance of the optimization algorithms

Algorithm name	Total score	Substitutions	Time
Greedy Algorithm Plural	8 333 kgCO2eq	90.1%	11.03s
MBM Plural	8 465 kgCO2eq	90.6%	12.22s
Greedy Algorithm	9 320 kgCO2eq	89.0%	6.86s

The design tool was executed with 3 algorithms, namely: Greedy Algorithm Plural, MBM Plural, and Greedy Algorithm. The Greedy Algorithm Plural yielded the lowest score, as shown in the table. The substitutions by this algorithm was completed in 11.027 seconds.