NTNU

May 26, 2023

Results from the Design Tool

Project name: Case Study 3

Construction site located at: 63.4154, 10.3995

Summary of results

Total score	Score without reuse	Savings	Substitutions
NOK 4 292 427	NOK 4 309 674	0.4%	44.2%

The best results was obtained by the following algorithm: Greedy Algorithm Plural. This algorithm sucessfully substituted 442/1000 (44.2%) of the demand elements with reusable elements. Using 'Combined' as the optimization metric, a total score of NOK 4 292 427 was achieved. For comparison, a score of NOK 4 309 674 would have been obtained by employing exclusively new materials. This resulted in a total saving of 0.4%, which corresponds to NOK 17 247. Note that impacts of transporting the materials to the construction site was accounted for and contributed to 0.65% of the total score. Open the Excel file "Case_Study_3_substitutions.xlsx" to examine the substitutions.

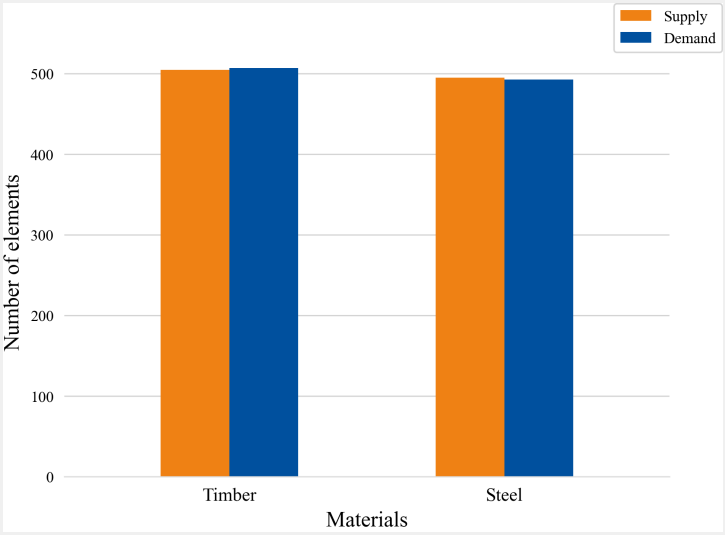
Constants used in the calculations

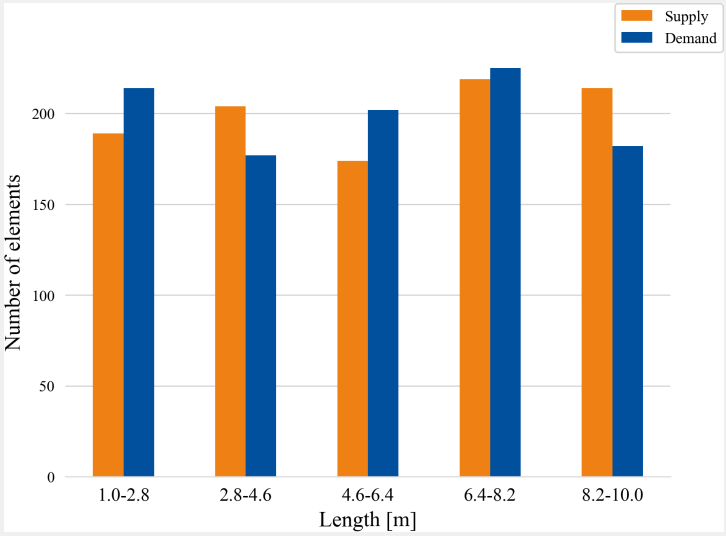
Constant	Value	Unit
Density timber	491.0	kg/m^3
Density steel	7850.0	kg/m^3
GWP new timber	28.9	kgCO2eq
GWP reusable timber	2.25	kgCO2eq
GWP new steel	9263.0	kgCO2eq
GWP reusable steel	278.0	kgCO2eq
Valuation of GWP	0.7	NOK/kgCO2eq
Price new timber	3400.0	NOK/m^3
Price reusable timber	3400.0	NOK/m^3
Price new steel	67.0	NOK/kg
Price reusable steel	67.0	NOK/kg
GWP transportation	89.6	g/tonne/km
Price of transportation	4.0	NOK/tonne/km

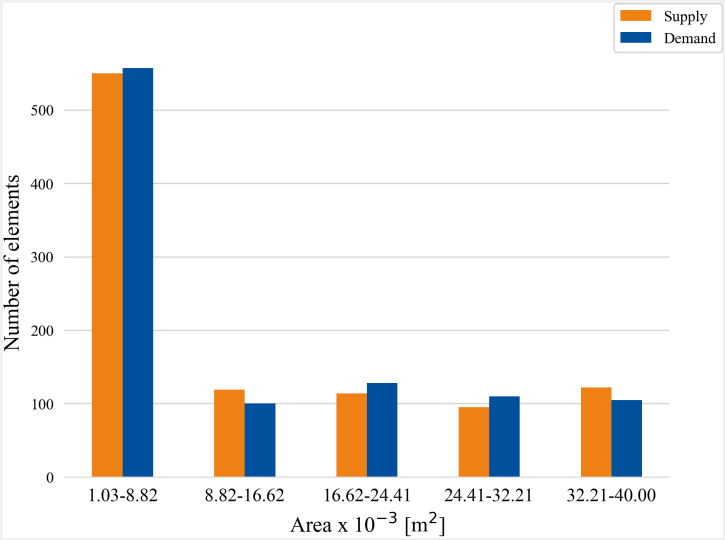
Information about the datasets

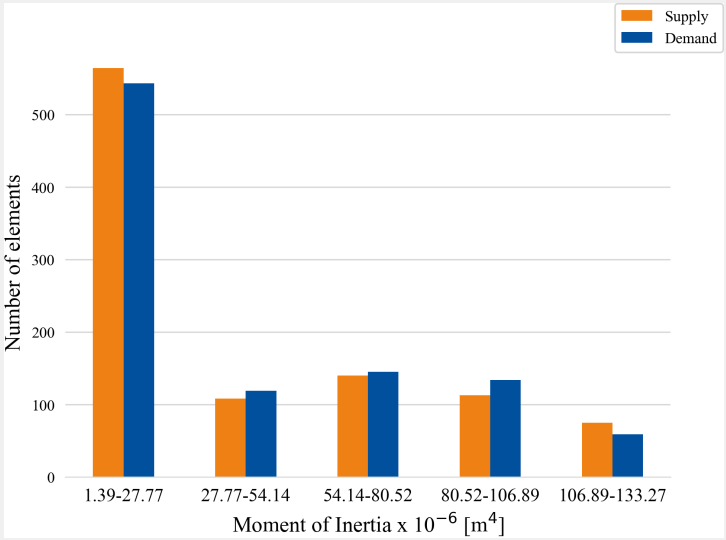
Elements	Filename	Number of elements
Supply	master_thesis_supply.xlsx	1000
Demand	master_thesis_demand.xlsx	1000

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.





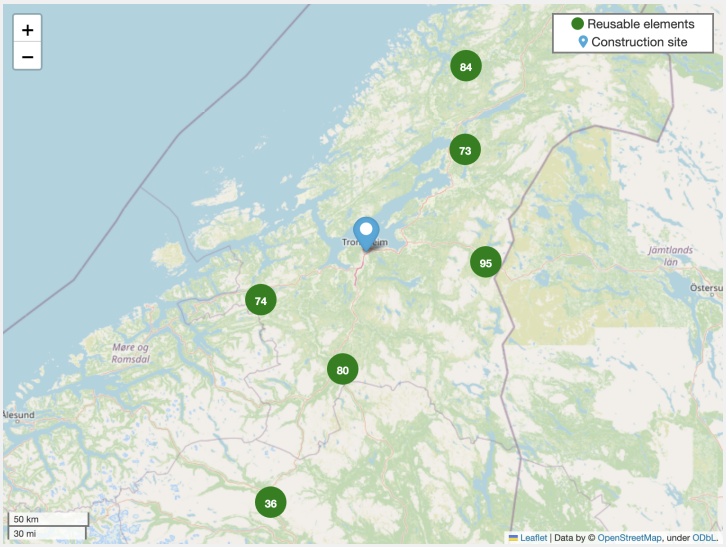


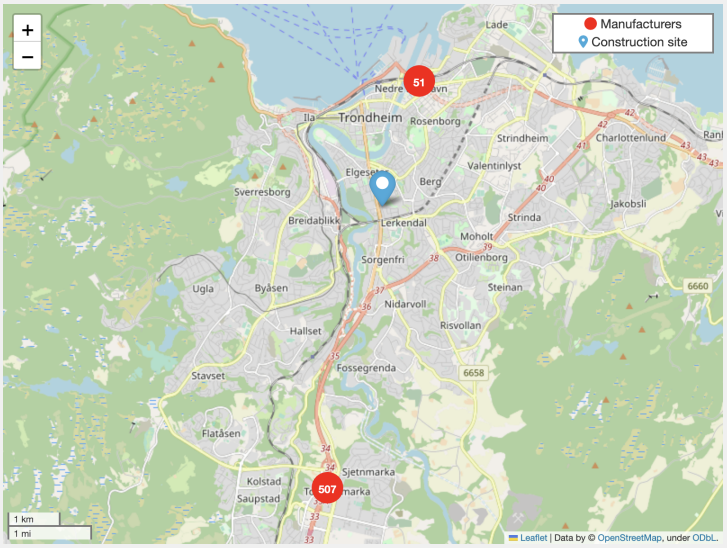


Impact of transportation

Utilizing reusable elements	Percentage of total score	Only manufactured elements
NOK 27 749	0.65%	NOK 1 693

All calculations in this report accouned for the effects of material transportation to the construction site. Transportation itself was responsible for NOK 27 749. This accounts for 0.65% of the total score of NOK 4 292 427. For comparison, the transportation impact for exclusively using new materials would have been NOK 1 693. Two maps are included to show the locations of the suggested element substitutions from the design tool. The numbers on the maps indicate the number of elements transported from each location.





Performance of the optimization algorithms

Algorithm name	Total score	Substitutions	Time
Greedy Algorithm Plural	NOK 4 292 427	44.2%	11.19s
MBM Plural	NOK 4 292 438	44.0%	5.61s
Greedy Algorithm	NOK 4 292 519	42.8%	6.75s

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 11.192 seconds.