NTNU

June 04, 2023

Results from the Design Tool

Project name: Case Study 4

Construction site located at: 63.4154, 10.3995

Summary of results

Total score	Score without reuse	Savings	Substitutions
NOK 2 442 463	NOK 4 770 040	48.8%	90.3%

The best results was obtained by the following algorithm: MBM Plural. This algorithm sucessfully substituted 903/1000 (90.3%) of the demand elements with reusable elements. Using 'Combined' as the optimization metric, a total score of NOK 2 442 463 was achieved. For comparison, a score of NOK 4 770 040 would have been obtained by employing exclusively new materials. This resulted in a total saving of 48.8%, which corresponds to NOK 2 327 577. Note that impacts of transporting the materials to the construction site was accounted for and contributed to 1.99% of the total score. Open the Excel file "Case_Study_4_substitutions.xlsx" to examine the substitutions.

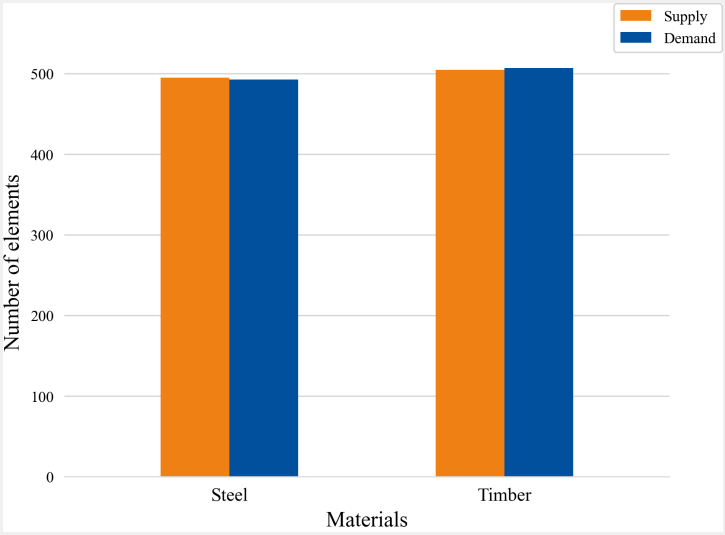
Constants used in the calculations

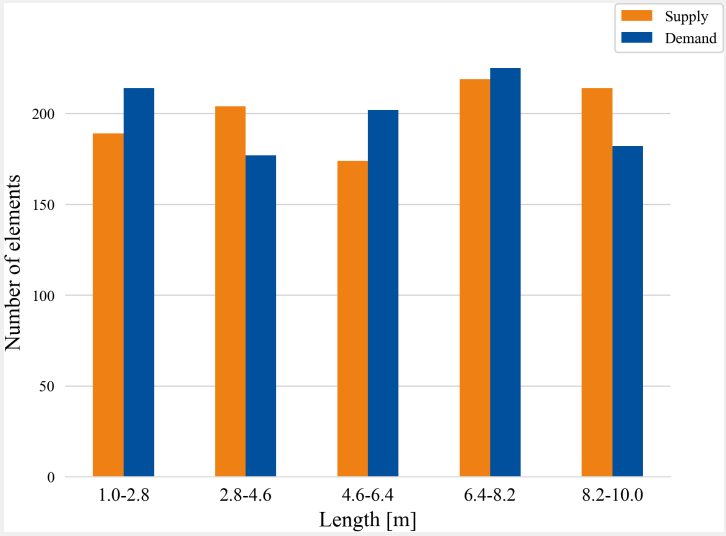
Constant	Value	Unit
Density timber	491.0	kg/m^3
Density steel	7850.0	kg/m^3
GWP new timber	28.9	kgCO2eq/m^3
GWP reusable timber	2.25	kgCO2eq/m^3
GWP new steel	9263.0	kgCO2eq/m^3
GWP reusable steel	278.0	kgCO2eq/m^3
Valuation of GWP	7.0	NOK/kgCO2eq
Price new timber	3400.0	NOK/m^3
Price reusable timber	1700.0	NOK/m^3
Price new steel	67.0	NOK/kg
Price reusable steel	33.5	NOK/kg
GWP transportation	89.6	g/tonne/km
Price of transportation	4.0	NOK/tonne/km

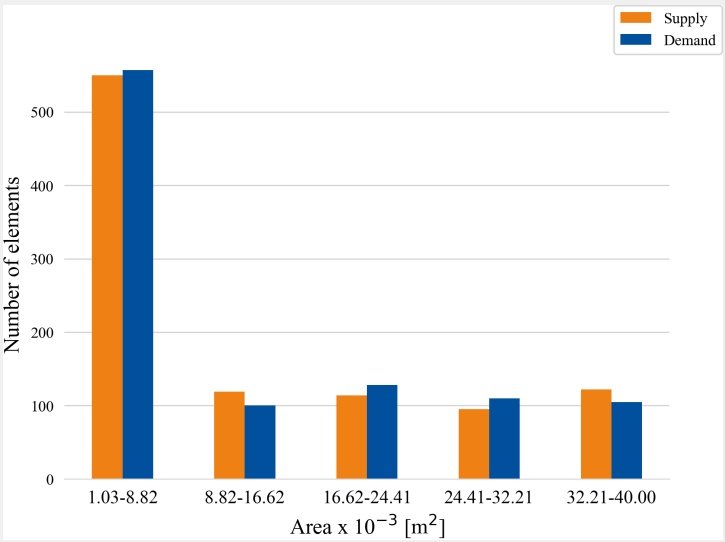
Information about the datasets

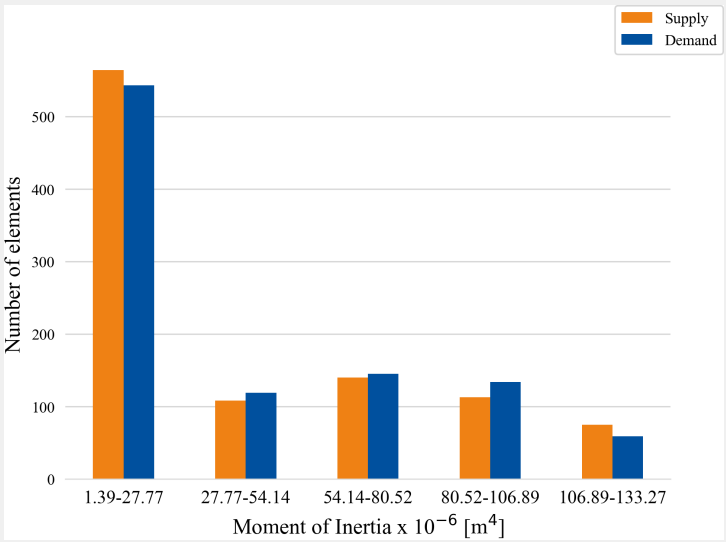
Elements	Filename	Number of elements
Supply	master_thesis_supply.xlsx	1000
Demand	master_thesis_demand.xlsx	1000

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.





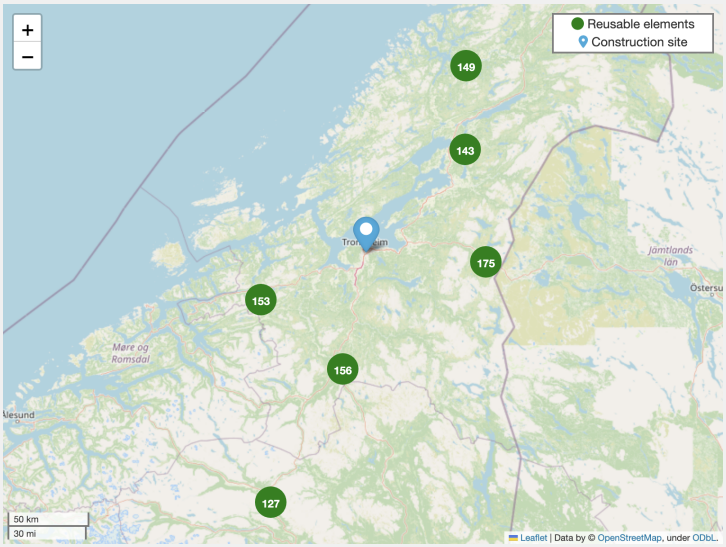


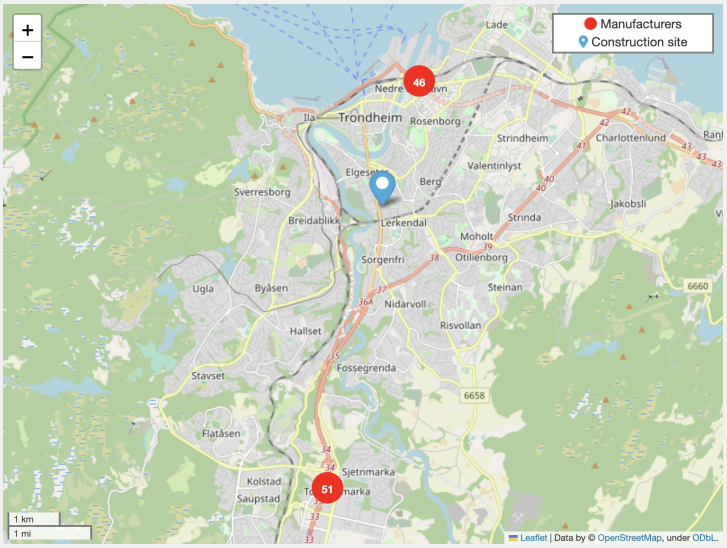


Impact of transportation

Utilizing reusable elements	Percentage of total score	Only manufactured elements
NOK 48 605	1.99%	NOK 1 928

All calculations in this report accouned for the effects of material transportation to the construction site. Transportation itself was responsible for NOK 48 605. This accounts for 1.99% of the total score of NOK 2 442 463. For comparison, the transportation impact for exclusively using new materials would have been NOK 1 928. 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
MBM Plural	NOK 2 442 463	90.3%	15.93s
Greedy Algorithm Plural	NOK 2 445 272	90.5%	11.12s
Greedy Algorithm	NOK 2 488 956	88.6%	6.8s

The design tool was executed with 3 algorithms, namely: MBM Plural, Greedy Algorithm Plural, and Greedy Algorithm. The MBM Plural yielded the lowest score, as shown in the table. The substitutions by this algorithm was completed in 15.926 seconds.