NTNU

June 06, 2023

Results from the Design Tool

Project name: Con_lowest_benchmark

Construction site located at: 53.463, -2.295

Summary of results

Total score	Score without reuse	Savings	Substitutions
NOK 50 723 073	NOK 50 781 640	0.12%	40.65%

The best results was obtained by the following algorithm: MBM Plural. This algorithm sucessfully substituted 935/2300 (40.65%) of the demand elements with reusable elements. Using 'Combined' as the optimization metric, a total score of NOK 50 723 073 was achieved. For comparison, a score of NOK 50 781 640 would have been obtained by employing exclusively new materials. This resulted in a total saving of 0.12%, which corresponds to NOK 58 566. Note that impacts of transporting the materials to the construction site was accounted for and contributed to 0.17% of the total score. Open the Excel file "Con_lowest_benchmark_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	0.02975	NOK/kgCO2eq
Price new timber	289.0	NOK/m^3
Price reusable timber	289.0	NOK/m^3
Price new steel	5.695	NOK/kg
Price reusable steel	5.695	NOK/kg
GWP transportation	89.6	g/tonne/km
Price of transportation	0.34	NOK/tonne/km

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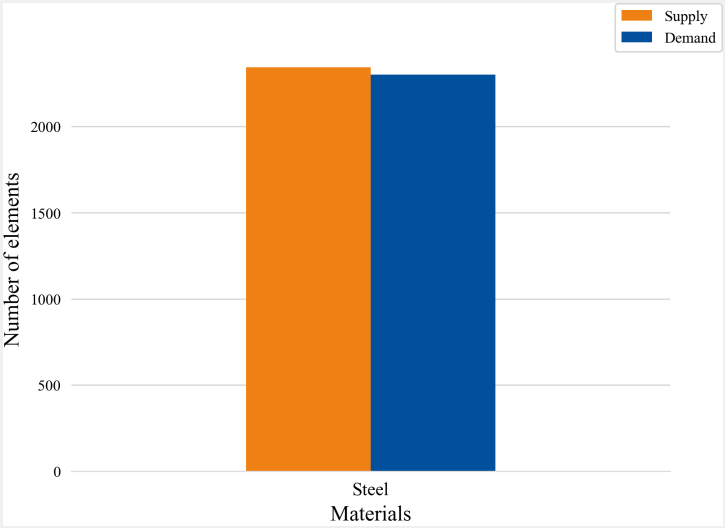
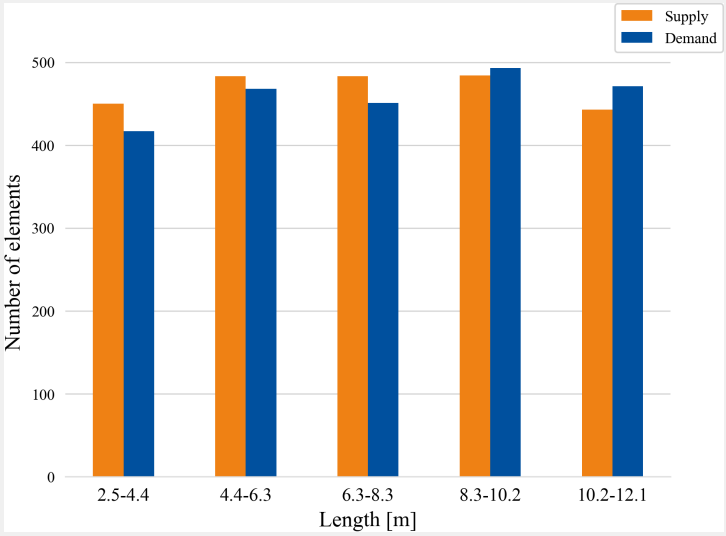
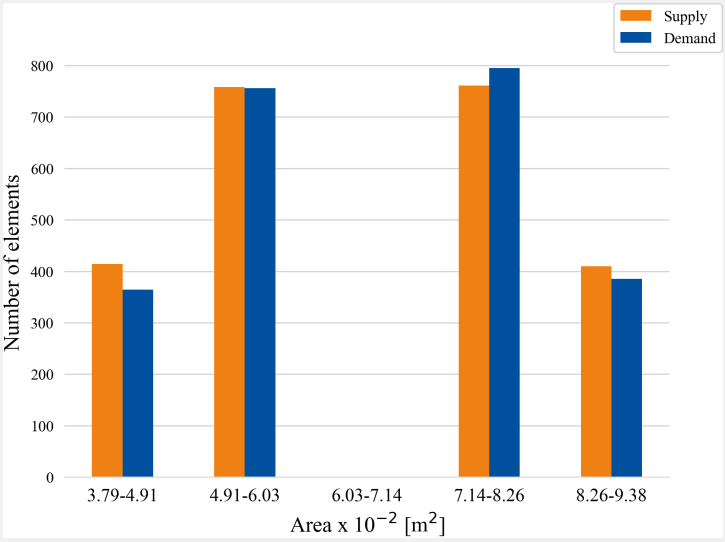
Information about the datasets

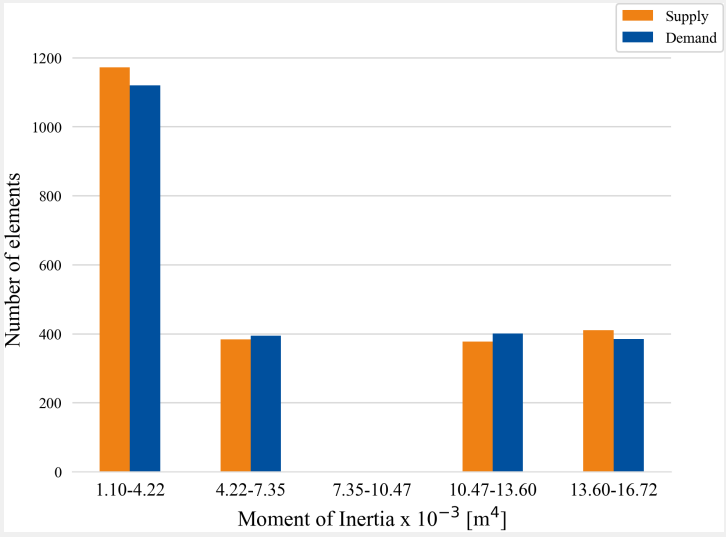
Elements	Filename	Number of elements
Supply	con_new_supply.xlsx	2343
Demand	con_new_demand.xlsx	2300

The datasets contains 2343 supply elements and 2300 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.





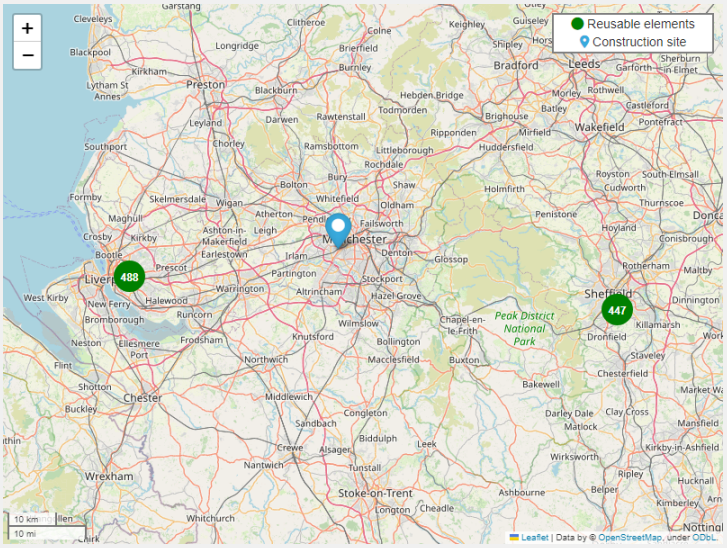


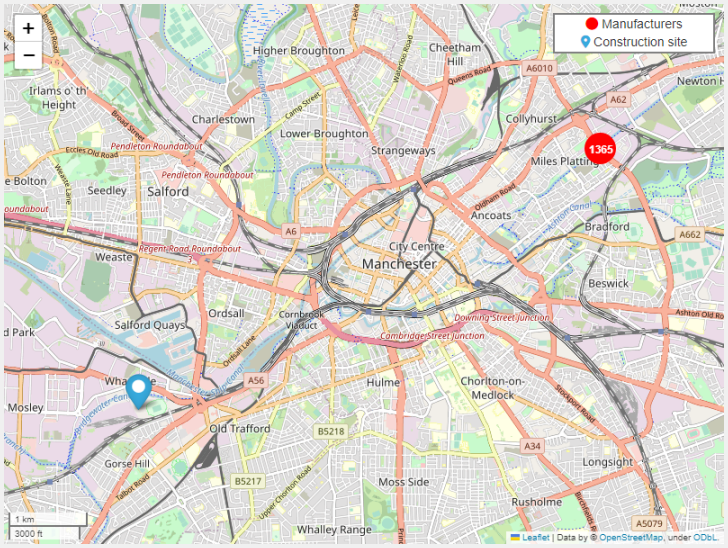


Impact of transportation

Utilizing reusable elements	Percentage of total score	Only manufactured elements
NOK 86 054	0.17%	NOK 26 940

All calculations in this report accouned for the effects of material transportation to the construction site. Transportation itself was responsible for NOK 86 054. This accounts for 0.17% of the total score of NOK 50 723 073. For comparison, the transportation impact for exclusively using new materials would have been NOK 26 940. 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 50 723 073	40.65%	265.81s
Greedy Algorithm Plural	NOK 50 723 073	40.65%	522.43s

The design tool was executed with 2 algorithms, namely: MBM Plural, and Greedy Algorithm Plural. The MBM Plural yielded the lowest score, as shown in the table. The substitutions by this algorithm was completed in 265.808 seconds.