NTNU

May 21, 2023

Results from Element Matching

Project name: ASUS

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 demand elements (44.2%). 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%. 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 CSV-file "ASUS_Study_Case_3_substitutions.xlsx" to examine the substitutions.

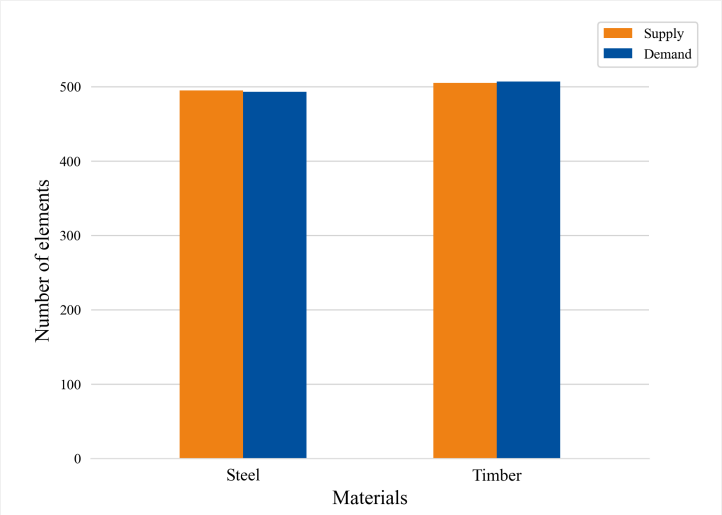
Constants used in calculations

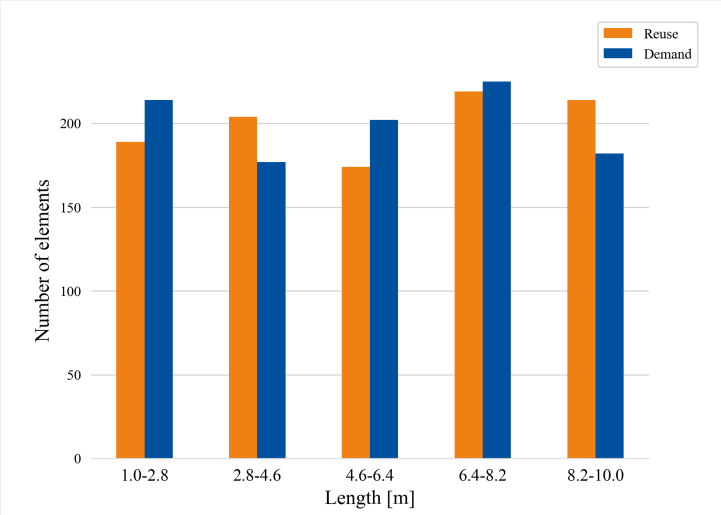
Constant	Value	Unit
Density timber	491.0	kg/m^3
Density steel	7850.0	kg/m^3
GWP new timber	28.9	kgCO2eq
GWP reused timber	2.25	kgCO2eq
GWP new steel	9263.0	kgCO2eq
GWP reused steel	278.0	kgCO2eq
Valuation of GWP	0.7	NOK/kgCO2eq
Price new timber	3400.0	NOK/m^3
Price reused timber	3400.0	NOK/m^3
Price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

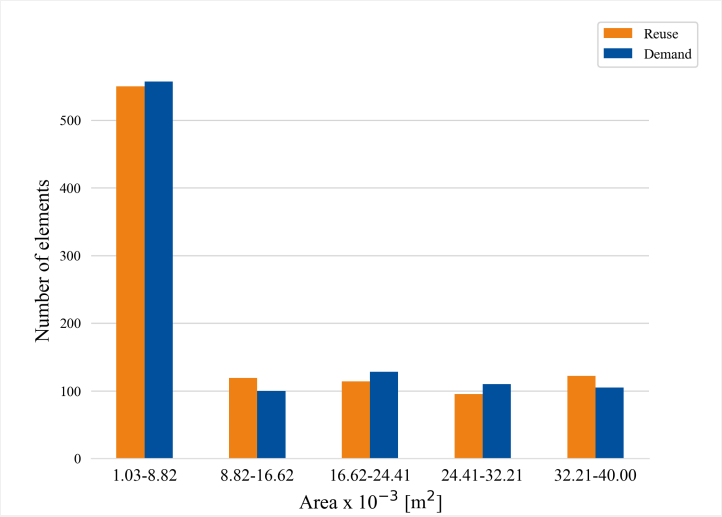
Information about datasets

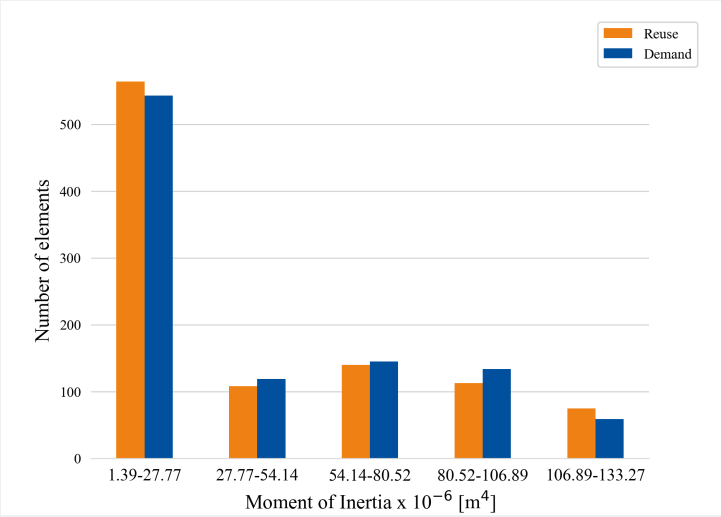
Elements	Filename	Number of elements
Reused	master_thesis_supply.xlsx	1000
Demand	master_thesis_demand.xlsx	1000

The files used contains 1000 reuse elements and 1000 demand elements. The graphs below depicts the distribution of some of the properties of the elements, including the materials, lengths, areas, and moment of inertias.





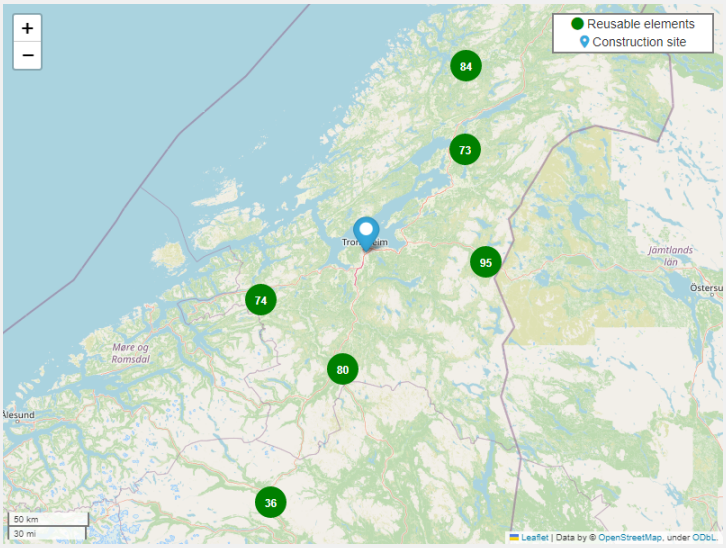


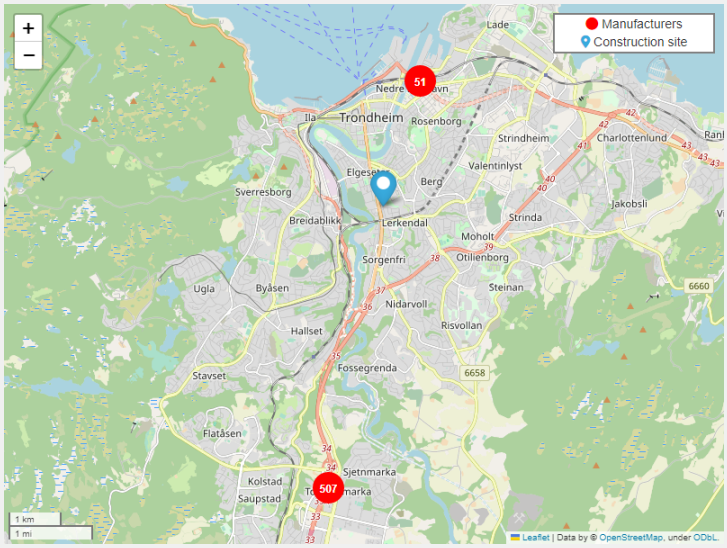


Impact of transportation

Transportation score	Percentage of total score	Transportation all new
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 location of the suggested substitutions of reused elements and the manufacturer locations where new elements can be obtained. The numbers on the maps indicate the number of elements present at each location.





Performance of algorithms

Name	Total score	Substitutions	Time
MBM Plural 4 292 438 .37 12.216 Greedy Algorithm Plural	Greedy Algorithm	44.2%	4 292 427 .09s
MBM Plural 4 292 438 .37 12.216 Greedy Algorithm Plural	Greedy Algorithm	44.0%	4 292 438 .37s
MBM Plural 4 292 438 .37 12.216 Greedy Algorithm Plural	Greedy Algorithm	42.8%	4 292 518 .59s

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 26.376 seconds.