NTNU

May 09, 2023

Results from Element Matching

Project name: Testing PDF

Construction site located at: 63.4154, 10.3995

Summary of results

Total score	Score without reuse	Savings	Substitutions
1430.04 kg CO2 equivalents	7 570 kg CO2 equivalents	81.11%	85.0%

The 'MILP' algorithm yields the best results, substituting 85/100 demand elements (85.0%). Using 'GWP' as the optimization metric, a total score of 1430.04 kg CO2 equivalents is achieved. For comparison, a score of 7570.5 kg CO2 equivalents would have been obtained by employing exclusively new materials. This results in a total saving of 81.11%. Note that impacts of transporting the materials to the construction site is accounted for and contributes to 3.33% of the total score. Open the CSV-file "Testing PDF_substitutions.csv" to examine the substitutions.

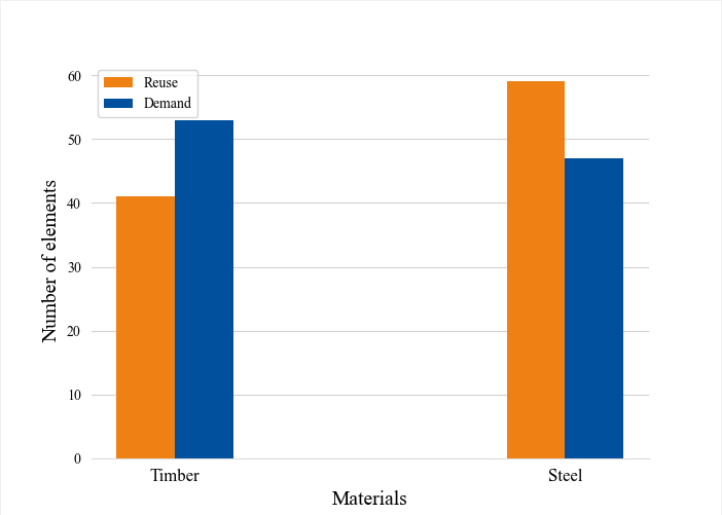
Constants used in calculations

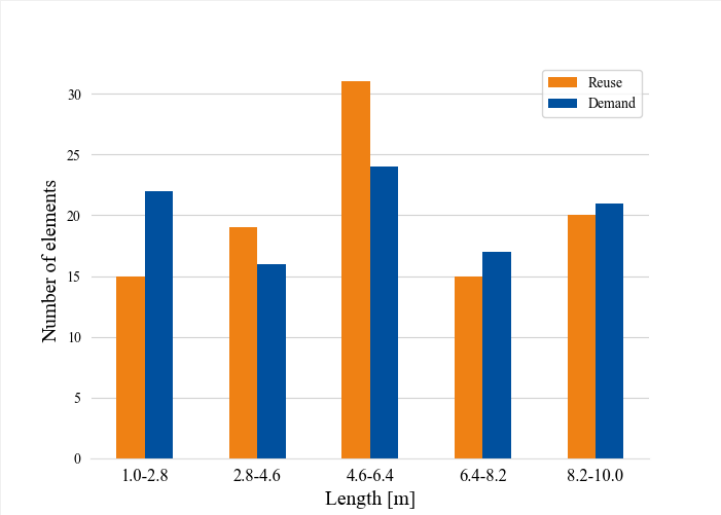
Constant	Value	Unit
Density timber	491.0	kg/m^3
Density steel	7850.0	kg/m^3
GWP new timber	28.9	kg C02 equivalents
GWP reused timber	2.25	kg C02 equivalents
GWP new steel	9263.0	kg C02 equivalents
GWP reused steel	278.0	kg C02 equivalents
GWP transportation	89.6	kg/m^3 per tonne

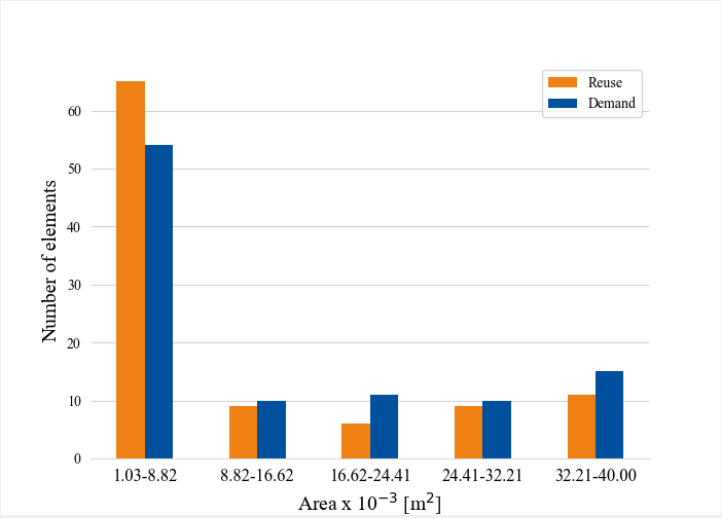
Information about datasets

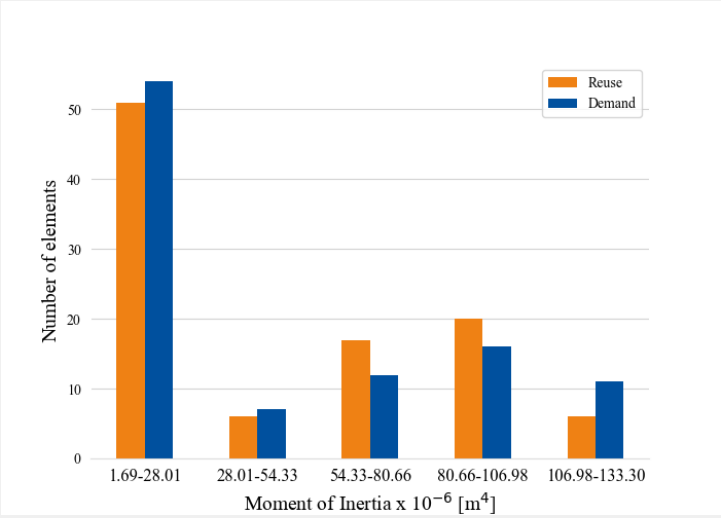
Elements	Filename	Number of elements
Reused	testing_pdf_supply.csv	100
Demand	testing_pdf_demand.csv	100

The files contains 100 reuse elements and 100 demand elements. The graphs below depicts some of the properties of the elements, including length, area, moment of inertia and the material distribution.





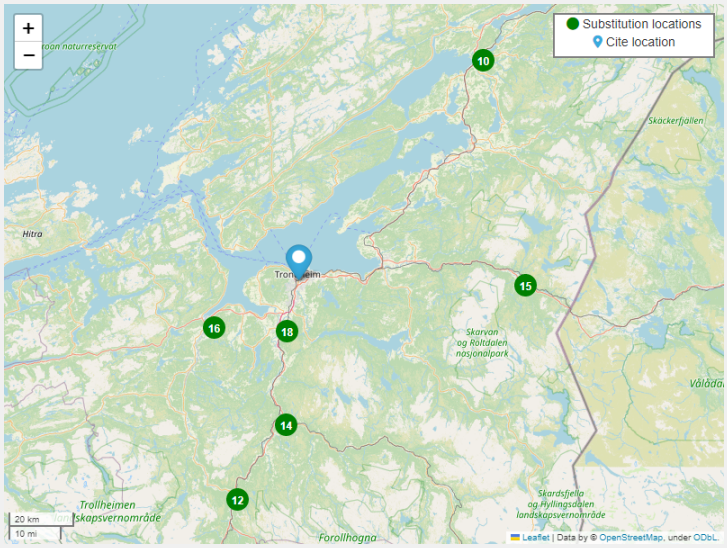


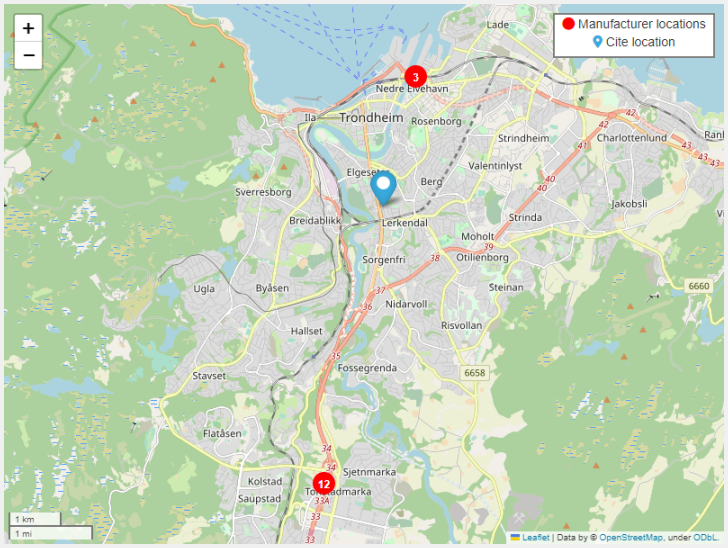


Impact of transportation

Transportation score	Percentage of total score	Transportation all new
47.67 kg CO2 equivalents	3.33%	3.86 kg CO2 equivalents

All calculations in this report take impacts of transportation of the materials to the construction site into consideration. Transportation itself is responsible for 47.67 kg CO2 equivalents. This accounts for 3.33% of the total score of 1430.04 kg CO2 equivalents. For comparison, the transportation impact for exclusively using new materials would have been 3.86 kg CO2 equivalents. 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
MILP	1430.04 kg CO2 equivalents	85.0%	4.016s
Maximum Bipartite Matching Plural	1433.26 kg CO2 equivalents	82.0%	0.109s
Greedy Algorithm Plural	1638.51 kg CO2 equivalents	78.0%	0.322s

The design tool is runned with 3 algorithms, namely: MILP, Maximum Bipartite Matching Plural, and Greedy Algorithm Plural. The MILP yields the lowest score, as shown in the table. The substitutions by

this algorithm are completed in 4.016 seconds.