NTNU

May 07, 2023

Results from Element Matching

Project name: Campus development NTNU

Construction site located at: 63.4154, 10.3995

Summary of results

Total score	Score without reuse	Savings	Substitutions
4442228.57 kr	4442355.73 kr	0.0%	15.9%

The 'Maximum Bipartite Matching Plural' algorithm yields the best results, substituting 159/1000 demand elements (15.9%). Using 'Combined' as the optimization metric, a total score of 4442228.57 kr is achieved. For comparison, a score of 4442355.73 kr would have been obtained by employing exclusively new materials. This results in a total saving of 0.0%. Note that impacts of transporting the materials to the construction site is accounted for and contributes to 0.01% of the total score. Open the CSV-file "Campus_development_NTNU_substitutions.csv" to examine the substitutions.

Constants used in calculations

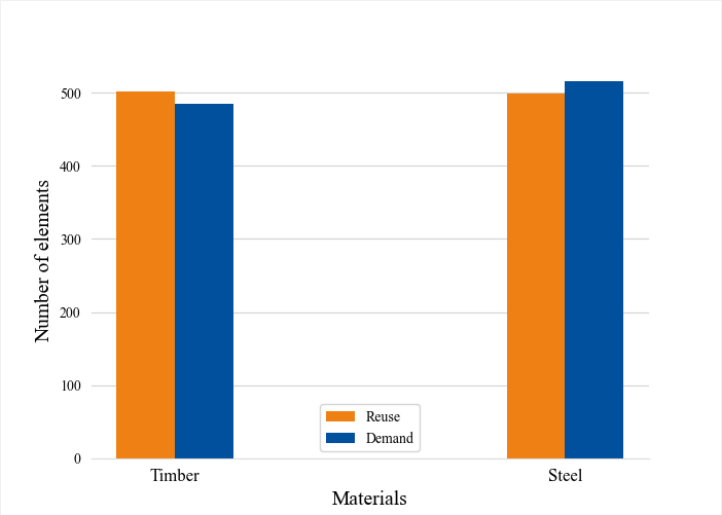
Constant	Value	Unit
Density timber	491.0	kg/m^3
Density steel	7850.0	kg/m^3
GWP new timber	28.9	kg C02 equivalents
GWP reused timber	2.25	kg C02 equivalents
GWP new steel	9263.0	kg C02 equivalents
GWP reused steel	278.0	kg C02 equivalents
Valuation of GWP	0.7	kr/kg C02 equivalents
Price new timber	3400.0	kr/m^3

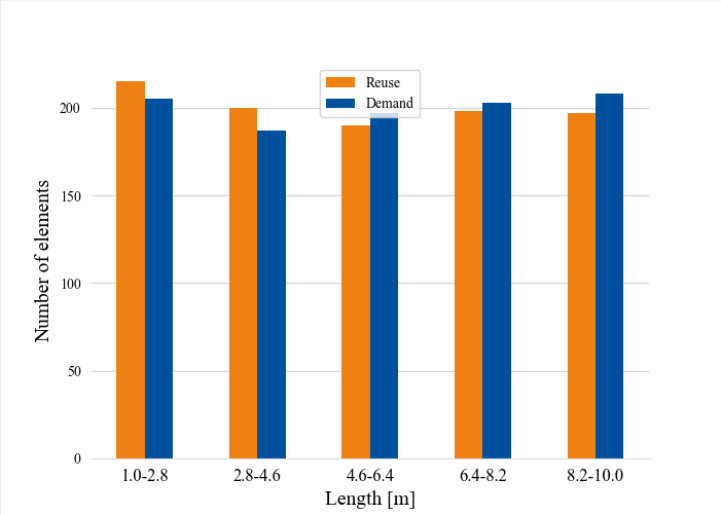
Price reused timber	3400.0	kr/m^3
Price new steel	100.0	kr/m^3
Price reused steel	100.0	kr/m^3
GWP transportation	89.6	kg/m^3 per tonne
Price of transportation	0.3	kr/km/tonne

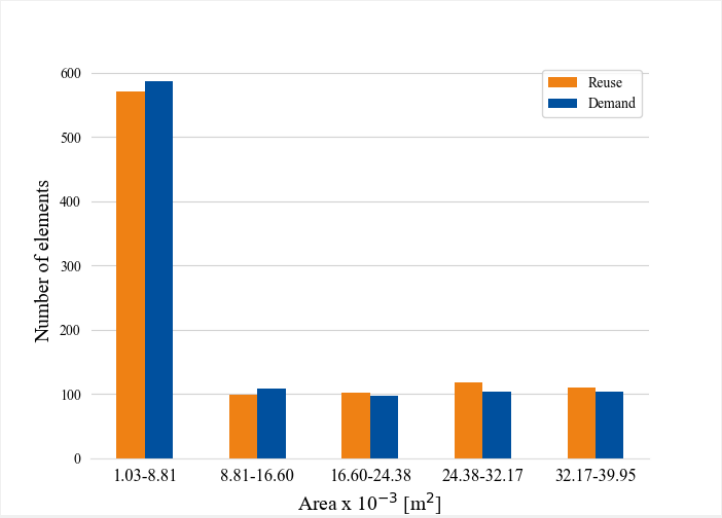
Information about datasets

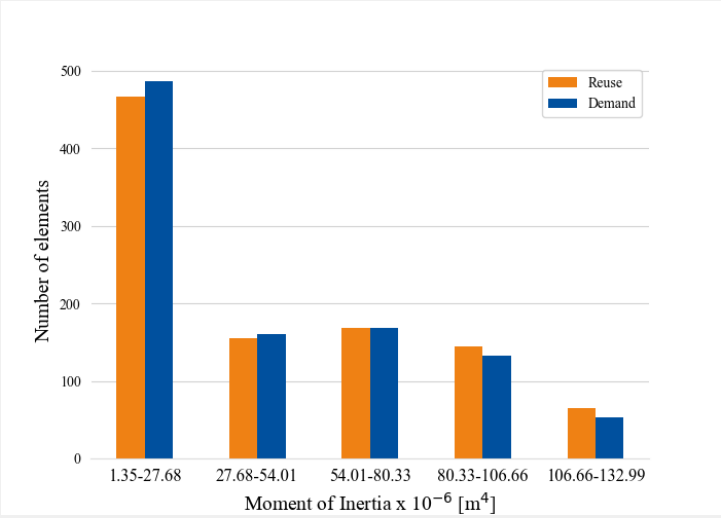
Elements	Filename	Number of elements
Reused	study_case_supply.xlsx	1000
Demand	study_case_demand.xlsx	1000

The files contains 1000 reuse elements and 1000 demand elements. The graphs below depicts some of the properties of the elements, including length, area, moment of inertia and the material distribution.





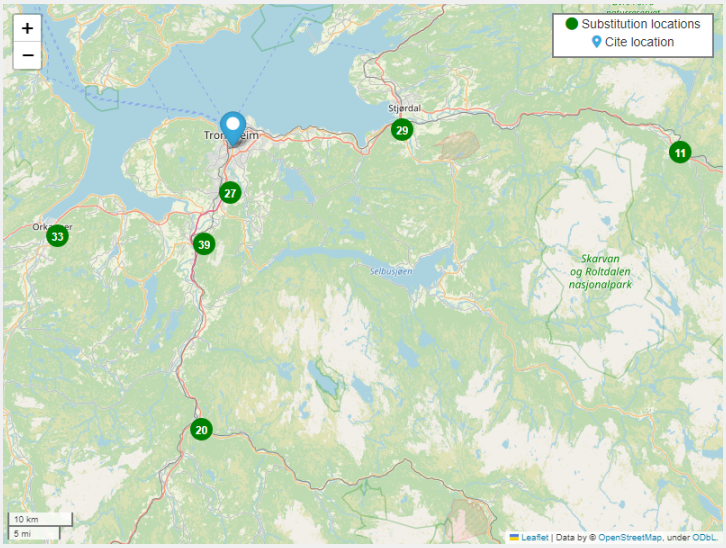


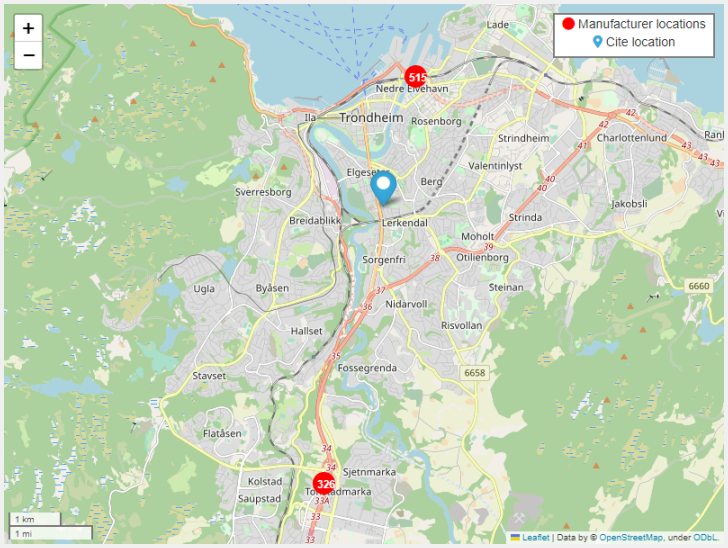


Impact of transportation

Transportation score	Percentage of total score	Transportation all new
234.66 kr	0.01%	151.82 kr

All calculations in this report take impacts of transportation of the materials to the construction site into consideration. Transportation itself is responsible for 234.66 kr. This accounts for 0.01% of the total score of 4442228.57 kr. For comparison, the transportation impact for exclusively using new materials would have been 151.82 kr. 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
Maximum Bipartite Matching Plural	4442228.57 kr	15.9%	3.27s
Maximum Bipartite Matching	4442233.58 kr	15.1%	1.456s
Greedy Algorithm Plural	4442235.96 kr	16.0%	28.706s

The design tool is runned with 3 algorithms, namely: Maximum Bipartite Matching Plural, Maximum Bipartite Matching, and Greedy Algorithm Plural. The Maximum Bipartite Matching Plural yields the

lowest score, as shown in the table. The substitutions by this algorithm are completed in 3.27 seconds.