

# Results from Element Matching

**Project name:** Campussamling Hesthagen

**Construction site located at:** 63.4154, 10.3995

## Summary of results

Total score	Score without reuse	Savings	Substitutions
4 381 977 NOK	4 382 067 NOK	0.0%	11.5%

The 'Maximum Bipartite Matching Plural' algorithm yields the best results, substituting 115/1000 demand elements (11.5%). Using 'Combined' as the optimization metric, a total score of 4 381 977 NOK is achieved. For comparison, a score of 4 382 067 NOK 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 "Campussamling Hesthagen Study Case 3\_substitutions.csv" to examine the substitutions.

## Constants used in calculations

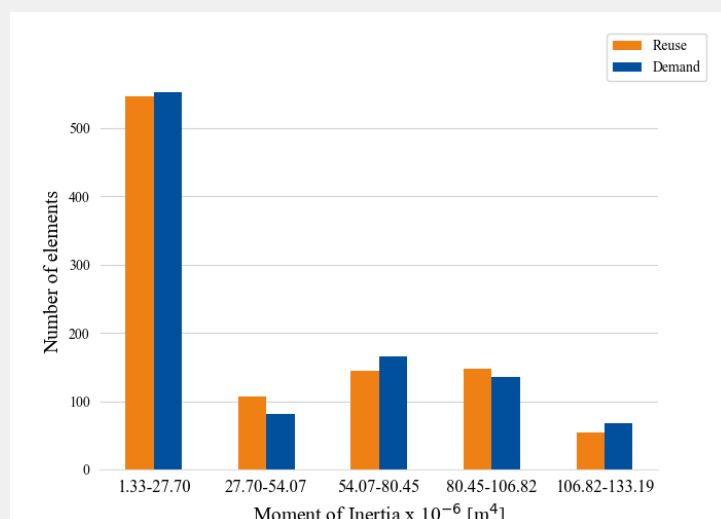
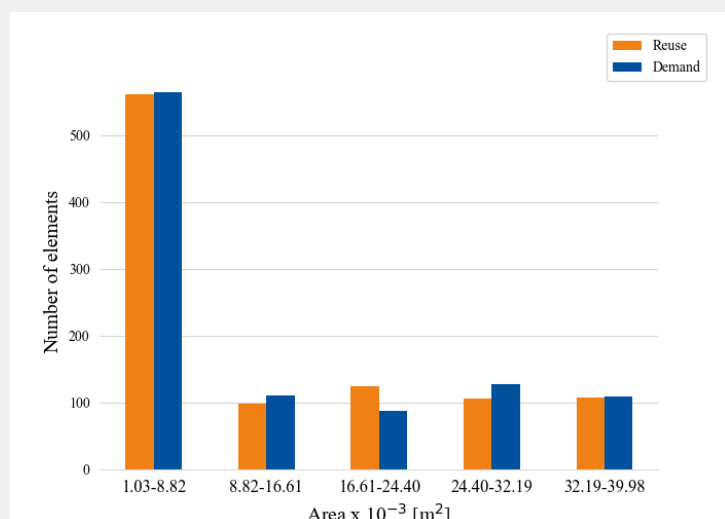
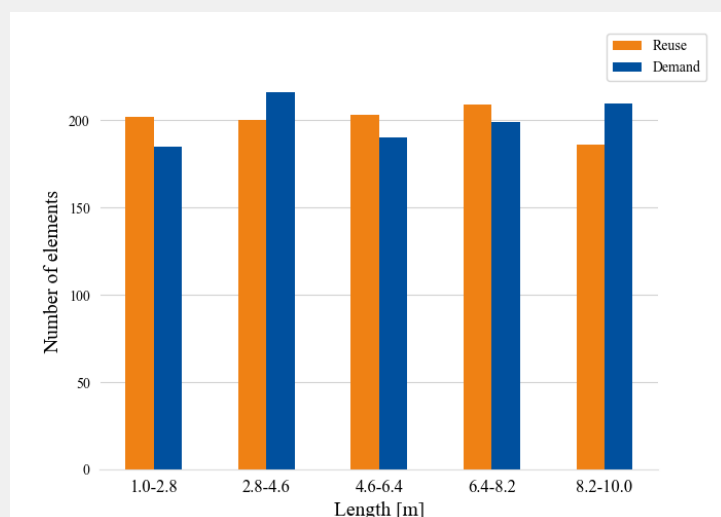
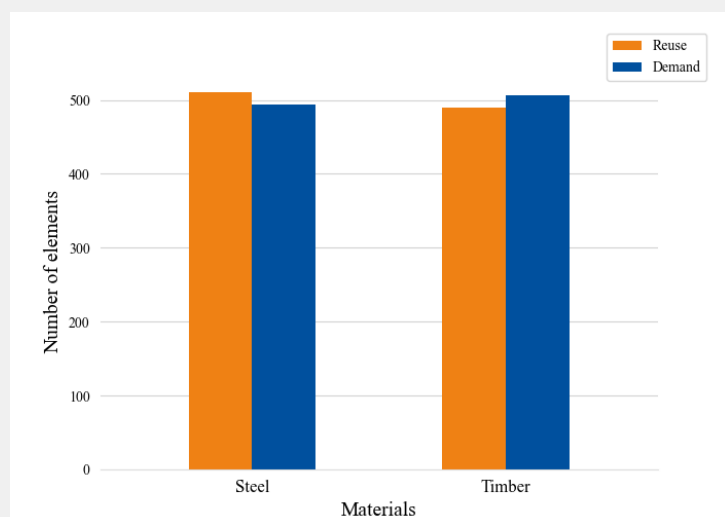
Constant	Value	Unit
Density timber	491.0	kg/m <sup>3</sup>
Density steel	7850.0	kg/m <sup>3</sup>
GWP new timber	28.9	kgCO <sub>2</sub> eq
GWP reused timber	2.25	kgCO <sub>2</sub> eq
GWP new steel	9263.0	kgCO <sub>2</sub> eq
GWP reused steel	278.0	kgCO <sub>2</sub> eq
Valuation of GWP	0.7	NOK/kgCO <sub>2</sub> eq
Price new timber	3400.0	NOK/m <sup>3</sup>

Price reused timber	3400.0	NOK/m <sup>3</sup>
Price new steel	100.0	NOK/m <sup>3</sup>
Price reused steel	100.0	NOK/m <sup>3</sup>
GWP transportation	89.6	g/tonne/km
Price of transportation	0.3	NOK/tonne/km

## Information about datasets

Elements	Filename	Number of elements
Reused	master_thesis_study_case_supply.csv	1000
Demand	master_thesis_study_case_demand.csv	1000

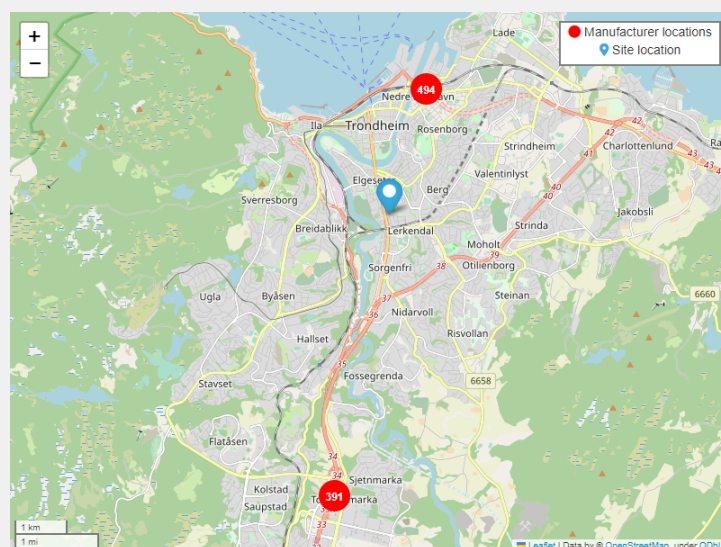
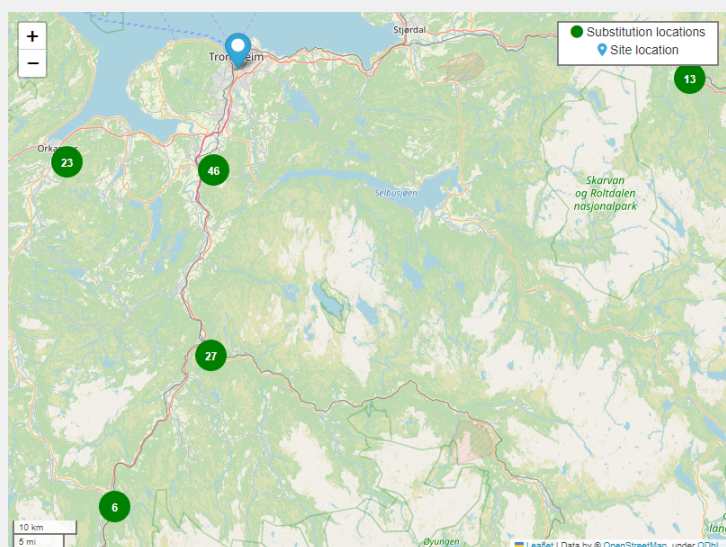
The files contains 1000 reuse elements and 1000 demand elements. The graphs below depicts some of the properties of the elements, including length, area, moment of inertia and the material distribution.



## Impact of transportation

Transportation score	Percentage of total score	Transportation all new
234 NOK	0.01%	153 NOK

All calculations in this report take impacts of transportation of the materials to the construction site into consideration. Transportation itself is responsible for 234 NOK. This accounts for 0.01% of the total score of 4 381 977 NOK. For comparison, the transportation impact for exclusively using new materials would have been 153 NOK. 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	4 381 977 NOK	11.5%	2.683s
Greedy Algorithm Plural	4 381 982 NOK	11.6%	27.272s
Greedy Algorithm	4 381 985 NOK	11.0%	15.73s

The design tool is runned with 3 algorithms, namely: Maximum Bipartite Matching Plural, Greedy Algorithm Plural, and Greedy Algorithm. The Maximum Bipartite Matching Plural yields the lowest score, as shown in the table. The substitutions by this algorithm are completed in 2.683 seconds.