

# Results from the Design Tool

**Project name:** Demo

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

## Summary of results

| Total score                | Score without reuse         | Savings | Substitutions |
|----------------------------|-----------------------------|---------|---------------|
| 7 969 kgCO <sub>2</sub> eq | 34 838 kgCO <sub>2</sub> eq | 77.12%  | 84.2%         |

The best results was obtained by the following algorithm: MBM Plural. This algorithm successfully substituted 421/500 (84.2%) of the demand elements with reusable elements. Using 'GWP' as the optimization metric, a total score of 7 969 kgCO<sub>2</sub>eq was achieved. For comparison, a score of 34 838 kgCO<sub>2</sub>eq would have been obtained by employing exclusively new materials. This resulted in a total saving of 77.12%, which corresponds to 26 868 kgCO<sub>2</sub>eq. The savings is equivalent to 260 flights for one person between Oslo and Trondheim. Note that impacts of transporting the materials to the construction site was accounted for and contributed to 5.21% of the total score. Open the Excel file "Demo\_Test\_substitutions.xlsx" to examine the substitutions.

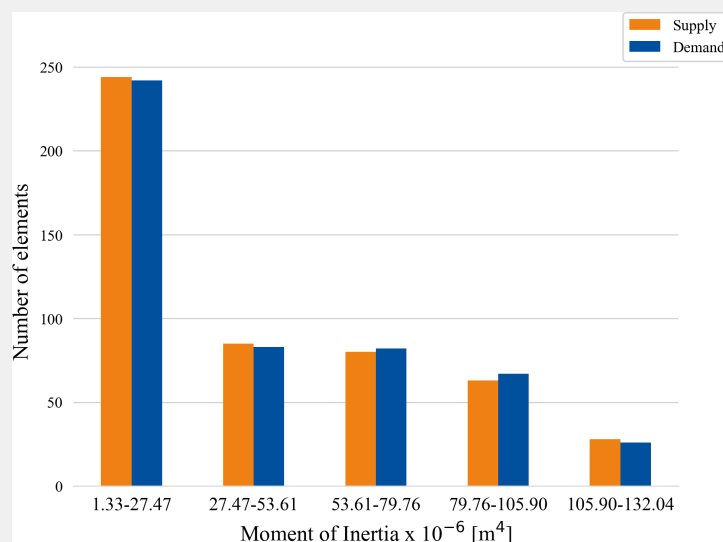
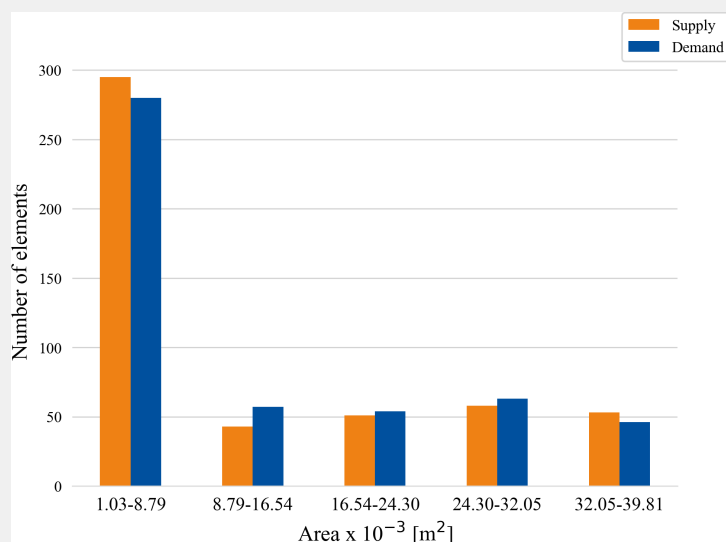
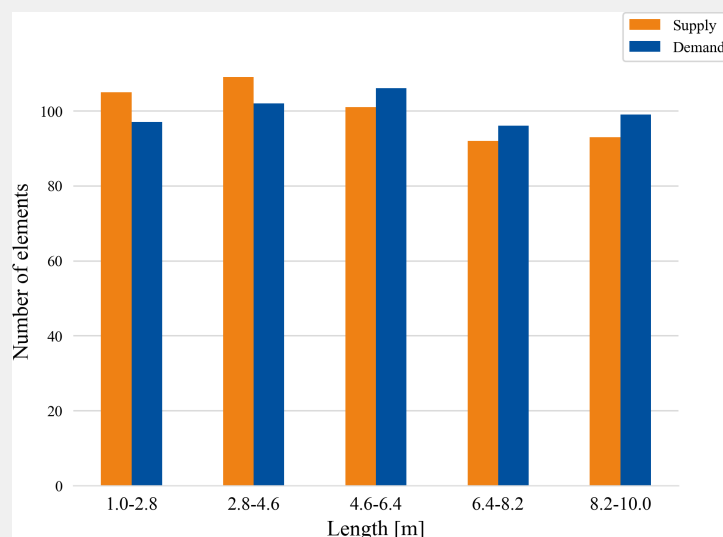
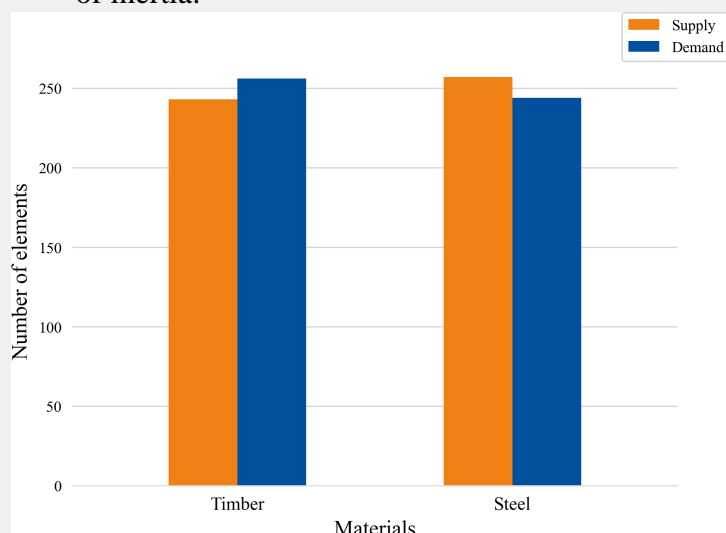
## Constants used in the calculations

| 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 reusable timber | 2.25   | kgCO <sub>2</sub> eq |
| GWP new steel       | 9263.0 | kgCO <sub>2</sub> eq |
| GWP reusable steel  | 278.0  | kgCO <sub>2</sub> eq |
| GWP transportation  | 89.6   | g/tonne/km           |

## Information about the datasets

| Elements | Filename         | Number of elements |
|----------|------------------|--------------------|
| Supply   | demo_supply.xlsx | 500                |
| Demand   | demo_demand.xlsx | 500                |

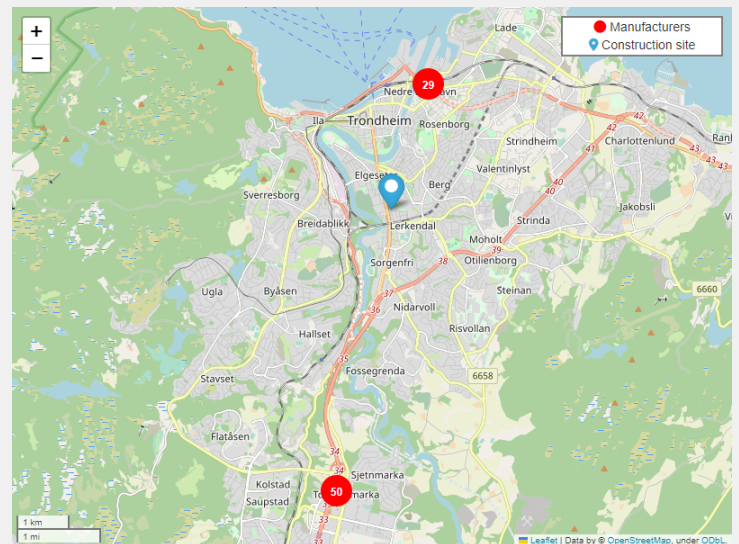
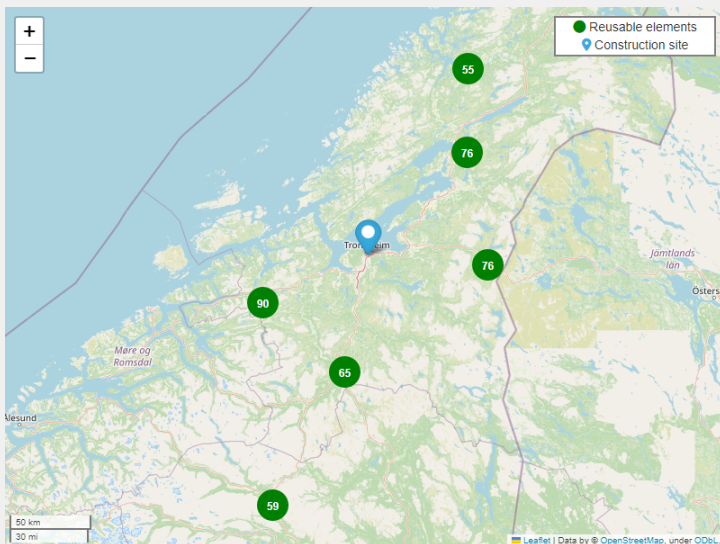
The datasets contains 500 supply elements and 500 demand elements. The graphs below depicts the distribution of some of the properties of the elements, including the material, length, area, and moment of inertia.



## Impact of transportation

| Utilizing reusable elements | Percentage of total score | Only manufactured elements |
|-----------------------------|---------------------------|----------------------------|
| 415 kgCO2eq                 | 5.21%                     | 18 kgCO2eq                 |

All calculations in this report accounted for the effects of material transportation to the construction site. Transportation itself was responsible for 415 kgCO<sub>2</sub>eq. This accounts for 5.21% of the total score of 7 969 kgCO<sub>2</sub>eq. For comparison, the transportation impact for exclusively using new materials would have been 18 kgCO<sub>2</sub>eq. 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              | 7 969 kgCO <sub>2</sub> eq | 84.2%         | 4.99s |
| Greedy Algorithm Plural | 8 209 kgCO <sub>2</sub> eq | 83.8%         | 4.8s  |
| Greedy Algorithm        | 8 212 kgCO <sub>2</sub> eq | 83.6%         | 2.38s |

The design tool was executed with 3 algorithms, namely: MBM Plural, Greedy Algorithm Plural, and Greedy Algorithm. The MBM Plural yielded the lowest score, as shown in the table. The substitutions by this algorithm was completed in 4.987 seconds.