

Summary

This design study was performed as a further development of Diverto's earthmover, a machine that can dig as well as load. The goal of the study was researching the possibility of making a full composite version of the stick, a part of the machine's arm connected to the bucket, and whether this composite version would create a great weight advantage. The study is based on theoretical calculations and the use of Microsoft Excel and Kolibri (Lightweight Structures B.V., Delft University of Technology). The main research question of the study was formulated as:

Can the existing steel stick design of the Diverto earth mover be converted to a composite stick design and will this result in a weight advantage?

First the necessary formulas needed when calculating a composite structure were gathered. After that the methodology used for the design using above stated software was described. One cross section of the stick was calculated to check the feasibility of composites in such a design. This check was positive and resulted in a big weight advantage, around 80%, for a simple cross section.

Using the same methods to calculate for different cross sections and after devising a suitable structure to cope with all these sections and with manufacturing a design was obtained. This final design has a cross section consisting of two C-sections on the top and bottom side and two straight plates at the sides for the cross section. The top and bottom plates are made of a 24 layer carbon epoxy laminate. The side plates are made of a 20 layer carbon epoxy laminate. In the middle of the cross section a core is placed making manufacturing easier and the plates resistant to wrinkling for the load cases concerned.

After this, the structure was theoretically checked on fatigue and impact resistance. Fatigue is not likely to form problems when using a carbon composite. The impact resistance is more likely to be problematic, it depends on the impact cases from practice. A number of calculations were done to show the impact resistance of the structure and a recommendation is made when using the machine in a high impact risk environment.

As a conclusion one can say that the existing steel stick design can be converted into a composite counterpart and that this will lead to a great weight advantage; the advantage for the total stick excluding cylinders and bearings is estimated to be 90 kg of the original estimated 130 kg of the stick.